# Medical investigation and Clinical Changes in the early phases of post burn adult inpatients as indicators for prompet infection diagnosis in the Hospital for Burn and Plastic Surgery, Sulaimanyah, Iraq

# Abstract

**Background:** Burn injury is adevastating formof trauma that affects human, and it is one of the leading causes of morbidity and mortality worldwide. It leavesshort or long term damages on the patients depending on how severity of the injury.

# Aim of the study

To elaborate on the early laboratory and microbial culture changes in adult burn inpatients, and to make use of subtle changes in the laboratory investigations, to predict and detect infections in burn victims in its early phases.

**Patients and Methods:** A Clinical observational study included a random sample of one hundred adult burn inpatients from Sulaymaniyah Burn Hospital, admited from April 2019 to January 2021, retrospectively and prospectively followed up during the course of the study.

**Results:** all patients were adults and aged ≥18 years. 51 % of them had II-III degree burns. Hematocrit decreased, total WBC count increased while platelet in most of the patients was normal .Blood urea was increased, Serum creatinine levels were normal in most of the patient in first three weeks of their admission. Both total serum protein and serum albumin levels were decrease compared to normal person. In a total of 100 patients we studied, 11 of them died. 36% of the patients who died had TBSA% of more than 60%, and 72% of them had II and III degree burns.

90% of the patients had infection, majority of the results were Gram-negative bacteria (66.8%), and (33.2%) were Gram-positive, Pseudomonas aeruginosa (32.5%) was most common gram negative. staphylococcus aureus (33.2%) was the only gram positive organism recovered. 66.6% of patients had fever during the first week, 55.5% of patients had fever in second week. Most of the patients, who had fever, were infected with S..aureus (MRSA) and Pseudomonas aeruginosa throughout the second week post burn.

**Conclusion and recommendations**; Many laboratory and microbial parameter changes occur in the early phases of post burning of which Leukocytosis can be a good predictor for infection in burns, especially when it happens in the second week and more. But it cannot distinguish gram negative from gram positive infections. To have basic background parameters for the patients and do regular rechecks to detect any change in the laboratory parameters as soon as they happen, infections in burns can be detected or suspected when subtle changes happen in these findings.

# Introduction

# Background

The skin is the largest organ of the body, it functions as a sensory organ and protects against the invasion of foreign bodies and organisms. (1, 2),it’s burn is one of the most severe form of trauma that has affected mankind since the beginning of time, but the development of since and medicine has led to more sufficient treatment and decreased mortality rate.(3). Thermal burns are the most common type of burn, composing about 86% of the burned patients that require hospitalization.(4,5,6)

## Electrical, chemical, and sun are lesser but important caused of burns in human with variable depth of injury accordingly(7-12).

Estimation of burn parts of the body may not be done accurately even by expert physicians making degree and severity calculations entiteled by many formulations and categorization authorities (13-19)

A study,USA, results showed over the first week after injury, Hb and HCT decreased. This decrease was due to loss of red blood cells. WBC counts was initially elevated but decreased over the first 4 days. PLT also decreased over the first 4 days. Non-survivors had lower Hb, HCT, and PLT over the first week compared to survivors. Non-survivors had higher WBC compared to survivors.(20)

Another study in Iraq; The total WBC count began to increase immediately after burn injury and reach the peak within 12 hours and then decreased at days 3 to 4 and then began increasing, this fluctuation in leukocyte count is due to dramatic changes within the first 72 hours after burn injury and it depends on burn size.(21)

Other studies with variable laboratory findings ( 22-24) supporting and contradicting our findings are available from different centers around the globe.

Inhalation injury and burn shock are the most common cause of death in first 48 hours after injury.(25). A significantly higher mortality rate was recorded in the group of patients aged more than 80 (26),(27).Several studies showed that size of burn has major effect on the mortality rate following burn injury at any age, the higher the TBSA% the higher risk of death..(28),(29).In severe burn injuries the function and structure of almost every organ is impaired (30-32)Critically burn patients are more likely to get infection. Bloodstream infections in the first week is called early BSI, and called late BSI during the second week and oncoming weeks.(33-39)

# Patients and Methods

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The study involved a random sample of 100adult burn patients in Sulaimaniyah burn Hospital.

April 2019 to january 2021, retrospective and prospectively. Laboratory parameter changes were chronologically monitored from the first week of admission to the date of the discharge. The laboratory parameters were statistically analyzed against back ground microbiological and clinical follow up charts so as to correlate changes in the parameters and clinical findings with possible infections.

# Results

A total of 100 patients were studied, of which 31 (28.2%) patients were male and 66 (60%) were female. The study showed that 41.8% of patient’s ages were (18-28) years old, and 7% aged more than 48 years old , and most of them were married and lived in rural areas.

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | | Frequency | Percent |
| Age range | 18-28 | 46 | 46 |
| 28-38 | 30 | 30 |
| 38-48 | 14 | 14 |
| >48 | 7 | 7 |
| Total | 97 | 97 |
| Missing\* | System | 3 | 3 |
| Total | | 100 | 100 |
| Gender | Male | 31 | 31 |
| Female | 66 | 66 |
| Total | 97 | 97 |
| Missing\* | System | 3 | 3 |
| Total | | 100 | 100 |
| Residency | City | 44 | 44 |
| Rural | 53 | 53 |
| Total | 97 | 97 |
| Missing\* | System | 3 | 3 |
| Total | | 100 | 100 |
| Marital status | Single | 28 | 28 |
| Married | 69 | 69 |
| Total | 97 | 97 |
| Missing\* | System | 3 | 3 |
| Total | | 100 | 100 |

**Table 1 Demographic Data of Burn Patient enrolled in the study.**

(\* not recorded in the case sheet)

# Degree and total body surface area

Our study showed that 25% of the patient had a TBSA of 40-50%, and 51 % of them had II-III degree burns.

|  |  |  |  |
| --- | --- | --- | --- |
| Total body surface area | | Frequency | Percentage |
|  | < 20% | 17 | 17% |
|  | 20-30% | 23 | 23% |
|  | 30-40% | 21 | 21% |
|  | 40-50% | 25 | 25% |
|  | 50-60% | 6 | 6% |
|  | >60% | 8 | 8% |
|  | | | |

**Table 2 Total body surface area of burn**

|  |  |  |  |
| --- | --- | --- | --- |
| Degree | | Frequency | Percentage |
| II | 38 | 38% |
| III | 11 | 11% |
| II-III | 51 | 51% |

**Table 3 Degree of burn**

# Effect of burn on HCT, Total WBC and PLT during the first three weeks

The results in figures (1,2,3) show Hematocrit (HCT) level, total white blood cell (WBC × 109/L), Platelet (PLT× 109/L) count.

Hematocrit level decreased in burn patients compare to normal people in all three week, especially in second and third week.

**Figure 1. HCT value during first three weeks**

Total WBC count was mostly increased in the burn patients in all three weeks compared to a normal person.

**Figure 2. Total WBC count during first three weeks**

Platelet count levels decreased in the first week then increased in second and third week, but overall it still stayed at normal range, in majority of the patients platelet count was normal but it is decreased in some of the patients.

**Figure 3. PLT count levels in first three weeks**

# Effect of burn on kidney function tests

Our study showed that blood urea levels were increased in burn patients in compare to normal subjects, the levels were decreasing gradually throughout the three weeks.

**Figure 4. Blood Urea level during first three weeks**

Serum creatinine level was normal in most of the patients, and it stayed normal in all three weeks.

**Figure 5. Serum creatinine level during first three weeks**

# Effect of burn on total serum protein and serum albumin

Our results showed that levels of total serum protein are decreased in burn patients compared to normal subjects in all three weeks.

**Figure 6. Total serum protein levels during three weeks**

Our results showed that levels of serum albumin are decreased compared to normal subjects in all three weeks.

**Figure 7. serum albumin levels during three weeks**

# Relation between Total WBC count change and Total body surface area

To detect the relation, we collected the result of total WBC during the three weeks and compared each week to the total body surface area, change in the Total WBC count has occurred, but it has no relation with total body surface area, (P > 0.05) in other words it is not statistically significant.

**Figure 8. Total body surface area and total WBC count change in the first week**

**Figure 9. Total body surface area and total WBC count change in the second week**

**Figure10. Total body surface area and total WBC count change in the third week**

# Mortality rate

In a total of 100 patients, 11 of them have died, and 89 of them survived.

**Figure 11. Mortality rate of the burn patients**

## Mortality rate according to the total body surface area and degree of burn

36% of the patients who died had TBSA% of more than 60%. And 72% of them had II and III degree burns.

**Figure 12. Mortality rate according to total body the surface area**

**Figure 13. Mortality rate according to degree of burn**

## Mortality and kidney function test

According to the results serum crieatinine levels showed statistically significant increase (P<0.05) in nonsurvivors compared to the survivors in all three weeks.

**Figure 14. mortality and serum creatinine levels**

Levels of blood urea were increased in non survivors compared to the survivors in the first and third week, but decreased in the second week. There is no statistically significant relation (P > 0.05)

**Figure 15. mortality and B.uria levels**

## Mortality rate according to total serum protein and albumin

The results show that levels of total serum protein were statistically decreased (p< 0.05) in nonsurvivors compare to the survivors in all three weeks

**Figure 16. mortality and total serum protein levels**

The levels of serum albumin showed decrease in non survivors compared to the survivors only in the first week, in second and third week there was not a significant change in their level, there is no statistically significant relation (p>0.05)

**Figure 17. mortality and serum albumin levels**

## Mortality and total WBC change

The levels of WBC count show a decreased level in the non survivors compared to the survivors in all three weeks, although there is no statistically significant relation according to the p-value (p > 0.05)

**Figure 18. mortality and total WBC change**

## Mortality and abnormalities in total WBC

The results show that most of the non survivors had leukocytosis in the first and third week, but in the second week they mostly had a normal WBC count.

**Figure 19. Mortality and abnormalities in total WBC**

# Common pathogen and bacterial infection in burn patients

Out of 100 burn patients, 90 of them had infection, a total of 14 different types of bacteria were isolated, majority of the results were Gram-negative bacteria (66.8%), and (33.2%) were Gram-posative. Pseudomonas aeruginosa (32.5%), and Klebsiella pneumonia (11%) and Acinetobacter baumannii (9.5%) were the most common gram negative organisms, and staphylococcus aureus (33.2%) was the only gram positive organism recovered.

|  |  |  |
| --- | --- | --- |
| Type of bacteria | Frequency | Percentage |
| Acinetobacter baumannii | 16 | 9.5 |
| SS. aureus | 57 | 33.2 |
| Enterobacter cloacae | 9 | 5.2 |
| Escherichia Coli | 6 | 3.4 |
| Klebsiella pneumoniae | 19 | 11 |
| Pseudomonas aeruginosa | 56 | 32.5 |
| Raultella (Kleb) terrigene | 1 | 0.5 |
| Burkholderia (Pseudo) | 1 | 0.5 |
| Cepacia (CDCEO-1 gene I) | 1 | 0.5 |
| Enterobacter aeruginosa | 1 | 0.5 |
| Serratitaliquefaciens | 1 | 0.5 |
| Pseudomonas luteola | 1 | 0.5 |
| Klebsiella oxytoca | 1 | 0.5 |
| Enterobacter skazakii | 1 | 0.5 |

**Table4.Types of bacteria**

# Types of the bacteria that cause fever in burn patients

The result show that 66.6% of patients had fever during the first week, 55.5% of them had fever in second week.

20% of the patients who had fever infected with SS.aureus (MRSA), and 17% were infecterd with Pseudomonas aeruginosa in first week, but in the second week 27% infected with SS.aureus and 24.3% of them were infected with Pseudomonas aeruginosa.

|  |  |  |
| --- | --- | --- |
| week | First week | Second week |
| Fever | 66.6% | 55.5% |
| Not fever | 12.2% | 22.2% |
| Data missing | 21.1% | 22.2% |

**Table 5. Fever of the infected patients**

|  |  |  |  |
| --- | --- | --- | --- |
| First week | | |  |
| Type of Bacteria | | fever |  |
|  | Acinetobacter baumannii (MDRO) | 4.5% |
| SS. aureus (MDRO) | 1.1% |
| Acinobacterbaumannii | 9% |
| Escherichia Coli(ESBL) | 1.1% |
| Klebsiella pneumoniae | 9% |
| Klebsiella pneumoniae ( MDRO ) | 1.1% |
| Pseudomonas aeruginosa | 17% |
| Pseudomonas aeruginosa (MDRO) | 13.6% |
| SS. aureus | 13.6% |
| SS.aureus (MRSA) | 20% |
| Burkholderia (Pseudo) | 1.1% |
| Cepacia (CDCEO-1 gene I) | 1.1% |
| Enterobacter cloacae (ESBL) | 2.3 % |
| Enterobacter cloacae | 1.1% |
| Raultella (Kleb) terrigene | 1.1% |
| Enterobacter skazakii (MDRO) | 1.1% |
| Klebsiella oxytoca | 1.1% |

**Table 6. Types of the bacteria that cause fever in first week**

|  |  |
| --- | --- |
| Second week | |
| Types of Bacteria | fever |
| Acinetobacter baumannii (MDRO) | 2.7 % |
| SS. aureus (MDRO) | 2.7 % |
| Acinobacterbaumannii | 2.7 % |
| Escherichia Coli (ESBL) | 2.7 % |
| Klebsiella pneumoniae | 13.5 % |
| Pseudomonas aeruginosa | 24.3 % |
| Pseudomonas aeruginosa (MDRO) | 18.9 % |
| SS. aureus | 5.4 % |
| SS.aureus (MRSA) | 27 % |
| Serratitaliquefaciens | 2.7 % |

**Table 7. Types of bacteria that cause fever in second week**

# Abnormalities of total WBC count during the first three weeks post burn

In the first week most of the patients had normal WBC count, but in the second week 64% of the patients had high WBC count (leukocytosis), and in the third week the patients who had high WBC count increased compared to the first and second week.

The number of the patients who had low WBC count (Leukopenia) was very low throughout the whole three week.

**Figure 20. Abnormality of total WBC count**

## Leukocytosis in burn patients who had infection

Our study showed that most of the patients who had leukocytosis were infected with pseudomonas aeruginosa and staphylococcus aureus.

|  |  |  |
| --- | --- | --- |
| Leukocytosis in first week | | |
| Types of bacteria | Frequency | Percentage |
| SS.aureus | 23 | 32.3 |
| Pseudomonas aeruginosa | 29 | 40 |
| Klebsiella pneumoniae | 7 | 10 |
| Acinobacterbaumannii | 3 | 4 |
| Enterobacter cloacae | 5 | 7 |
| Escherichia Coli | 4 | 6 |

**Table 8. Leukocytosis in the first week**

|  |  |  |
| --- | --- | --- |
| Leukocytosis in second week | | |
| Types of bacteria | Frequency | Percentage |
| SS.aureus | 33 | 35 |
| Pseudomonas aeruginosa | 35 | 37 |
| Klebsiella pneumoniae | 10 | 10.6 |
| Acinobacterbaumannii | 6 | 6.3 |
| Enterobacter cloacae | 6 | 6.3 |
| Escherichia Coli | 4 | 4.3 |
|  | | |

**Table 9. Leukocytosis in the second week**

|  |  |  |
| --- | --- | --- |
| Leukocytosis in third week | | |
| Types of bacteria | Frequency | Percentage |
| SS.aureus | 30 | 34.4 |
| Pseudomonas aeruginosa | 32 | 36.7 |
| Klebsiella pneumoniae | 10 | 11.5 |
| Acinobacterbaumannii | 9 | 10.3 |
| Enterobacter cloacae | 3 | 3.44 |
| Escherichia Coli | 3 | 3.44 |

**Table 10. Leukocytosis in the third week**

## 4.10.2. Leukopenia in burn patients who had infection

In the first week 6 patients had leucopenia, they were infected with SS.aureus, Pseudomonas aeruginosa, Klebsiella pneumonia, Enterobacterskazakii.

|  |  |  |
| --- | --- | --- |
| Leukopenia in first week | | |
| Types of bacteria | Frequency | Percentage |
| SS.aureus | 2 | 33.4 |
| Pseudomonas aeruginosa | 2 | 33.4 |
| Klebsiella pneumoniae | 1 | 16.6 |
| Enterobacter skazakii | 1 | 16.6 |

**Table 11. leukopenia in the first week**

In the second week we had 3 cases that had leucopenia, they were infected with SS.aureus, Enterobacter cloacae, Klebsiella pneumonia.

|  |  |  |
| --- | --- | --- |
| Leukopenia in second week | | |
| Types of bacteria | Frequency | Percentage |
| SS.aureus | 1 | 33.3 |
| Klebsiella pneumoniae | 1 | 33.3 |
| Enterobacter cloacae | 1 | 33.3 |

**Table 12. leukopenia in the second week**

In the third week we had one patient who had leucopenia, infected by Serratitaliquefaciens.

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# Discussion

Burn injuries are a significant cause of both mortality and morbidity, leaving the victims with lifelong physical, psychological and emotional disability. We conducted this study to identify the method of burn injuries in sulaimanyah city, and the most important factors associated with outcome of burn injuries.

In our study female to male ratio of the burn patients was nearly (2:1), this result correlates with a studyundertaken at the Al-Fayhaa Burn Centre in Basra city(40), and it is contrast to demographic research done in Karachi that reported the ratio of the burn patients was (1:1)(41), and to another study that was conducted in Alabama University in USA (42) that reported (76.3%) of the patients were male and 382 (23.7%) were female.

The reasons why females have higher risk of burn in our study may be due to their association with cooking, using unsafe cooking stove which can ignite loose clothing, and self-inflicted or interpersonal violence are also factors.

Our study showed that 41.8% of patient’s ages were (18-28) years old, and 7% aged more than 48 years old , a study by Gupta et al reported that the majority (79%) of the cases were in the 15-45 ages group (43), another study in Karachi reported that (58.2%) of the cases were 16-30 years followed by those aged between 31-45 age group(41).Therefore we can say that people aged between 16-45 years are more likely to suffer from burn injuries than any other age group.

The results showed that 25% of the patient had a TBSA of 40-50% and 51% of them had II-III degree burns.In most cases (28.7%), total body surface area burned was 16-30%, mean percentage of total body surface area burned was 35.49 ± 27.276%, which is consistent with a study by Lari et al., that reported mean body surface area burned to be 30.6% (44).

In our study Hematocrit level was deceased, especially inthe second and third week, that agrees with the study conducted in USA(20) and another one in Egypt (22). The cause of this decrease in HCT level is blood loss due to the wounds caused by burn.

In our study Total WBC count was increased in all three weeks, this correlates with the study in Egypt (22) that reported significant leukocytosis from the first day after burn, also agrees with another study in Iraq (21) and Korea (23). WBC level dramatically changes post burn injury, due to physiological trauma to the body and infection. According to our results there is no statistically significant relation between WBC count and TBSA%, but this result is constant to a studies conducted in Iraq(21) and Korea(23).

Platelet count levels showed a decreased level during the first week, and then increased in second and third week, but still stayed at normal range in all three weeks, this result is contrast with a study in Egypt (22) and a study in Korea (23).

In our study the results showed that B.urea levels were increased, and Serum creatinine level was normal, a study in Egypt that reported that B urea level was increased which stays aline with our result, but the level of Creatinine was also increased in their study, which is contrast with our result of serum creatinine(22).

Results of total serum protein and serum albumins were decreased; this correlates with a study conducted in Hilla(24) and another one in Germany(45).

According to the results of our total of 100 patients, 11 of them have died, and 89 of them survived, which is a low rate of mortality, this result correlates with a study in Basra City (40). One of the causes that has effect on increasing mortality rate is TBSA%, according to our resultsthe higher the TBSA%, the higher the mortality rate, this relates with studies conducted in Italy (28), and USA (29).

We compared some parameters between the survived and non survived groups to determine which one has effect on mortality rate, according to our results total serum protein showed a statistically significant decrease in non survivors in all three weeks, this result agrees with a study conducted in India (46). Although the level of our results on serum albumin showed a decrease in the first week, there was no statistically significant relation between the two groups, which is constant with the results of the same study in India (46) and another study in Mexico (47).

Serum crieatinine levels showed statistically significant increase in nonsurvivors compared to the survivors in all three weeks. Levels of blood urea were increased in non survivors compared to the survivors in the first and third week, but decreased in the second week, but ultimately there was no statistically significant relation.The levels of WBC count showed a decreased level in the non survivors compared to the survivors in all three weeks, but there was no statistically significant relation according to the p-value.

Out Of 100 burn patients, 90 of them had infection, a total of 14 different types of bacteria were isolated, majority of the results were Gram-negative bacteria (66.8%), and (33.2%) were Gram-posative, which correlates with a study carried out inVienna, Austria(34).

Pseudomonas aeruginosa (32.5%), and Klebsiella pneumonia (11%) and Acinetobacter baumannii (9.5%) were the most common gram negative organisms, and staphylococcus aureus (33.2%) was the only gram positive organism recovered, this relates with a study in Iran (35).

Our study show that 66.6% of theinfected patients had fever during the first week, 55.5% of them had fever in second week, so according to our results we can predict presence of infectiondepending on fever in burn patients, this result is contrast with a study done in USA (48) that reports we can’t depend on presence of fever to determine blood stream infection in severe burn patients.

20% of the patients who had fever infected with SS.aureus (MRSA), and 17% were infected with Pseudomonas aeruginosa in first week, but in the second week 27% infected with SS.aureus and 24.3% of them were infected with Pseudomonas aeruginosa.

Our results on WBC count changes during three weeks showed that in the first week most of the patients had normal WBC count, but in the second week 64% of the patients had high WBC count (leukocytosis), and 68% had leucocytosis in the third week.

The number of the patients who had low WBC count (Leukopenia) was very low throughout the whole three week.We can say leucocytosis can be relied on in predicting infection in burn patients, but leucopenia can’t, this result does not agree with a study conducted in USA(48).

Our study showed that most of the patients who had leukocytosis in the first week were infected with pseudomonas aeruginosa (40%) and staphylococcus aureus (32.3). In second the weekpseudomonas aeruginosa (37%) and staohylococcus aureus (35%). The third week pseudomonas aeruginosa (36.7%) and staphylococcus aureus (34.4%).

In the first week 6 patients had leucopenia, they were infected with SS.aureus, Pseudomonas aeruginosa, Klebsiella pneumonia, Enterobacterskazakii. The second week we had 3 cases that had leucopenia, they were infected with SS.aureus, Enterobacter cloacae, Klebsiella pneumonia. In the third week we had one patient who had leucopenia, infected by Serratitaliquefaciens.

# Conclusion and Recommendation

# Conclusion

Leukocytosis can be a good predictor for infection in burns, especially when it happens in the second week and more.But it cannot be parameter distinguishing gram negative from gram possitive infections.

Fever can be a prediction for infections, but again it cannot be used as significant finding to differentiate infection caused by gram positive orgram negative bacteria. Also fever is mostly useful to be used as a sign of infection from second or 3rd week and above. Total serum protein and serum albumins are not good predictor that there is no or little change in their levels.

Kidney function test showed a statistically significant increase in non survived patients.

Platelet count levels decreased during the first week, and then increased in second and third week. a significant decrease in platelet count which was observed in patients with moderate and severe burn injuries.

Hematocrit level changes in the second and third weeks, but it can not be a significant finding to differentiate gram positive from gram negative infection.

# Recommendation

To have basic background parameters for the patients and do regular rechecks to detect any change in the laboratory parameters as soon as they happen, infections in burns can be detected or suspected when subtle changes happen in the background laboratory findings.  
Better and more organized timely performing laboratory checks, better timing of tissue culture or swab performing with the laboratory investigations, so that more accurate correlations be found with the results of the previous procedure with the laboratory findings.

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