International Surgery Journal
*Lunawat A et al. Int Surg J. 2016 Feb;3(1):271-276*
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20160241

**Research Article**

# Predicting mortality in burns: a new scoring system

**Ajay Lunawat[1]*, Rishi Kant Vashistha[1], Vishad Patel[1], Ravindra Chhabra[2], Venkatesh Kolla[1]**

[1]Department of Surgery, SAMC, PGI, Indore, MP, India
[2]Department of Genetics, SAMC, PGI, Indore, MP, India

**Received:** 30 November 2015
**Accepted:** 18 December 2015

***Correspondence:**
Dr. Ajay Lunawat,
E-mail: drajay_lunawat@rediffmail.com



## ABSTRACT

**Background:** An analysis of various prognostic factors in burn patients was done which included age, sex, TBSA, onset of SIRS, septicemia, TLC, platelet count and grade of inhalational injury which could help in estimating the prognosis and probability of death of patients. On basis of these parameters a scoring system is designed, values of which will help in early assessment of prognosis and mortality.
**Methods:** This is cross sectional retrospective study and was carried out on 60 patients. Two groups were made one of survivors and other of non survivors with 30 patients in each group. Comparison of above mentioned parameters was done between two groups and a scoring system was designed on basis of six most significant parameters which are age, TLC, platelet count, grade of inhalational injury, TBSA and presence or absence of SIRS. Each parameter is scored according to its weightage. Scoring system has a maximum score of 420 and minimum of 60. Higher score corresponds to higher mortality.
**Results:** There was a significant difference in mean age of survivors and non-survivor. TBSA >45% showed high mortality. SIRS and sepsis was present in all non survivors. In 72% of non survivors blood culture was positive, inhalational injury was present 33.3% survivors and 53.3% non survivors and prolonged hospital stay was seen in survivors with inhalational injury. Non survivors showed leucocytosis or leucopenia; where gram negative sepsis accounted for fall in leucocytes. Survivor group did not show any persistent thrombocytopenia whereas persistent thrombocytopenia was present in non survivors. A death probability scoring system is designed which shows if score is more than 200 chance of mortality is 94%.
**Conclusions:** High mortality and poor prognosis was seen in patients of higher age group, TBSA more than 45%, presence of early SIRS. A non cumbersome death probability scoring system was developed which does not requires sophisticated techniques, equipment and investigations; can help clinicians to foresee the course of prognosis in burn patients.

**Keywords:** SIRS, TLC, Platelet, Inhalation injury, TBSA

## INTRODUCTION

Fire is boon for mankind when under control, becomes catastrophic when uncontrolled; the root of mightiest disasters mankind would have ever witnessed claiming innumerable lives. In cases of severe burns the mortality has rapidly decreased in last few decades.[1] Still even today sepsis remains major cause of mortality in burn patients.[2] All patients who are admitted in the burn ICU have reserved prognosis and are subjected to various complications. The survival rate is significantly impaired in elderly as compared to younger patients due to age associated immune dysfunction.[3] Factors responsible for development of sepsis in burn patients during course of treatment includes, severe dysfunction of immune system,[4,5] a large cutaneous bacterial load, possibility of

gastrointestinal bacterial translocation,[6] and prolonged hospitalization.

In a burn patient skin cannot act as a barrier against the entrance of micro-organisms. As the stratum corneum is also destroyed, this opens door to micro-organism and also allow them to multiply. Malfunction and destruction of langerhan's cells can further aggravate the situation by altering local immune response and making patients more susceptible to life threatening infections.[7]

This retrospective study was carried out in the burn unit of 1100 bedded tertiary care center catering to central India.

An analysis of various prognostic factors in burn patients was done which included age, burn percentage, onset of SIRS, septicemia, thrombocyte and leukocyte counts, which could help in estimating the prognosis and probability of death in the patients. Thus helping us to council the patients, their relatives and also making medical decisions easier.

On basis of above mentioned parameters a scoring system is designed, value of which will help in assessment of prognosis.

## METHODS

This cross sectional retrospective study was conducted on 60 patients admitted in our burn unit with similar total burn surface area and degree of burn. Two groups were made, one of survivors and other of non survivors, with 30 patients in each group. The prognostic factors were compared among both the groups. Randomization of patients was done by generating random number table, generated with online tool (graphpad.com).

A detailed Proforma was prepared to collect data of all patients, case files were retrieved and entry was done into master chart.

A comparison between following parameters of survivors and deceased was done- mean age, TBSA, presence of Inhalational injury, SIRS and sepsis. Leukocyte and platelet counts were compared on post burn day one, five and seven.

A scoring system was made taking six parameters (Age, TBSA, TLC, Platelet Counts, Grade of inhalational injury and SIRS) with maximum score of 420 and minimum of 60.[8] Higher the score; higher will be mortality and morbidity.

The Inclusion criteria's of the study includes as follow;

1. All patients with age >18 years
2. All flame and thermal burns (superficial to deep)
3. TBSA >35% and <60%

Exclusion criteria's of this study as follows;

1. Age <18years
2. Electrical and Chemical burns
3. Patients died before post burn day 7
4. Patients admitted after 6 hours post burn
5. Pregnant patients
6. Patients with any other co-morbidity
7. Immunocompromised patients
8. Patients with injury to visceral organs.

All patients received an unvarying regime of treatment which consisted of fluid resuscitation, nutritional support, plasma expanders and prophylactic antibiotic therapy. Wounds were dressed with topical silver sulfadiazine. Early excision of eschar and skin grafting was done in suitable patients up to 10-15% TBSA in each sitting.

Inhalational injury was confirmed by history if fire had occurred in closed space, and by bronchoscopy on the day of admission revealing soot particles below level of vocal cords, or if carboxyhemoglobin levels were high on admission.[9]

Before presenting statistics regarding SIRS and development of septicemia, we are providing definitions for classification according to the Consensus Conference of the American College of Physicians and the Society of Critical Care Medicine.[10]

1. SIRS (Systemic Inflammatory Response Syndrome) is regarded as a clinical situation when patient presents two or more of the following conditions:

- Temperature >38$^{o}$C or <36$^{o}$C
- Heart rate >90 beats/min
- Respiration >20/min or $PaCO_2$ <32 mm Hg
- Leukocyte count >12,000/mm$^3$, <4000/mm$^3$

2. Sepsis is confirmed when SIRS is present along with a documented infection site (i.e., with a positive local culture from that site). Even when the blood culture is not positive.
3. Severe sepsis considered when sepsis is associated with organ dysfunction, hypoperfusion abnormalities (e.g., lactic acidosis, oliguria, altered mental status) or hypotension.

Daily monitoring of temperature, respiratory rate, pulse rate, white cell counts, fluid requirements, and platelet counts was done.

### *Statistical analysis*

Mann Whitney U test was applied to see the difference in quantitative data in between two groups. Chi square test was used to see the difference in frequency of qualitative data in two groups. P value <0.05 was considered significant.

## RESULTS

The characteristics of survivors and non survivors are tabulated in Table 1. There was significant difference between mean ages of survivors and non survivors (p<0.0001) however there was no difference regarding gender of patients in both the groups, but results showed female predominance in incidence rate. Total burn surface area (TBSA) >45% was seen only in 23.3% of survivors while it was seen in 73.3% of non survivors (p<0.0001).

**Table 1: Demographic and clinical characteristics between survival and non-survival patients.**

| Parameter | Survivors (30) | Non-survivors (30) | P value |
|---|---|---|---|
| Mean age | 28.67± 8.16 | 40.53± 10.01 | <0.0001 |
| Gender females | 19 (63.3) | 19 (63.3) | - |
| TBSA >45% | 23.3 | 73.3 | <0.0001,9.036(2.802-29.134) |
| Blunt torso traumas | 2 (6.7) | 4 (13.3) | 0.389,2.154(0.363-12.764) |
| Inhalational injury | 10 (33.3) | 16 (53.3) | 0.118,2.286(0.804-6.4495) |
| SIRS | 10 (33.3) | 26 (86.7) | <0.0001, 13.0(3.551-47.59) |
| Sepsis | 5 (16.7) | 26 (86.7) | <0.0001,32.5(7.818-135.104 |
| Pulmonary complications | 8 (26.7) | 19 (63.7) | 0.004,4.750(1.584-14.245) |
| Tachycardia | 10 (33.3) | 27 (90) | <0.0001,18.0(4.378-74.017) |
| Hospital stay | 21.33± 8.36days | 10.17± 6.62days | <0.0001 |

All the non survivors developed SIRS while only 14(46.7%) survivors developed SIRS. Among survivors only 16.7% developed sepsis while it was 100% in non survivors, and blood culture was positive in 10% and 72.4% of them respectively (p<0.0001). There was no significant difference in inhalational injuries in two groups and it was present in 10 (33.3%) and 16 (53.3%) survivors and non survivors patients respectively (p=0.118). Non survival patients had significantly higher number of pulmonary complications as compared to survived patients. Five patients had blunt torso traumas however there was no significant association of blunt torso traumas was observed with mortality.

Mean hospital stay was found to be 21.33±8.36 days in survivors while it was 10.17±6.22 in non survivors. Among survivors presence or absence of inhalational injury in respect to mean hospital stay showed that the patients without inhalational injuries had significantly lower number of stay days (p=0.041), while among non survivors it was insignificant (p=0.812).

Table 2 shows comparison of leukocyte counts on post burn day 1, 5 and 7. On PBD 1 there was no significant difference among the groups (p=0.147), a higher value of leukocyte counts on day one was found and it was probably due to haemoconcentration. The survivor group showed leukocyte counts within normal limits by post burn day 7, whereas non survivors with gram positive sepsis showed a high leukocyte count on day 7 (17,700±12092/$mm^3$), where as many patients with gram negative sepsis showed a constant fall in the counts (6,163±5,172/$mm^3$), suggesting gram negative sepsis responsible factor for leucopenia.

**Table 2: Leukocyte counts (/$mm^3$) on post burn days.**

| | Survivors | | | Non-survivors | | | |
|---|---|---|---|---|---|---|---|
| | Gram +ve sepsis (3) | Gram –ve sepsis (2) | Non septic (25) | Gram +ve sepsis (3) | Gram –ve sepsis (20) | Mixed (4) | Non septic (3) |
| PBD 1 | 17533±6120 | 11950±4030 | 14808±4961 | 22566± 18204 | 16677± 8691 | 27550± 13770 | 14433±3669 |
| PBD 5 | 14766±4080 | 10100±2545 | 11976±3302 | 14800± 8464 | 7763± 4312 | 13900± 697 | 9466±493 |
| PBD 7 | 13933±3056 | 10100±5091 | 9932±3010 | 17700± 12092 | 6163± 5,172 | 21775± 6,839 | 7466±2150 |

Comparison of platelet counts in Table 3 shows a significant progressive decrease in platelet counts when compared to survivors on PBD 5 (p=0.001) and on PBD 7 (p<0.0001). The survivors showed no thrombocytopenia.

**Table 3: Platelet counts (N x $10^6$/$mm^3$) on post burn days.**

| | Survivors | Non-survivors | P value |
|---|---|---|---|
| PBD 1 | 3.36± 1.38 | 2.78 ± 1.043 | P<0.003 |
| PBD 5 | 2.41± 1.35 | 1.42 ± 1.14 | P<0.0001 |
| PBD 7 | 2.13± 1.15 | 0.93 ± 1.27 | P<0.0001 |

In survivor group after development of SIRS in 10 patients only 5 patients were complicated with sepsis, but none progressed to severe sepsis or MODS. While among non survivors 26 patients developed SIRS and all 26 patients showed severe sepsis and ultimately went into MODS.

**Table 4: Multinomial logistic regression analysis results.**

| Variable | P value | EXP (B) | 95%CI |
|---|---|---|---|
| Age | 0.006 | 1.214 | 1.056-1.395 |
| Sepsis | 0.008 | 39.73 | 2.605-606.066 |
| BSA >45% | 0.014 | 94.417 | 2.549-3497.39 |
| Tachycardia | 0.029 | 22.812 | 1.369-380.224 |

**Table 5: Scoring system.**

| Parameter | Score |
|---|---|
| **TLC** | |
| 4000-11000 | 0 |
| >11000 | 25 |
| <4000 | 50 |
| **PLT** | |
| >150000 | 25 |
| 100000-150,000 | 50 |
| 50000-100000 | 75 |
| <50000 | 100 |
| **Age** | |
| <25 | 25 |
| 25-35 | 50 |
| 35-45 | 75 |
| >45 | 100 |
| **Inhalation injury** | |
| Absent | 0 |
| Grade 1 | 20 |
| Grade 2 | 40 |
| Grade 3 | 60 |
| Grade 4 | 80 |
| **Total Burn surface area** | |
| <30 | 10 |
| 30-40 | 20 |
| 40-50 | 30 |
| >50 | 40 |
| **SIRS** | |
| Absent | 0 |
| Present | 50 |

Multinomial logistic regression analysis were performed to see the independent predictor of mortality within 45 days after burn and we observed that age, burn surface area >45%, presence of sepsis and tachycardia as independent predicator of mortality among burn patients (Table 4).

From the data collected we designed a simple probability scoring system shown in Table 5. Scoring system has a maximum score of 420 and minimum of 60. Mortality was seen in 94% patients with score >200. Survivors showed a mean score of 117.66±45.10 while non-survivors showed mean of 280.83±65.07. We done the pilot study of scoring system initially on 10 samples and chronbach's α test was applied to check the reliability of scores and we observed a chronbach's α >0.08 suggesting the good scoring system. Further this scoring system was applied to all the patients and we were able to predict mortality in 48 out of 50 patients.

The scoring is based on six parameters, which is as followed:

i. TLC-Normal range of TLC is given score of zero, TLC count >11000 are given score of 25 and leucopenia i.e TLC <4000 are given score of 50 indicating high fatality of leucopenia.
ii. Platelet Counts- Since lower platelet counts account for high mortality, thus in our scoring system lowest platelet count correspond to highest score (score inversely proportional to counts).
iii. Age- As per data collected in our study we inferred that with increase in age risk of mortality increased; hence age group below 25 years was given least score of 25 and above 45 years was given maximum score of 100.
iv. Inhalational Injury- Higher grade of inhalational injury showed higher mortality, score was given on scale of 0 to 80 starting from absence of inhalational injury to grade IV injury.
v. TBSA- burn surface area less than 30% is given score of 10, 30-40% is given score of 20, 40-50% is given score of 30 and more than 50% was given maximum score of 40. Showing more TBSA is associated with high mortality.
vi. SIRS- If SIRS was present a score of 50 was given.

On the basis of this scoring system which is based on simple and most essential parameters we can easily foresee the prognosis of patients. Scoring system uses basic investigations and tests, thus could be easily used in centers with minimal facilities and can be of great value.

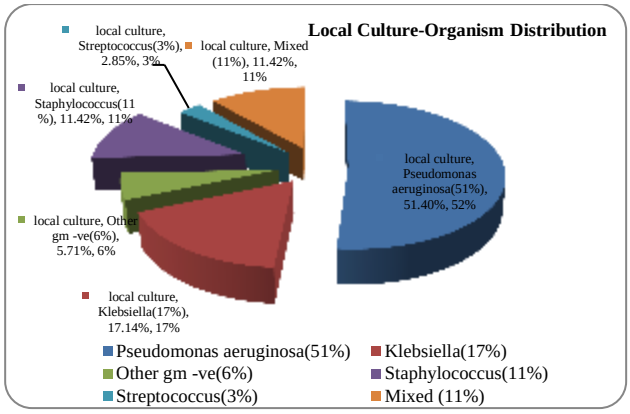


**Figure 1: Presents data of various organisms isolated from local wound.**

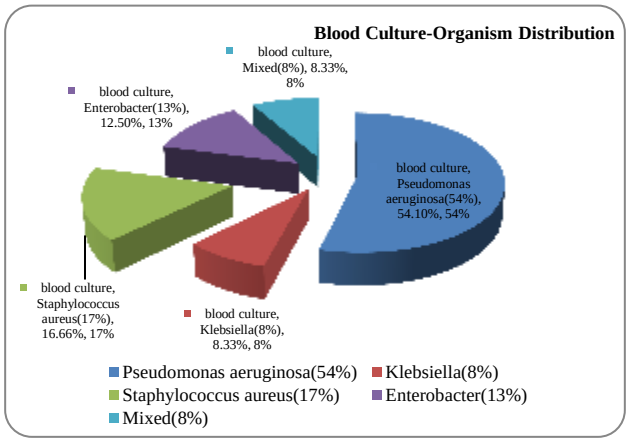


**Figure 2: Presents data of organisms isolated from blood sample.**

## DISCUSSION

Our study yielded various parameters, which are of great importance in deciding the prognosis of patients. There are various other death probability index[11,12] which are used e.g.

$$\text{Log } (\pi_i/1 - \pi_i) = \text{log}O_i = \alpha + \beta_i(I_i) + \beta_2(T_i) + \beta_3(A_i) + \beta_4(H_i) + C + E(1)$$

Where logO, is the log odds of a high mortality rate, $\beta_i (I_i)$ is the vector of the injury characteristics variables, $\beta_2 (T_i)$ is the vector of the transport variables, $\beta_3 (A_i)$ is the vector of the admission variables, and $\beta_4 (H_i)$ is the vector of the hospital course variables. C is the control variable and E is the error term.[12] Its really complex, tedious, requires high logistics and vast data with accuracy, thus there by making its use inconvenient.

Other index is based on Serum cholesterol, serum triglycerides and presence of echinocytes with toxic granules.[11] This index has low cost affectivity and puts extra burden on clinician as well as on patient financially.

Baux scoring system[13] and modified baux[14] scoring systems are already using parameter's of TBSA, age, inhalational injury in predicting mortality in burn which have shown significant importance in our study too.

It is difficult for low socio economic groups to afford the financial burden, which comprise majority of the victims.[15,16] This was the prerequisite for developing a mortality scoring system which is lucrative for patient's side; uses simple parameters, isn't cumbersome and can be applied by anyone with great ease.

Similar to our observations of leucopenia in gram negative sepsis was reported by Locke and brown.[17] Exotoxin A may be responsible for the leukopenia which accompanies pseudomonas infection.[18] A steep fall of leukocyte count was noted between day one and day seven suggestive of toxic shock syndrome and high mortality.[19] Gram negative sepsis might remain undetected for course of time until and unless leucopenia shows up. Thus clinician should not be totally dependent on counts to confirm sepsis, other parameters defining sepsis should be taken into consideration.[20] The group with mixed sepsis showed significantly high leukocyte counts (21,775± 6,839/$mm^3$).

Thus gram positive and mixed sepsis shows persistent high leukocyte counts and is strong indicator of mortality, whereas gram negative sepsis shows mixed picture with leukopenia being high.

## CONCLUSION

High mortality and poor prognosis was seen in patients of higher age group, TBSA more than 45%, presence of early SIRS and its early complication with sepsis or septicemia. Inhalational injury significantly increased the duration of hospital stay.

Probability score of more than 200 is an indicator for bad prognosis with high chances of death. Risk of death is directly proportional to the death probability score.

Gram negative septicemia remains leading cause of mortality and was predominantly caused by pseudomonas aeruginosa, can be undetectable initially and highly fatal. Prompt and adequate interventions should be taken to manage the patients.

Therefore these simple to apply non cumbersome death probability scoring system if available will be highly beneficial and handy as it does not requires sophisticated techniques, equipments and investigations; can help clinicians to foresee the course of prognosis in burn patients. Simple and easy to analyze prognostic factors will be greatly helpful for junior doctors, as well as valuable for experienced clinicians. In many parts of world where most of the burn victims belong to low socio economic status, these early mortality indicators based on routine investigations will prove to be cost effective as

they can help the clinician to explain the course of disease within few days, and help relatives to take decisions regarding continuation or termination of treatment as per the prognosis and their financial circumstances.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the institutional ethics committee*

## REFERENCES

1. Kasten KR, Makley AT. Update on critical care management of severe burns. J Intensive care Med. 2011;26(4):223-36.
2. Merrel SW, Saffle JR. The declining incidence of fatal sepsis following thermal injury. J Trauma. 1989;29:1362-6.
3. Rani M, Schwacha MG. Aging and the pathogenic response to burn. Aging Dis. 2012;3(2):171-80.
4. Munster AM. Immunologic response of trauma and burns: an overview. Am J Med. 1984;76(3A):142-5.
5. Ninneman JL. Immunological defenses against infection: alterations following thermal injuries. J Burn Care Rehabil. 1982;3:355-66.
6. Deitch EA, Berg R. Bacterial translocation from the gut: a mechanism of infection. J Burn Care Rehabil. 1987;8:475-82.
7. Belba M. Complications in severely burned patients and their development according to periods of the disease. J Annals of burns and fire disaster. 2002;15(1).
8. Dries, Endorf. Inhalation injury: epidemiology, pathology, treatment strategies. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2013;21:31.
9. Ryan CM, David S. Objective estimates of the probability of death from burn injuries. The New England Journal of Medicine. 1988;338,(6):362-7.
10. Society of Critical Care Medicine Consensus Conference. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. crit. Care Med. 1992;20:864-75.
11. Dalal R, Sharma CA, Chakravarty BB. A study of prognostic factors for prediction of complications and outcomes in burn patients. Indian J Burns. 2014;22:56-61.
12. Wolf SE, Rose JK. Mortality Determinants in Massive Pediatric Burns. J Annals of Surgery. 1997;225(5):554-69.
13. Osler T, Glance LG, Hosmer DW. Simplified estimates of the probability of death after burn injuries: Extending and updating the baux score. The Journal of trauma. 2010;68(3):690-7.
14. Osler T, Glance LG, Hosmer DW. Simplified estimates of the probability of death after burn injuries: extending and updating the baux score. J Trauma. 2010;68(3):690-7.
15. Park JO, Shin SD. Association between socioeconomic status and burn injury severity. Burns. 2009;35(4):482-90.
16. Forjuoh SN. Burns in low- and middle-income countries: a review of available literature on descriptive epidemiology, risk factors, treatment, and prevention. Burns. 2006;32:529.
17. Brown A. Studies of Burns and Scalds. MRC Special Report. 1945;249:480.
18. Stuart R, Pollack M. *Pseudomonas aeruginosa* Exotoxin A Inhibits Proliferation of Human Bone Marrow Progenitor Cells In Vitro. Infection and Immunity. 1982;206-11.
19. Brain AN, Frame JD. Early lymphopenia in burned children with and without the toxic shock syndrome. Burns. 1988;14(2):120-4.
20. Dellinger RP, Levy MM, Carlet JM. Surviving sepsis Campaign: International guidelines for management of severe sepsis and septic shock. Crit Care Med. 2008;36(1):296-327.

**Cite this article as:** Lunawat A, Vashistha RK, Patel V, Chhabra R, Kolla V. Predicting mortality in burns: a new scoring system. Int Surg J 2016;3:271-6.