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Original Research Article

Factors affecting mortality in burns: a single center study

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ABSTRACT

Background: Burns injury continues to be the greatest challenge to the trauma surgeon. A multitude of factors determine the mortality in burns patients. The present study aims at identifying those factors which have a significant impact on mortality in burns patients.
Methods: A total 80 patients presenting with burns injury were studied prospectively. Various factors which included age, sex, aetiology, mode of injury, total body surface area which is burnt (BSA), duration of stay, time interval up to admission, pregnant state, inhalation injury, systemic complications, wound complications, and psychological impact were studied.
Results: The mean age was 24.07 years. 59 were females, 21 were males. 19 (23.75%) cases were suicidal in aetiology whereas the remaining 61(76.25%) were accidental. Flame injury was the most common mode of injury in 65 patients (81.25%). The mean BSA in the study was 53.5% whereas the mean BSA in those patients who expired was 71.4%. Mean duration of stay in hospital was 6.55 days whereas mean time interval between burns injury and admission to hospital was 101.33 minutes. All 12 pregnant women had spontaneous miscarriages with a mortality in 11 patients. Inhalation injury was seen in 49 patients (61%) with mortality of 42 (83.7%) patients. Systemic complications seen in 60 patients mortality and BSA was high in patients who had infection. 31 patients in the study had severe depression with a mortality of 91.32%. 50 out of the 80 patients studied expired.
Conclusions: Increased age, BSA, mode of injury, presence of inhalation injury, systemic complication, pregnant state, wound infection and depression had a significant impact on the mortality of burns patients.

Keywords: Burns, Factors, Treatment, Complications, Mortality, Outcomes

INTRODUCTION

Burns is one of the most dreadful surgical emergency with devastating physical and financial implications. More than 2 million burn injuries occur in a year in India. It has complex consequences with increased morbidity and mortality. Mortality in the developing nations continues to be high.[1] Various factors affect the outcome in the form of mortality in burns patients. Identifying these factors will help in significantly reducing the mortality. The present study aims at identifying the various factors that influence the mortality in burns patients.

METHODS

The observational study aims at identifying potential factors that have an impact on mortality in burns patients. The factors studied are age, sex, etiology (accidental/suicidal), mode of injury (flames, scalds, electric, chemical), associated inhalation injury, total body surface area affected by burn (BSA), time interval between the injury and admission to hospital, duration of stay, pregnant state, complications (systemic and local), and psychological impact.

Inclusion criteria

All children with 10% or more BSA, adults with 15% or more BSA, patients with inhalation burns injury and pregnant women with any percentage of burns.

Exclusion criteria

Patients with known co-morbid conditions like diabetes, heart disease, etc and patients who left the hospital against medical advice.

The observational study was approved by the Institutional Ethics Committee. 80 cases presenting to a single surgical unit in a tertiary care hospital in Navi Mumbai, India over a period of 6 months from July 2019 to December 2019 were studied prospectively. Sample size was based on all patients admitted in the six month period. After admission to hospital, a detailed proforma was completed which included all the demographic data as well as details pertaining to each factor during the course of the hospital admission. Each patient was managed by uniform protocol. All patients on admission underwent preliminary procedures such as central venal access, urinary catheterization, and nasogastric decompression with a Ryle's tube. Intravenous fluid resuscitation was done using the modified Brooke's formula. Presence of facial burns, burning of facial hair, burns injury to the nostrils, singing of nasal hair was noted as evidence of inhalation burns injury. Antibiotic combination comprised of ceftriaxone and amikacin. Analgesia was achieved by administering pentazocine, phenergan and paracetomol. Injectable antacids were commenced as well. For patients with upto 20% BSA and superficial burns, open method of wound management was done which comprised of daily bathing of patient followed by application of topical Silver Sulphadiazine. Patients with more than 20% BSA were managed with closed method of dressing. After completion of initial fluid resuscitation, psychological evaluation was done. Wound management was continued taking care to avoid infection and contractures. The patients were followed up to discharge. The data collected was studied and statistically analysed.

RESULTS

Age

The mean age of the patients in the study was 24.07 (±SD 14.39) (Table 1) with a range of 9 months to 80 years. The mortality increased with advancing age. There was a significant correlation between age and mortality. ($p<0.001$)

Sex

Of the 80 cases studied, 59 were females and 21 were males. Thereby revealing a female preponderance in burns. There was no correlation between sex and outcome. (Table 2)

Table 1: Age-wise distribution of mortality.

Age group (in years)	No. of cases	Mortality	Mortality in % terms
0-10	16	3	18.75
11-20	13	9	69.23
21-30	34	25	73.52
31-40	10	6	60
41-50	4	4	100
51-60	2	2	100
> 60	1	1	100
Total	80	50	62.5

Table 2: Outcome based on sex.

Count Row Pct Col Pct	Male	Female	Total
Expired	11	39	50
Row Pct	22	78	62.5
Col Pct	52.4	66.1	
Discharged	10	20	30
Row Pct	33.3	66.7	37.5
Col Pct	47.6	33.9	
Column total **%**	21 26.3	59 73.8	80 100.0
Chi-Square	**Value**	**DF**	**Significance**
Pearson	1.24401	1	0.26570
Continuity correction	0.72747	1	0.39371
Likelihood ratio	1.22325	1	0.26872
Mantel-Haenszel test for linear association	1.22846	1	0.26771
Minimum expected frequency – 7.875 Number of missing observations: 0 The above table shows that sex of the patient does not influence the outcome.			

Etiology

Amongst the 50 cases who expired, 19 (23.75%) were suicidal and 31 (76.25%) were accidental. The mean BSA in suicidal cases was 76.26% (± SD 21.6). This was statistically significant ($p< 0.001$) (Table 3).

Mode of injury

65 (81.25%) patients had flame injuries and 15(18.75%) patients had scalds. (Table 4) Therefore, flame injury was the most common mode of injury. There were no electric or chemical burns in the patients studied.

Of the 65 patients of flame injury, 19 (29.23%) were burned by setting ablaze, 39(60%) by stove burst, 2 (3%) by candle falling on bed, 3(4.6%) by close catching fire and 2 (2%) by cylinder burst. (Table 4)

Table 3: Outcome based on aetiology.

Count Row Pct Col Pct	Male	Female	Total
Expired	11	39	50
Row Pct	22	78	62.5
Col Pct	52.4	66.1	
Discharged	10	20	30
Row Pct	33.3	66.7	37.5
Col Pct	47.6	33.9	
Column Total **%**	21 26.3	59 73.8	80 100.0
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Minimum Expected Frequency – 7.875 **Number of Missing Observations: 0** **The above table shows that sex of the patient does not influence the outcome.**			

Amongst the male patients, 15 (71.25%) sustained flame injuries while 6 (28.57%) sustained scalds, whereas in female group, 50 (84.74%) patients sustained flame injuries while 9 (15.25%) patients sustained scalds. (Table 4).

Table 4: Distribution of patients based on mode of injury.

Mode of Injury	No. of patients	%
Flame	65	81.25
Scald	15	18.75
Electric	0	0
Chemical	0	0
Total	80	
Mode of flame injury	**No. of patients**	**%**
Setting ablaze	19	29.23
Stove burst	39	60.00
Candle falling on bed	2	3.07
Clothes catching fire	3	4.61
Cylinder burst	2	3.07
Total	65	

With respect to the age-wise distribution of mode of injury, flame injuries were common in age group 21-30 years whereas scalds were common in age group 0-10 years.

Table 5: BSA.

	No. of cases	Mean	SD	SE of Mean	
Expired	50	70.4600	21.614	3.057	
Discharged	30	25.2333	10.855	1.982	
Total	80				
Mean difference = 45.2267, Levene's test for equality of variances: F= 22.555; p=0.000, t-test for equality of means 95%					
Variances	**t-value**	**df**	**2-Tail sig**	**SE of diff**	**CI for diff**
Equal	10.66	78	0.000	4.241	(36.781, 53.672)
Unequal	12.41	76.13	0.000	3.643	(37.969, 52.484)

BSA

Of the 80 cases studied, the mean BSA was 53.5% ranging from 10-100%. In the patients who expired (n=50), the mean BSA was 70.46% which was found to be statistically significant (p<0.001). (Table 5)

Time interval from injury to hospital admission

The mean time interval between sustaining the injury and admission to hospital was 102.31 minutes. 98.75% of the patients presented within 24 hours of the injury. Of the 50 patients who expired, the mean time interval of presentation was 80 minutes. However, the mean time of presentation in the discharge group of patients was 139 minutes. However, no significant correlation was found between time interval and outcome. (Table 6)

Pregnancy

Out of the 59 female patients studied, 12 were pregnant at the time of admission. All 12 of them had a spontaneous abortion. Of the 50 patients who expired in the female group, 11 were pregnant. (Table 7) Pregnancy is a significant risk factor which significantly increases mortality.

Inhalation injury

49 (61%) patients had inhalation injury, out of which 41 (83.7%) patients expired. Inhalation injury was found to be

a significant factor in predicting the outcome (p<0.001). (Table 8) Another observation was that the presence of inhalation injury significantly increased the chances of developing systemic complications. Of the patients who had inhalation injury, 9 developed septicaemia, 6 developed respiratory distress syndrome (RDS), 4 developed shock, and 28 had a combination of shock and RDS, whereas 2 did not develop any systemic complication. Inhalation burns injury significantly increases the chances of developing systemic complications. (Table 9)

Table 6: Time interval from injury to admission versus outcome.

	No. of cases	Mean	SD	SE of mean	
Expired	50	80.1000	70.837	10.018	
Discharged	30	139.3333	262.953	48.008	
Total	80				
Mean Difference = -59.2333, Levene's Test for Equality of Variances: F= 5.853; p=0.018, t-test for Equality of Means 95%					
Variances	**T-value**	**df**	**2-Tail sig**	**SE of diff**	**CI for diff**
Equal	-1.51	78	0.135	39.232	(-137.357, 18.890)
Unequal	-1.21	31.55	0.236	49.043	

Table 7: Pregnant state vs outcome.

Count Row Pct Col Pct	Pregnant	Not Pregnant	Total
Expired	11	39	50 62.5
Row Pct	22.0	78.0	
Col Pct	91.7	57.4	
Discharged	1	29	30 37.5
Row Pct	3.3	96.7	
Col Pct	8.3	42.6	
Column Total (%)	12 (15.0)	68 (85.0)	80 (100.0)

Chi-Square	Value	DF	Significance
Pearson	5.12418	1	0.02359
Continuity Correction	3.76471	1	**0.05235**
Likelihood Ratio	6.17397	1	0.01296
Mantel-Haenszel test for linear association	5.06013	1	0.02448
Fisher's Exact Test:			
One-Tail	0.02062		
Two-Tail	0.02593		

Minimum Expected Frequency – 4.500
Cells with Expected Frequency < 5- 1 of 4 (25.0%)
Number of Missing Observations: 0

Table 8: Inhalation injury vs mortality.

Count Row Pct Col Pct	Present	Absent	Total
Expired	41	9	50 62.5
Row Pct	82.0	18.0	
Col Pct	83.7	29.0	
Discharged	8	22	30 37.5
Row Pct	26.7	73.3	
Col Pct	16.3	71.0	
Column Total	49	31	80
%	61.3	38.8	100.0

Continued.

Chi-Square	Value	DF	Significance
Pearson	24.18784	1	0.00000
Continuity Correction	21.91266	1	0.00000
Likelihood Ratio	24.88441	1	0.00000
Mantel-Haenszel test for linear association	23.88549	1	0.00000
Minimum Expected Frequency – 11.625 Number of Missing Observations: 0 The above table shows that inhalation injury is a significant factor in predicting the outcome (p<0.001).			

Table 9: Inhalation injury vs systemic complications.

Count Row Pct Col Pct	Septicemia	RDS	Shock	Shock + RDS	Nil	Total
Inhalation Inj Present	9	6	4	28	2	49 61.3
Row Pct	18.4	12.2	8.2	57.1	4.1	
Col Pct	60.0	100.0	36.4	100.0	10.0	
Inhalation Inj Absent	6		7		18	31 38.8
Row Pct	19.4		22.6		58.1	
Col Pct	40.0		63.6		90.0	
Column Total **%**	15 18.8	6 7.5	11 13.8	28 35.0	20 25.0	80 100.0

Chi-Square	Value	DF	Significance
Pearson	46.52343	4	0.00000
Likelihood Ratio	59.20440	4	0.00000
Mantel-Haenszel test for linear association	3.47304	1	0.06238
Minimum Expected Frequency – 2.325 Cells with Expected Frequency < 5- 3 of 10 (30.0%) Number of Missing Observations: 0			

Table 10: Systemic complications vs mortality

Count Row Pct Col Pct	Septicemia	RDS	Shock	Shock + RDS	Nil	Total
Expired **Row Pct** **Col Pct**	15 30.0 100.0		7 14.0 63.6	28 56.0 100.0		50 62.5
Discharged **Row Pct** **Col Pct**		6 20.0 100.0	4 13.3 35.4		20 66.7 100.0	30 38.8
Column Total **%**	15 18.8	6 7.5	11 13.8	28 35.0	20 25.0	80 100.0

Chi-Square	Value	DF	Significance
Pearson	69.13939	4	0.00000
Likelihood Ratio	91.42952	4	0.00000
Mantel-Haenszel test for linear association	12.65045	1	0.00038
Minimum Expected Frequency – 2.250 Cells with Expected Frequency < 5- 3 of 10 (30.0%) Number of Missing Observations: 0			

Systemic complications

A combination of RDS and shock was the most common complication. Septicemia and the combination of RDS and shock were associated with a 100% mortality. It was observed that presence of systemic complications significantly increased the mortality (p<0.001) (Table 10).

Wound complications

57 (71%) patients developed infections, 3 (4%) developed infections and contractures, whereas 20 (25%) did not

develop wound complications. It was also observed that wound complications were associated with higher mortality which was statistically significant. Patients with higher BSA had higher incidence of wound complications.

Psychological impact

31 (38.75%) patients developed depression, of whom, 28 (98.32%) expired. It was observed that depression significantly increases the mortality ($p<0.001$).

Duration of stay

The mean duration of stay was 6.55 days (± SD 8.03) ranging from 1 hour to 57 days.

DISCUSSION

The mortality rate in the study was 62.5% (50/80). Various factors contributed to the higher mortality.[1-3]

Age

Mean age of the patients in the present study was 27.04 years. The mortality increased with increasing age, especially after the age of 40 years. (Table 1) This was observed in many other studies.[1-3] Aged patients are more prone to developing complications as well as have higher incidence of increased BSA. The metabolic response to injury weakens with advancing age, thereby weakening the immune response as well as increased susceptibility to infection.[1,2] Aged patients also have increased difficulty in protecting themselves at the time of injury, thereby predisposing to increased BSA and poor outcomes.[3]

Sex

In the present study, 59 were females and 29 were males. The preponderance of females is related to more kitchen activities near gas or oil run heating appliances. The mortality was high in females. However, the sex of the patient did not influence the outcome. (Table 2) This was in conformity with other studies.[4,5]

Etiology

Aetiology is an important determinant of BSA.[6,7] In the present study, 23% cases were suicidal whereas 76% were accidental. The mean BSA in suicidal cases was higher i.e. 76.26 (± SD 21.6). This was found to be higher than the overall BSA in the present study which was 53.5. This was found to be statistically significant, hence a suicidal aetiology is associated with high mortality due to increased BSA. (Table 3)

Mode of injury

In the present study, flame injuries were seen in 65 patients whereas scalding was seen in 15 patients. (Table 4) Flame injuries have a variety of mechanisms. These include cylinder burst, clothes catching fire, candles or oil lamps falling on the bed, stove bursts and setting ablaze. (Table 4) Stove injuries were most common in female patients. Stove is a traditional heating appliance used in India which runs on kerosene. The safety mechanisms are extremely poor with lack of manufacturing quality control. Therefore, bursting of the oil chamber is a common cause for severe accidental burns in women. The entire front side which includes the face, chest, and abdomen is severely burnt in stove-burst injuries. In men, 15 (71.42%) patients had flame injuries whereas 6 (28.57%) patients had scalds. Age is also a significant factor which determines the mode of injury. Scald injuries are one of the most common in the pediatric age group whereas flame injuries are more common in the adult group.[8,9]

BSA

BSA continues to be the most important determinant of outcome, especially mortality. As BSA increases, the mortality also increases.[1,2,10,11] As a large portion of body tissues are affected, thereby leading to significant fluid loss, loss of protective skin cover predisposing to infection. In the present study, the mean BSA was 70.46 in the 50 patients who expired whereas the mean BSA was 25.23 in remaining 30 patients who survived. (Table 5) BSA therefore is a significant risk factor or determinant of mortality in burns patients.

Time interval

The time interval between injury and admission to hospital is an important determinant of survival. Longer the duration, worst is the prognosis.[1,2] This is best explained on the basis of prolonged state of fluid depletion, thereby leading to continuing hemodynamic instability. Prompt fluid resuscitation is pivotal for a positive outcome. Increased insensible loss of fluid leads to hypovolemia, hypotension and multiorgan dysfunction. The dehydrated tissues are more susceptible to infection. Therefore, patients presenting late to hospital have increased incidence of wound infection. Even in patients with inhalation burns injury, the prolonged hypoxic state leads to pulmonary complications, ending with ARDS. Therefore, earlier presentation to hospital with prompt commencement of resuscitation is associated with improved survival. In the present study, 98.75% of patients presented within 24 hours of the injury. The mean time interval in patients who expired was 80.10 minutes. However, there was no significant statistical correlation between this time interval and outcome (Table 6).

Pregnancy

Out of the 59 women studied, 12 were pregnant at the time of admission. (Table 7) All 12 of them had a spontaneous miscarriage. 11 of the pregnant patients expired. This was found to be statistically significant supporting the fact that pregnancy is a risk factor which significantly increases mortality in burns patients.[12] A pregnant state leads to a

variety of hemodynamic changes. Severe burns can cause fluid depletion which compromises the hemodynamic status of both the mother and the fetus.[13] Spontaneous miscarriages add to the complexity of complications thereby increasing the mortality.[14]

Inhalation injuries

Patients who sustained burns injury in a closed space or room invariably have a component of inhalation injury.[15] Presence of facial burns, burning of facial hair, burns injury to the nostrils, singing of nasal hair are all suggestive of inhalation burns injury.[15] In the present study, 49 patients (61%) had inhalation injury of which 41 patients (83.7%) expired. This was found to be statistically significant. (Table 8) Inhalation injuries cause damage to the respiratory passages as well as gross alteration in the ventilation perfusion ratio. The respiratory defence mechanisms are damaged predisposing to severe respiratory infection. Hypersensitivity of the respiratory passages can also cause severe bronchospasm. Alteration in the gas exchange at alveolar level leads to hypo perfusion and hypoxia.[16] Hypoxia is instrumental in initiating a diffuse inflammatory process in the lungs leading to ARDS.[16,17] Therefore, prompt identification of inhalation injury with immediate treatment can undoubtedly reduce the incidence of ARDS.[18-20] In the present study, inhalation injury was associated with systemic complications which included shock due to septicaemia. The correlation was found to be statistically significant. (Table 9)

Systemic complications

Systemic complications are a known accompaniment of burns injury.[21,22] The most common complications are hypovolemic shock followed by septicaemia. The mortality in such cases is extremely high as seen in the present study. (Table 10) Inhalation burns injury complicates the problem.[23] A combination of septic shock with ARDS has an extremely high mortality.[24] Systemic complications eventually lead to multiorgan dysfunction and death.

Wound complications

A typical burns injury has 3 zones. These include zone of coagulation in the centre surrounded by zone of stasis which is adjacent to it. This is surrounded by a zone of hyperaemia. Prompt fluid resuscitation increases the circulation in the zone of hyperaemia thereby limiting the progression of the zone of stasis.[25] The damaged central portion will remain limited as long as the zone of stasis is prevented from expanding. Initially, an eschar is formed which covers the burnt wound. If the eschar is dry, it aids or helps in enhancing wound healing by offering a protective cover. However, if the depth of the burns is full thickness, the protective effect of the eschar may not help in wound healing. Infection especially hospital acquired is commonly seen in burns patients.[25,26] Therefore, meticulous wound care with barrier nursing is the key to success. In the present study, 57 (71%) patients developed infection. 3 patients developed contractures after infection. It was also observed that infection was more common in patients who had increased BSA.[27] These patients had higher mortality.

Psychological impact

The main complication in patients who survive burns injury is development of scarring which may cause significant disfigurement. This is one of the common causes for depression.[28] It is a good clinical practice to evaluate the patient's psychological status. If found depressed, treatment can be commenced immediately. Depression is associated with increased mortality as of seen in the present study. In the present study, out of the 80 cases studied, 31 patients (38.75%) developed depression during the period of admission. 28 (98.32%) of these patients expired. The correlation was found to be statistically significant. Hence commencing antidepressant therapy will perhaps reduce the severity of depression thereby improving surgical outcomes.

Duration of stay

The duration of stay in hospital in variable. It is determined predominantly by the severity of burns injury and development of complications. In the present study, the mean duration of stay was 6.55 days. However, it ranged from 1 hour to 57 days. The study has few limitations. It is limited by the sample size. The type of nursing unit for managing burns patients needs to be further studied in view of is impact on the outcome. The wound management protocol also needs further appraisal.

CONCLUSION

The factors which affect mortality in burns patients were identified based on the results of the study. These include increasing age, increased BSA, inhalation burns injury, presence of systemic burns complications, pregnant state, wound infection and mental depression. Therefore, maximum stress should be laid upon attending to these factors while treating burns patients in order to reduce the mortality.

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