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A STUDY ON CLINICO - EPIDEMIOLOGICAL PROFILE AND MORTALITY RISK FACTORS AMONG ELECTRIC BURN PATIENTS

General Surgery

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ABSTRACT

Introduction: Electrical burns are devastating injuries with significant morbidity and mortality, particularly in low- and middle-income countries. These injuries result from unsafe occupational practices and inadequate safety measures. High-voltage burns (>1000 volts) often lead to extensive tissue damage and systemic complications, while low-voltage burns (<1000 volts) primarily cause localized injuries. Both types pose unique challenges, emphasizing the need for focused research. **Objectives:** This study aimed to evaluate the clinical-epidemiological profile of electric burn patients and identify key mortality risk factors, including transport time, burn characteristics, ECG changes, and associated complications. **Methods:** A prospective observational cohort study was conducted at the Government Medical College Haldwani and Dr. Susheela Tiwari Hospital over 18 months. A total of 120 electric burn patients were included. Data were collected on demographics, burn characteristics, voltage exposure, clinical management, and outcomes. Statistical analysis was performed to determine significant associations with mortality. **Results:** The majority of patients were male (81.7%), aged 31-45 years (52.5%), and from rural areas (83.3%). High-voltage burns constituted 65% of cases, with deep burns and larger body surface area involvement significantly associated with high voltage ($p < 0.05$). ECG changes such as bradyarrhythmia were linked to higher mortality (57.2%). Elevated CK-MB and WBC levels, hypoalbuminemia, and prolonged transport times (>2 days) significantly influenced outcomes ($p < 0.05$). Mortality was higher in high-voltage burns (72.7%) compared to low-voltage burns (27.3%). **Conclusion:** High-voltage burns are associated with severe injuries, systemic complications, and increased mortality. Early intervention, comprehensive monitoring, and public health strategies are critical to improving outcomes.

KEYWORDS

Electric Burns, High Voltage, Mortality Risk Factors, ECG Changes, Hypoalbuminemia

INTRODUCTION

Electrical burns are a unique and devastating category of injuries, posing significant challenges in both clinical management and public health. [1] Characterized by their potential to cause extensive tissue damage, systemic complications, and high mortality rates, these injuries are a major health burden, particularly in low- and middle-income countries like India. [2,3] Unsafe occupational practices, inadequate safety measures, and limited access to specialized care further exacerbate the impact of electrical burns in these settings. Despite advancements in burn care, the outcomes for patients with electrical burns remain suboptimal, emphasizing the need for targeted research and improved clinical protocols. [4]

Globally, electrical burns contribute significantly to burn-related morbidity and mortality. High-voltage burns (>1000 volts) are especially severe, often leading to deep tissue destruction, multi-organ involvement, and complex systemic effects. In contrast, low-voltage burns (<1000 volts) primarily cause localized injuries but can still result in significant complications. [5,6] The unique pathophysiology of electrical burns depends on factors such as the type and strength of the current, its pathway through the body, the duration of exposure, and the resistance of the skin and tissues. These variables contribute to diverse clinical presentations, ranging from superficial flash burns to extensive necrosis and organ dysfunction. [7,8,9]

The burden of electrical burns extends beyond the physical injuries. Associated conditions, such as cardiac arrhythmias, renal failure, respiratory distress, and neurological deficits, complicate management and increase the risk of mortality. Additionally, delayed transport to healthcare facilities and the lack of awareness about specialized care protocols contribute to poor outcomes in many cases. In India, the socioeconomic impact of these injuries is profound, affecting patients and their families due to high treatment costs and prolonged recovery periods. [10,11]]

Despite the significant health burden of electrical burns, existing literature reveals gaps in understanding the epidemiological patterns, clinical profiles, and factors influencing outcomes in these patients. This study aims to bridge these gaps by exploring the clinico-epidemiological characteristics of electrical burn patients and identifying key mortality risk factors. It will also analyze the impact of transport times, hemodynamic status at presentation, ECG changes, and treatment interventions such as fluid resuscitation on patient outcomes.

By providing valuable insights into the factors influencing survival and recovery, this research seeks to guide the development of targeted clinical protocols and public health strategies, ultimately aiming to reduce the morbidity and mortality associated with electrical burns. This study aspires to contribute to the broader understanding of electrical burns and enhance the quality of care for affected patients.

MATERIAL AND METHODS

Study Design: This prospective observational cohort study was conducted to evaluate the clinico-epidemiological profile and mortality risk factors among electric burn patients.

Place of Study: The study was carried out at the Department of Plastic Surgery and General Surgery, Government Medical College Haldwani, and Dr. Susheela Tiwari Government Hospital, Haldwani, Uttarakhand.

Duration Of Study: The study spanned 18 months, commencing after approval from the Institutional Ethics Committee (IEC).

Sample Size And Sampling Method: A total of 120 electric burn patients were included using total enumeration sampling. All cases presenting during the study period, whether referred or self-reported to the Casualty of STH Hospital, were enrolled.

Inclusion Criteria

- All electric burn patients, irrespective of burn severity.
- Patients who provided informed consent to participate in the study.

Exclusion Criteria

- Patients unwilling to participate.

Methodology

This study involved detailed clinical evaluations and comprehensive data collection for all enrolled patients. Clinical variables such as age, sex, occupation, socioeconomic status (classified using the Modified

Kuppuswamy Scale), mode of injury, time since injury, transport time, primary treatment received, percentage of body surface area burned (calculated using the Lund and Browder chart), voltage exposure, hospital course, mortality, limb loss, and prognosis were recorded.

Upon admission, all patients underwent standardized interventions, including fluid resuscitation, continuous cardiac monitoring, muscle enzyme analysis, and serial electrocardiography (ECG). Surgical procedures like cleaning, dressing, fasciotomy, escharotomy, and debridement were performed based on clinical need. Limb amputations, categorized as minor (e.g., finger or toe disarticulations) or major (e.g., below-knee or mid-thigh amputations), were conducted after evaluating the line of demarcation between viable and necrotic tissue.

Each patient was followed up for one year to monitor recovery, return to work, wound healing, mortality, and complications like contractures or functional limb loss. Written informed consent was obtained, and participants were briefed about the study's objectives and procedures.

Follow-Up

Participants were closely monitored for their physical, emotional, and social recovery outcomes. Special emphasis was placed on evaluating their return to normalcy and the impact of the injuries on their overall quality of life.

RESULTS

The socio-demographic and injury characteristics of the study population are shown in Table 1. The majority of participants fall within the 31-45 age group (52.5%) and are male (81.7%). A significant proportion resides in rural areas (83.3%) and belongs to the lower socio-economic class (65.0%). Occupation-wise, unskilled laborers make up the largest group (44.2%), followed by electricians (15.0%). High-voltage burns were predominant (65.0%), with the right upper limb being the most commonly affected anatomical site (33.3%).

Table 1: Socio-Demographic and Injury Characteristics of Study Participants

Category		Frequency (n)	Percentage (%)
Age Group (in years)	1-15	15	12.5
	16-30	29	24.2
	31-45	63	52.5
	>45	13	10.8
Gender	Male	98	81.7
	Female	22	18.3
Residence	Urban	20	16.7
	Rural	100	83.3
Socio-Economic Status	Upper Class	8	6.7
	Middle Class	34	28.3
	Lower Class	78	65.0
Occupation	Unskilled Labourer	53	44.2
	Electrician	18	15.0
	Farmer	16	13.3
	Student	15	12.5
	Housewife	9	7.5
	Business	7	5.8
Voltage of Electric Burns	Low Voltage	42	35.0
	High Voltage	78	65.0
Anatomical Site Involved	Head & Neck	13	10.8
	Chest & Abdomen	28	23.3
	Right Upper Limb	40	33.3
	Left Upper Limb	18	15.0
	Right Lower Limb	11	9.2
	Left Lower Limb	9	7.5
	Perineum	1	0.8

Association of the depth and percentage of burns with the voltage of electric burns is shown in Table 2. High-voltage burns are significantly associated with deeper injuries and larger burn areas. For depth, 76.7% of deep burns occurred with high voltage, compared to 23.3% with low voltage (p-value = 0.04). Regarding burn percentage, high-voltage burns dominate in larger burn areas (>50%) with 86.2%, compared to 13.8% for low voltage (p-value < 0.001). These findings highlight the severity of high-voltage burns.

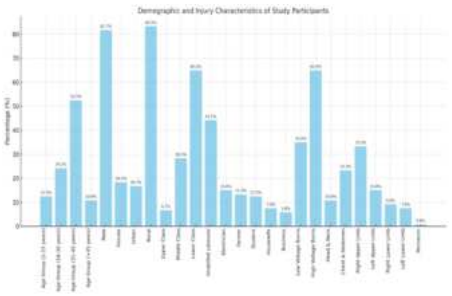
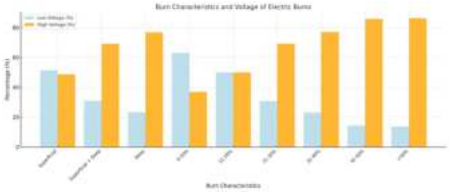


Table 2: Burn Characteristics And Voltage

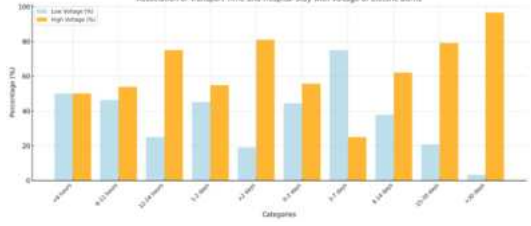
Depth of Burn	Voltage of Electric Burn				Total		X^2, df, p-value
	Low Voltage		High Voltage				
	No.	%	No.	%	No.	%	
Superficial	18	51.4	17	48.6	35	29.2	$X^2 = 6.35$, df = 2, p-value = 0.04
Superficial + Deep	17	30.9	38	69.1	55	45.8	
Deep	7	23.3	23	76.7	30	25.0	
Total	42	35.0	78	65.0	120	100.0	
% of Burn							
0-10%	17	63.0	10	37.0	27	22.5	$X^2 = 20.942$, df = 5, p-value = <0.001
11-20%	12	50.0	12	50.0	24	20.0	
21-30%	4	30.8	9	69.2	13	10.8	
31-40%	3	23.1	10	76.9	13	10.8	
41-50%	2	14.3	12	85.7	14	11.7	
>50%	4	13.8	25	86.2	29	24.2	
Total	42	35.0	78	65.0	120	100.0	



High-voltage burns are significantly associated with longer transport times and hospital stays is shown in Table 3. Most cases with transport times >2 days (81.0%) and hospital stays >30 days (96.7%) involved high-voltage burns. In contrast, low-voltage burns were more frequent in shorter transport times and hospital stays, indicating less severe injuries. These findings underline the increased severity and resource demands of high-voltage burns.

Table 3: Time-Related Factors in Mortality Risk.

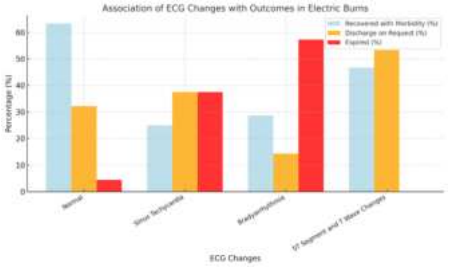
Transport Time (Days)	Voltage of Electric Burn				Total		X^2, df, p-value
	Low Voltage		High Voltage				
	No.	%	No.	%	No.	%	
<6 hours	3	50.0	3	50.0	6	5.0	$X^2 = 7.38$, df = 2, p-value = 0.02
6-12 hours	6	46.2	7	53.8	13	10.8	
12-24 hours	2	25.0	6	75.0	8	6.7	
1-2 days	23	45.1	28	54.9	51	42.5	
>2 days	8	19.0	34	81.0	42	35.0	
Total	42	35.0	78	65.0	120	100.0	
Duration of Hospital Stay (Days)							
0-2	4	44.4	5	55.6	9	7.5	$X^2 = 38.57$, df =4, p-value= <0.001
3-7	21	75.0	7	25.0	28	23.3	
8-14	11	37.9	18	62.1	29	24.2	
15-30	5	20.8	19	79.2	24	20.0	
>30	1	3.3	29	96.7	30	25.0	
Total	42	35.0	78	65.0	120	100.0	



The association of ECG changes and outcomes in electric burn patients is shown in Table 4. Normal ECG findings were the most common, with a recovery rate of 63.3% and a mortality rate of only 4.4%. Sinus tachycardia and bradyarrhythmia were associated with higher mortality rates (37.5% and 57.2%, respectively). ST segment and T wave changes showed no mortality but had the highest rate of discharge on request (53.3%). The chi-square test ($X^2 = 41.2$, $p < 0.001$) highlights a significant association between ECG changes and outcomes, underscoring the importance of cardiac monitoring in these patients.

Table 4: Association of ECG Changes with the Outcome of Electric Burn.

ECG Changes	Outcome of Electric Burn						Total		X^2, df, p-value
	Recovered with Morbidity		Discharge on Request		Expired				
	No.	%	No.	%	No.	%	No.	%	
Normal	57	63.3	29	32.2	4	4.4	90	75.0	X^2=41.2, df = 8, p-value = <0.001
Sinus tachycardia	2	25.0	3	37.5	3	37.5	8	6.7	
Bradyarrhythmia	2	28.6	1	14.3	4	57.2	7	5.8	
ST segment and T wave changes	7	46.7	8	53.3	0	0.0	15	12.5	
Total	68	56.7	41	34.2	11	9.2	120	100.0	



The association of injuries and biochemical markers with outcomes in electric burn patients is shown in Table 5. Cardiac arrest had the highest mortality (80%), while patients without associated injuries had the best recovery rate (62.1%). Elevated CK-MB levels and WBC counts >20 were associated with higher mortality rates (17.5% and 15.6%, respectively). Albumin levels of 0.8-1.5 g/dL showed better recovery (74.2%), whereas levels >3.0 g/dL had increased mortality (16.3%). Serum creatinine levels were highest among those who expired (1.29 ± 0.489). These findings emphasize the critical role of systemic complications in predicting outcomes.

Table 5: Association Of Injuries And Biochemical Markers With Outcomes In Electric Burn Patients

Associated Injury	Outcome of Electric Burn						Total		X^2, df, p-value
	Recovered with Morbidity		Discharge on Request		Expired				
	No.	%	No.	%	No.	%	No.	%	
Cardiac Arrest	1	20.0	0	0.0	4	80.0	5	4.2	X^2 = 41.59, df = 8, p-value = 0.000
Respiratory Failure	3	30.0	4	40.0	3	30.0	10	8.3	
Renal Failure	3	60.0	2	40.0	0	0.0	5	4.2	
Neurological Deficit	2	40.0	3	60.0	0	0.0	5	4.2	
No Associated Injury	59	62.1	32	33.7	4	4.2	95	79.2	
Total	68	56.7	41	34.2	11	9.2	120	100.0	
CK-MB									
Normal	52	65.0	24	30.0	4	5.0	80	66.7	X^2=8.706, df=2, p-value = 0.01
Elevated	16	40.0	17	42.5	7	17.5	40	33.3	
Total	68	56.7	41	34.2	11	9.2	120	100.0	
WBC (10^3/MICROLIT)									
4-10	8	66.7	3	25.0	1	8.3	12	10.0	X^2 = 11.19, df = 4, p-value = 0.03
10-19	43	68.3	17	27.0	3	4.8	63	52.5	
> 20	17	37.8	21	46.7	7	15.6	45	37.5	
Total	68	56.7	41	34.2	11	9.2	120	100.0	
ALBUMIN (g/dl)									
0.8-1.5	23	74.2	7	22.6	1	3.2	31	25.8	X^2=9.59, df=4, p-value = 0.05
1.6-3.0	20	50.0	18	45.0	2	5.0	40	33.3	
> 3.0	25	51.0	16	32.7	8	16.3	49	40.8	
Total	68	56.7	41	34.2	11	9.2	120	100.0	
S. Creatinine (Mean ± SD)	1.14 ± 0.348		1.26 ± 0.434		1.29 ± 0.489				

Images

Figure 1: It shows 8 years /male a/h/o high voltage electric burn accidental touching of wire while playing in ground ~ 25% electric burn of total body surface area.

Figure 2: Images A and B show 50y/male with a/h/o high voltage electric burn injury at Kicha railway line showing >80% burn of total body surface area.

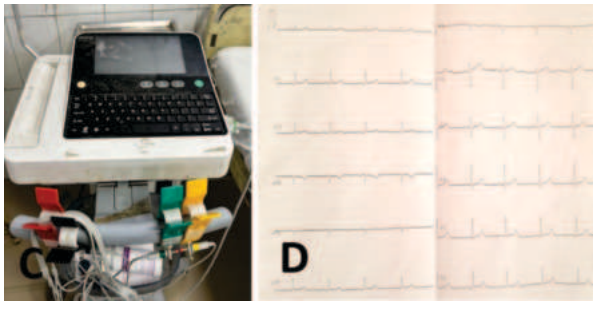


Figure 3: Images C and D show an ECG machine with Electrocardiograph showing Brady-arrhythmia

DISCUSSION

Our study analyzed the socio-demographic and clinical characteristics of electric burn patients, highlighting factors that influence outcomes. Among the participants, 52.5% were aged 31-45 years, predominantly male (81.7%), and from rural areas (83.3%). Most individuals belonged to the lower socio-economic class (65%), reflecting a vulnerable demographic. Accidental injuries accounted for 96.7% of cases, and high voltage burns were more frequent (65%) than low voltage burns (35%). These findings align with **Singh P et al. (2014) [12],** who reported a predominance of accidental injuries among industrial workers and laborers.

Anatomically, the right upper limb (33.3%) and chest/abdomen (23.3%) were the most commonly affected regions. This pattern is

consistent with **Ghavami et al. (2014) [13],** who found the upper limbs were frequently involved in electric burns. **Srivastava et al. (2018) [14]** similarly noted upper limb injuries as the most common site in electric burn patients. Regarding occupation, unskilled laborers constituted the majority (44.2%), followed by electricians (15%), indicating occupational hazards as significant risk factors.

The depth and extent of burns showed a clear association with voltage. Superficial burns were nearly evenly distributed between low and high voltage injuries, but superficial + deep burns (69.1%) and deep burns (76.7%) were more common in high voltage cases. Similarly, burns involving >50% of the body surface area were linked to high voltage injuries in 86.2% of cases. These findings align with **Latifi et al. (2017) [15]** and **Tiryaki et al. (2017) [16]**, who reported that high voltage burns were associated with extensive injuries and greater body surface area involvement.

Longer transport times and hospital stays were significantly associated with high voltage burns. For transport delays exceeding 2 days, 81% were high voltage cases. High voltage burns also accounted for 96.7% of hospital stays exceeding 30 days. These trends are consistent with **Latifi et al. (2017) [15],** who observed prolonged transport times and extended hospital stays for patients with severe high voltage injuries. The mean hospital stay in our study was 10.61 ± 8.56 days, reflecting varying recovery periods.

Our study analyzed complications such as contractures, gangrene, infections, and mortality. While gangrene (75%) and mortality (72.7%) were more frequent in high voltage burns, no statistically significant association was found between voltage and complications overall ($p = 0.73$). **Icer et al. (2016) [17],** however, observed a higher complication rate in high voltage burns, suggesting that such injuries may still pose an elevated risk of severe outcomes.

Outcomes showed a significant association with voltage ($p = 0.005$). Recovery with morbidity was the most common outcome (56.7%), but mortality was higher in high voltage burns (72.7%) compared to low voltage burns (27.3%). These findings align with **Tiryaki et al. (2017) [16],** who reported higher mortality rates and poorer outcomes in high voltage burns due to the extent and severity of injuries.

ECG changes revealed a strong link to outcomes. Bradyarrhythmia was associated with the highest mortality rate (57.2%), while sinus tachycardia and ST segment changes were also significant indicators of poor outcomes. **Ghavami et al. (2014) [13]** emphasized the importance of ECG monitoring in electric burn patients, noting that arrhythmias are critical predictors of mortality and morbidity.

Elevated CK-MB levels were significantly associated with poorer outcomes ($p = 0.01$). Patients with elevated levels had a lower recovery rate (40%) and a higher mortality rate (17.5%). This finding is consistent with **Icer et al. (2016) [17],** who reported that elevated CK-MB levels correlated with increased mortality and complications in electric burn patients.

WBC counts also significantly influenced outcomes ($p = 0.03$). Patients with counts >20 x 10^3/μL had the highest mortality rate (15.6%) and lower recovery rates. Similar findings were reported by **Tiryaki et al. (2017) [16],** who linked elevated WBC counts to systemic inflammatory response syndrome (SIRS) and sepsis, increasing the risk of poor outcomes.

Albumin levels were another important factor. Hypoalbuminemia (<1.5 g/dL) was associated with poorer outcomes, consistent with **Latifi et al. (2017) [15]**, who noted that low albumin levels indicated poor nutritional status and worse clinical recovery. Elevated serum creatinine levels were observed in patients with worse outcomes, with those who expired having the highest mean levels (1.29 ± 0.489). **Ahmed et al. (2021) [18]** also emphasized the prognostic value of creatinine in critically ill patients.

Overall, out study highlights the significant impact of high voltage burns, prolonged transport times, and physiological markers on outcomes. This study's findings supported by global studies, emphasize the need for prompt care, targeted interventions, and close monitoring of high-risk patients to improve prognosis in electric burn injuries.

CONCLUSION

In conclusion, high-voltage electric burns are associated with more severe injuries, including deeper tissue damage, larger burn areas, and prolonged hospital stays. These burns also correlate with longer transport times and increased mortality rates. ECG changes, particularly sinus tachycardia and bradyarrhythmia, were found to significantly influence patient outcomes, with more severe arrhythmias linked to higher mortality. Furthermore, systemic complications, such as cardiac arrest, respiratory failure, and renal dysfunction, play a critical role in predicting patient prognosis. The findings emphasize the importance of early intervention and comprehensive monitoring for electric burn patients.

Recommendations

This study highlights the need for targeted prevention strategies, including improved occupational safety measures and public awareness campaigns to reduce the incidence of electric burns. Additionally, early and specialized interventions, such as advanced cardiac monitoring and prompt transport to burn centers, should be prioritized to improve outcomes.

Limitations

The study was limited by its single-center design, which may affect the generalizability of findings. Furthermore, the retrospective nature of some data collection could have introduced recall bias, and a longer follow-up period would be needed to assess long-term outcomes comprehensively.

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Ethical Approval: Obtained.
Consent: Written consent secured.

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