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Research Article

Determinants of Survival and Mortality Patterns in 99 Consecutive Burn Admissions at a North-Indian Tertiary Network: A Retrospective Cohort Study

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Abstract
Background. Burns remain a major cause of injury in low- and middle-income countries, yet granular outcome data from North-Indian districts are scarce.
Methods. We retrospectively analysed 99 consecutive acute thermal-injury admissions (January 2023 – March 2024) to four linked tertiary units in western Uttar Pradesh. Demographic, clinical-burn and outcome variables were extracted from prospectively maintained ward registers and validated against referral slips. Primary outcome was in-hospital survival; secondary outcomes were timing and proximate cause of death. Categorical data were compared with x^2 or Fisher's exact test and continuous variables with *t*- or Mann–Whitney-*U* tests; $p<0.05$ was significant.
Results. Mean age was 32 ± 15 years (range 10 months–75 years); 57 patients were male (57.6%). Median total body surface area (TBSA) burned was 38 % (IQR 22–60 %). Overall survival was 38 % (38/99). Survival exceeded 80 % for TBSA < 20 % but fell sharply to 14 % for 60–80 % TBSA and nil for > 80 % (Table 2, Figure 2). Of 61 deaths, 26 (42.6 %) occurred within 72 h (early deaths), predominantly from airway obstruction with inhalational injury, whereas 35 (57.4 %) were delayed, chiefly due to septic and/or hypovolaemic complications (Table 3). Increasing TBSA, third-degree depth, and inhalation injury were independent predictors of mortality on multivariable analysis (all $p<0.01$).
Conclusion. In this under-resourced regional network, survival remains unacceptably low once TBSA exceeds 40 %, and deaths shift from airway-related to septic aetiology after 72 h. Extending critical-care capacity and infection-control bundles beyond the first week is likely to yield the greatest mortality benefit.

Keywords: Burns, Tbsa, Mortality, Sepsis, Inhalation Injury, India, Retrospective Cohort.

INTRODUCTION

Thermal burns contribute an estimated 180 000 deaths globally each year, with over two-thirds occurring in low- and middle-income countries (LMICs) where pre-hospital care and intensive-care resources are limited [1, 2]. India alone records roughly 1.6 million moderate-to-severe burns annually, translating into 163 000 fatalities and a disability-adjusted life-year burden second only to road-traffic injuries [3]. While national data highlight a rising proportion of female and paediatric victims [4], most single-centre series still originate from urban superspeciality institutes, risking referral bias and under-representation of rural districts [5].

TBSA remains the cornerstone prognosticator, yet the inflection point where survival drops precipitously varies across settings—from 30 % in high-income countries to as low as 20 % in resource-constrained units [6]. Moreover, the temporal pattern of death has shifted in the modern antibiotic era: early deaths (< 48–72 h) are frequently attributed to inhalational injury and shock, whereas late mortality (> 7 days) is dominated by septic complications [7]. Quantifying these phases locally is essential to optimise triage, bed allocation and antimicrobial stewardship.

Northern India's Gangetic belt hosts a populous agrarian community with high open-flame exposure, limited burn triage and a nascent referral network. Recent registry pilots hint at major-burn prevalence (> 20 % TBSA) of nearly 50 % and mortality exceeding 30 % [8]; however, granular survival curves and cause-specific lethality remain elusive. Against this backdrop, we aimed to (i) delineate demographic and clinical predictors of survival among consecutive burn admissions across four linked tertiary hospitals, and (ii) describe timing and proximate causes of death to identify modifiable care-pathway gaps.

MATERIALS AND METHODS

Study Design and Setting. A retrospective cohort study was conducted across four public

tertiary-care hospitals (Agra, Etah, Firozabad and Mainpuri) which share a unified referral catchment (~12 million population) and paper-based burn registries.

Participants. All patients of any age admitted with acute thermal injury between 1 January 2023 and 31 March 2024 were eligible. Chemical and electrical burns were excluded to maintain clinical homogeneity. Patients transferred out within 12 h were excluded.

Data Collection. Trained residents abstracted age, sex, marital status, burn aetiology, TBSA (Rule-of-Nines), depth (partial- vs full-thickness), time-to-presentation (morning/evening/night), and inhalational injury markers from ward registers and referral slips. Outcomes (survived, early death < 72 h, delayed death) and proximate cause (airway obstruction, septic shock, hypovolaemia, cardiac arrest) were cross-verified against death certificates.

Variables and Definitions. TBSA was grouped into five clinically relevant strata: < 20 %, 20–40 %, 40–60 %, 60–80 % and > 80 %. Early death was defined as death within 72 h of admission.

Statistical Analysis. Continuous variables were summarised as mean ± SD or median (IQR) and compared with Student's *t*-test or Mann–Whitney-*U* as appropriate. Categorical variables were analysed using χ^2 or Fisher's exact test. Variables with $p < 0.1$ on univariate analysis entered a backward stepwise multivariable logistic model for mortality. Analyses were performed with SPSS v27. The study adhered to STROBE guidelines and was approved by the joint institutional ethics committee (Ref: IEC/24/2023).

RESULTS

Two-thirds of victims were young adults (15–40 years), and 55.6 % were married (Table 1). Children < 15 years constituted 12 % of admissions.

Mortality Profile

Overall survival was 38 % (38/99). Among non-survivors (n = 61), 26 (42.6 %) died within the first 72 h. Early deaths were dominated by airway obstruction secondary to inhalational injury (69 %), followed by hypovolaemic shock (15 %) and fulminant sepsis (12 %). Delayed deaths (57.4 %) occurred at a median 8 (IQR 6–12) days and were principally attributable to septic shock (80 %) (Table 3).

TBSA and Outcome

Figure 1 depicts the TBSA distribution; 30 % of patients sustained 20–40 % burns, and 26 % exceeded 60 % TBSA. Survival exceeded 80 % for TBSA < 20 % but fell sharply to 14 % for 60–80 % and nil for > 80 % (Figure 2, Table 2). Logistic modelling identified TBSA > 40 % (OR 7.8, 95 % CI 3.1–19.4), full-thickness depth (OR 3.4, 1.4–8.0) and inhalation injury (OR 5.1, 2.0–13.0) as independent mortality predictors ($p < 0.01$).

Other Clinical Correlates

Presentation at night (22:00–06:00) was associated with 1.9-fold higher early mortality compared with daytime arrivals ($p = 0.04$), possibly reflecting delayed resuscitation capability. No significant sex-based mortality difference was observed ($p = 0.26$), although females presented with marginally higher median TBSA (41 % vs 37 %; $p = 0.08$).

Table 1 – Demographic and Clinical Profile (N = 99)

Variable	Value
Total patients	**99**
Male, n (%)	57 (57.6 %)
Female, n (%)	42 (42.4 %)
Mean age, years ± SD	32 ± 15
Age < 15 y, n (%)	12 (12.1 %)
Age 15–40 y, n (%)	61 (61.6 %)
Age > 40 y, n (%)	26 (26.3 %)
Married, n (%)	55 (55.6 %)

Table 2 – Outcome by Tbsa Category

TBSA Category	Total (n)	Survived (n)	Early Death (n)	Delayed Death (n)	Survival Rate %
< 20 %	18	15	1	2	83.3
20–40 %	30	17	5	8	56.7
40–60 %	25	4	8	13	16.0

60–80 %	16	2	8	6	12.5
> 80 %	10	0	4	6	0.0

Table 3 – Primary Cause of Mortality (N = 61 Deaths)

Cause of Death	Early Death (n)	Delayed Death (n)
Airway obstruction / inhalational injury	18	5
Sepsis	3	28
Hypovolaemic shock	4	2
Cardiac arrest	1	0

DISCUSSION

This regional cohort demonstrates an overall survival of 38 %, considerably lower than the 60–70 % reported from urban Indian superspeciality centres [4, 8] and global LMIC meta-estimates of 79 % [2]. Consistent with prior registry data [5], increasing TBSA, full-thickness depth and inhalational injury emerged as potent outcome determinants. Notably, the TBSA threshold beyond which no patient survived (> 80 %) echoes findings from recent Karnataka and Eastern-India series [9, 10], underscoring the unrelenting lethality of extensive burns where access to early excision and grafting is limited.

The bimodal death-time distribution corroborates classic observations by Herndon et al. [6] but with a higher later-sepsis burden (57 % vs 37 %). Contributing factors include high ambient temperatures, inadequate isolation cubicles and delayed debridement schedules. Implementing low-cost infection-control bundles—chlorhexidine bathing, early enteral nutrition and antibiotic de-escalation algorithms—has halved sepsis-related deaths elsewhere [7] and should be piloted here.

Our paediatric mortality (50 %) mirrors a recent North-Indian burn-registry pilot (47 %) [3], yet remains quadruple that of high-income settings. Community-level prevention—safer cooking stoves, flame-retardant fabrics—and district-wide first-aid training could meaningfully curb incidence. Additionally, night-hour presentations correlated with worse outcomes, replicating emergency-department staffing effect sizes reported by Al-Kassimi et al. [1].

Strengths include multisite enrolment, standardised registry abstraction and comprehensive outcome adjudication. Limitations are inherent to retrospective design, potential TBSA estimation error and single-region generalisability. Causality cannot be inferred from associations, and detailed resuscitation variables (lactate clearance, fluid shifts) were unavailable.

Future work should validate the predictive nomogram derived from our data and explore cost-effectiveness of early escharotomy and point-of-care lactate monitoring in district-level burn units.

CONCLUSION

In this four-centre North-Indian cohort, survival after major burns (TBSA > 40 %) remains poor, with mortality transitioning from airway compromise in the first 72 h to overwhelming sepsis thereafter. Targeted investments in early airway management, critical-care capacity, and infection-control bundles beyond the first week could substantially improve outcomes. Our findings provide an evidence base for regional burn-care planning and underscore the urgent need for context-appropriate prevention strategies.

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