



Original Article



Epidemiology and Outcomes of Liquefied Petroleum Gas (LPG) Burns at a Regional Burn Center in Karachi: A One-Year Retrospective Review

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ABSTRACT

Liquefied petroleum gas (LPG) burns have increased significantly in recent years, posing substantial public health challenges, particularly in resource-constrained environments such as Pakistan. Understanding the epidemiology and clinical profile of LPG burns can guide effective preventive and management strategies. **Objectives:** To analyze demographic and clinical features of LPG-related burn injuries and assess patient outcomes following treatment. **Methods:** This retrospective cross-sectional study was conducted at Dr. Ruth K.M. Pfau Civil Hospital's burn center in Karachi. Records from January 1 to December 31, 2022, were reviewed using convenience sampling. Demographic details, injury mechanisms, accident location, delay before hospital admission, total body surface area (TBSA) burned, anatomical injury sites, treatment interventions, and patient outcomes were analyzed. **Results:** Among 159 LPG burn patients, 108 (67.9%) were male. Children accounted for 38 (23.9%), while young adults comprised 79 (49.7%). Most patients, 93 (58.5%), belonged to low socioeconomic backgrounds, and 97 (61.0%) worked as laborers. Gas leaks caused most injuries, with 135 (84.9%) patients suffering deep, full-thickness burns involving more than 25% TBSA. Skin grafting was performed in 55 patients (56.7%), tangential excision in 36 (37.1%), and amputation in 6 (6.1%). The overall mortality rate was 62 (38.9%). **Conclusions:** LPG-related burns at our center are characterized by extensive full-thickness injuries and high mortality. These findings underscore the urgent need for enhanced safety regulations, routine equipment inspection, and targeted community education to prevent LPG burn incidents.

INTRODUCTION

Burn injuries impose a major health burden globally, especially in low- and middle-income countries (LMICs) where more than 90% of burn cases occur. Worldwide estimates indicate roughly 9-11 million new burn injuries and 120,000-180,000 burn deaths each year, with flames and cooking-related burns predominating [1, 2]. South Asia carries a disproportionate share of this burden. In India alone, over one million people sustain moderate-to-severe burns annually, and in Pakistan, burns are a leading cause of injury-related disability (often cited as the second leading cause of disability) [3]. As in much of South Asia, the home kitchen is a common setting for burns in Pakistan, and women and children are at particularly high risk [3, 4].

Liquefied petroleum gas (LPG) is widely used for cooking and heating in Pakistan, often as an alternative to kerosene or wood [5]. However, poorly maintained or substandard LPG equipment can cause catastrophic burns. In our region, sudden cylinder explosions and gas leaks have resulted in very severe burn injuries. A recent survey of LPG-related accidents at the National Burn Centre found that most patients had extremely high burn surface area (>60% TBSA) and a very high mortality (~60%) [6]. In contrast, studies from other settings with increasing LPG use have shown lower average severity. A Chinese burn center saw a mean TBSA ~31% and only 4.1% mortality among LPG-burn patients, while a study in Rwanda



reported a median TBSA of 25% and 16% mortality for LPG-related burns [7, 8]. Such comparisons highlight the exceptional severity of LPG cylinder explosions in our context. Given the scarce burn surveillance in Pakistan, facility-based studies are needed to fill gaps. By identifying predictors of morbidity and mortality specific to LPG burns, our findings will underpin targeted prevention campaigns, inform safety regulations, and optimize clinical protocols in resource-constrained contexts.

Despite the increasing reliance on liquefied petroleum gas (LPG) for domestic and occupational use in Pakistan, systematic epidemiological data on LPG-related burn injuries remain scarce. Most available literature focuses on general burn patterns, with limited attention to the distinct mechanisms, severity profiles, and outcomes associated specifically with LPG leaks and cylinder explosions. Furthermore, there is insufficient region-specific evidence from major urban burn centers to inform targeted prevention strategies and safety regulations. This knowledge gap hinders the development of contextually appropriate interventions aimed at reducing morbidity and mortality from LPG-related burns. This study aims to characterize patient demographics, delineate injury mechanisms, anatomical patterns, TBSA involvement, and evaluate management strategies, including conservative care, grafting, excision, and amputation, and their outcomes.

METHODS

This retrospective, cross-sectional study was conducted at the Burn Center of Dr. Ruth K.M. Pfau Civil Hospital, Karachi. Using convenience sampling, all patient records from January 1 to December 31, 2022, of individuals admitted for burns related to LPG leakage or cylinder explosions were examined. Ethical approval was obtained from the Dow University of Health Sciences Institutional Review Board (Ref. No. IRB-3106/DUHS/EXEMPTION/2023/400). The study used convenience sampling in retrospective chart reviews. Patients admitted during the study period with burn injuries resulting from liquefied petroleum gas (LPG) leakage or cylinder explosion were eligible for inclusion. Sample size was calculated using the WHO sample size calculator for a single population proportion. Assuming a 95% confidence level, a margin of error of 5% and an expected prevalence of LPG burns among burn admissions of 11%, the calculation yielded ≈ 151 cases [6]. To compensate for an anticipated 20% rate of incomplete or missing data, the sample was inflated to 181. Twenty records lacking key documentation (e.g., burn depth, total body surface area) and two files about non-LPG burn causes were excluded. The final analytic cohort comprised 159 patients. Socioeconomic status was determined using the Modified Kuppaswamy Scale,

updated for Pakistan's 2022 CPI (IW). This composite index scores the household head's occupation, educational attainment, and monthly family income to stratify patients into lower, middle, and upper socioeconomic classes [9]. Data extraction was performed independently by two trained reviewers using a standardized proforma; any discrepancies were resolved through discussion or adjudicated by a third reviewer. Collected variables included demographics (age group, sex, residence, occupation), clinical parameters (burn etiology, setting, degree, and total body surface area [TBSA]), timeliness of care (interval from injury to presentation, first-aid measures), presence of inhalation injury, interventions (conservative management, skin grafting, tangential excision, amputation), and outcomes (length of stay, discharge status: recovery, death, or leave-against-medical-advice). Outcome variables were defined as follows: mortality (in-hospital death), length of stay (days from admission to discharge, death, or LAMA), burn complications (wound infection per CDC criteria, sepsis by Sepsis-3 definitions, acute respiratory distress syndrome, acute kidney injury by KDIGO, and contractures), functional recovery (restoration of activities of daily living and joint range of motion at discharge), burn severity (first-degree/superficial to third-degree/full-thickness or mixed), and TBSA (estimated by Rule of Nines in adults or Lund and Browder chart in children). Statistical analyses were conducted in SPSS version 23.0 (IBM Corp., Armonk, NY), with categorical variables presented as counts and percentages and continuous variables as means \pm standard deviations; associations were tested using chi-square analyses, with $p < 0.050$ indicating statistical significance.

RESULTS

A total of 159 patient records with complete data were analyzed. The cohort comprised 51 females (32.1%) and 108 males (67.9%). Age distribution was: 38 children under 18 years (23.9%), 79 young adults aged 18–40 (49.7%), 34 older adults aged 41–60 (21.4%), and 8 elderly patients over 60 (5.0%). Most patients (93; 58.5%) came from lower socioeconomic backgrounds; 75 (47.2%) had completed secondary education. Private-sector laborers constituted 97 cases (61.0%), while 43 were housewives (27.0%), 11 were unemployed (6.9%), and 8 were in business (5.0%) (Table 1).

Table 1: Characteristics of End Stage Renal Disease Patients on Maintenance Hemodialysis (N=144)

| Characteristics | Category | Frequency (%) |
|-----------------|----------|---------------|
| Gender | Female | 51 (32.1%) |
| | Male | 108 (67.9%) |
| Age group | < 18 | 38 (23.9%) |
| | 18–40 | 79 (49.7%) |
| | 41–60 | 34 (21.4%) |

| | | |
|----------------------|------------------|------------|
| | > 60 | 8 (5.0%) |
| Socioeconomic Status | Lower | 93 (58.5%) |
| | Middle | 44 (27.7%) |
| | Upper | 22 (13.8%) |
| | | |
| Education | Primary | 45 (28.3%) |
| | Secondary | 75 (47.2%) |
| | Matric | 15 (9.4%) |
| | Intermediate | 12 (7.5%) |
| | Graduate & above | 12 (7.5%) |
| | | |
| Occupation | Private job | 97 (61.0%) |
| | Housewife | 43 (27.0%) |
| | Unemployed | 11 (6.9%) |
| | Business | 8 (5.0%) |
| | | |

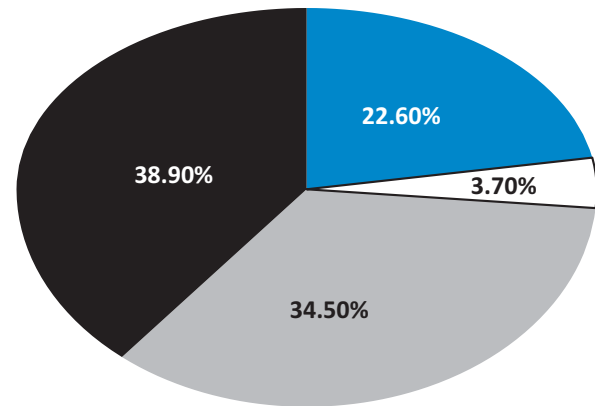
Seventy-one percent (113) presented directly to the burn center; the remaining 28.9% were referrals after first aid elsewhere. LPG burns resulted from gas leaks in 97 cases (61.0%) and cylinder blasts in 62 (39.0%). Injuries occurred most often at workplaces (110; 69.2%), followed by vehicles (26; 16.4%), homes (19; 11.9%), and other sites (4; 2.5%). Regarding severity, 135 patients (84.9%) had full-thickness burns over >25% total body surface area (TBSA); 19 (11.9%) had partial-thickness burns. Inhalation injury was noted in 129 cases (81.1%). Time to presentation was under 6 hours in 108 patients (67.9%), 6–12 hours in 21 (13.2%), 12–24 hours in 17 (10.7%), and beyond 24 hours in 13 (8.2%). First-aid had been administered in 72 cases (45.3%). (Table 2).

Table 2: Clinical Variables of Burn Patients

| Characteristics | Category | Frequency (%) |
|---------------------------------------|-------------------|---------------|
| Cause of Injury | Gas leak | 97 (61.0%) |
| | Cylinder blast | 62 (39.0%) |
| Place of injury | Home | 19 (11.9%) |
| | Workplace | 110 (69.2%) |
| | Vehicle | 26 (16.4%) |
| | Other | 4 (2.5%) |
| | | |
| Time from Burn Injury to Presentation | < 6 hours | 108 (67.9%) |
| | 6–12 hours | 21 (13.2%) |
| | < 24 hours | 17 (10.7%) |
| | > 24 hours | 13 (8.2%) |
| First Aid | Received | 72 (45.3%) |
| | Not received | 87 (54.7%) |
| Inhalation Injury | Present | 129 (81.1%) |
| | Absent | 30 (18.9%) |
| TBSA Burned | < 15% | 15 (9.4%) |
| | 15–30% | 53 (33.3%) |
| | 31–45% | 26 (16.4%) |
| | 46–60% | 22 (13.8%) |
| | 61–75% | 20 (12.6%) |
| | > 75% | 23 (14.5%) |
| Degree of Burn | Full thickness | 135 (84.9%) |
| | Partial thickness | 19 (11.9%) |
| | Mixed | 5 (3.1%) |

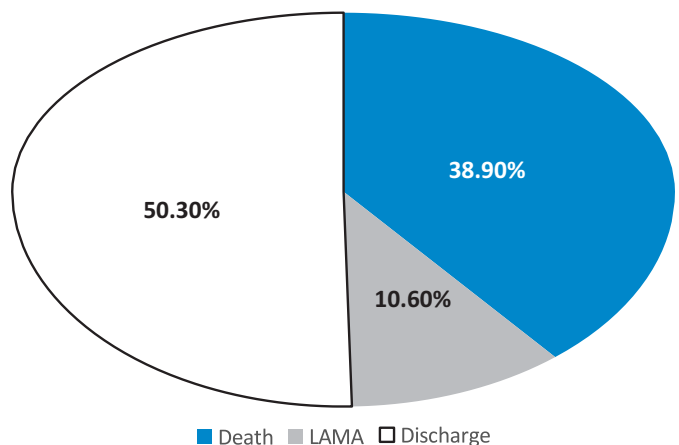
| | | |
|-------------------------|-------------------------|-------------|
| Procedure Performed | Conservative management | 62 (39.0%) |
| | Grafting | 55 (34.6%) |
| | Amputation | 6 (3.8%) |
| | Tangential excision | 36 (22.6%) |
| Length of Hospital Stay | ≤ 7 days | 107 (67.3%) |
| | 8–14 days | 36 (22.6%) |
| | > 14 days | 16 (10.1%) |
| Outcome | Discharge | 80 (50.3%) |
| | Death | 62 (39.0%) |
| | LAMA | 17 (10.7%) |

The burns involved various regions of the body, including the head, neck, upper and lower limbs, trunk, and genitalia. Surgical management was required in 97 patients: 55 (34.6%) underwent skin grafting, 36 (22.6%) had tangential excision, and 6 (3.8%) required amputation; the remaining 62 (39.0%) were managed conservatively (Figure 1).



■ Tangential excision □ Amputation ■ Grafting ■ Conservative management

Figure 1: Percentages of Procedures Performed on Burn Patients
Hospital stays were ≤7 days for 107 patients (67.3%), 8–14 days for 36 (22.6%), and >14 days for 16 (10.1%). At study end, 80 patients (50.3%) were discharged after full recovery, 17 (10.7%) left against medical advice (LAMA), and 62 (39.0%) died (Figure 2).



■ Death ■ LAMA □ Discharge

Figure 2: Outcomes of Burn Patients
Patients with full degree burn, only 39.3% of patients were discharged after completing treatment, while 45.2% died

in hospital, and 15.6% LAMA. Two-thirds (68.9%) of survivors stayed one week or less; 22.2% remained for one to two weeks, and 8.9% for more than two weeks. The majority (67.3%) had short stays (≤ 1 week), with 22.6% admitted for 1–2 weeks and 10.1% exceeding two weeks. A Pearson chi-square test showed a significant association between burn depth and patient outcome ($\chi^2=16.734$; $p=0.002$), whereas no significant relationship was found between burn degree and length of stay ($\chi^2=1.774$; $p=0.777$) (Table 3).

Table 3: Degree of Burn by Clinical Outcomes, Length of Stay, and Inhalational Injury (N=159)

| Degree of Burn | Outcomes | | | Length of Stay | | |
|-----------------------------|--------------------|----------------|---------------|---------------------------|-----------------------|----------------------|
| | Discharge N (%) | Death N (%) | LAMA N (%) | ≤ 1 Week N (%) | 1-2 Weeks N (%) | >2 Weeks N (%) |
| Full-Thickness (N=135) | 53 (39.3) | 61 (45.2) | 21 (15.6) | 93 (68.9) | 30 (22.2) | 12 (8.9) |
| Partial-Thickness (N=19) | 15 (78.9) | 1 (5.3) | 3 (15.8) | 11 (57.9) | 5 (26.3) | 3 (15.8) |
| Mixed (N=5) | 3 (60.0) | 0 (0.0) | 2 (40.0) | 3 (60.0) | 1 (20.0) | 1 (20.0) |
| Total (N=159) | 71 (44.7) | 62 (39.0) | 26 (16.4) | 107 (67.3) | 36 (22.6) | 16 (10.1) |
| p-Value | 0.002* | | | 0.777 | | |

DISCUSSION

In this study of LPG-related burns, we found very severe injuries with unusually high mortality. Most of our patients suffered large flame burns, reflecting the high-energy nature of cylinder explosions. Compared to the global burn registry data, our cohort had much larger burns. The WHO registry analysis shows that cookstove burns often average $\sim 30\%$ TBSA with mortality around 41% [2], but our patients' TBSA values exceeded this (the majority $>60\%$). Similarly, in China, the mean TBSA for LPG burns was only $\sim 31\%$ [7]. In current study mortality (nearly 50%) was also dramatically higher than reported elsewhere: the Chinese series had 4.1% mortality, and the Rwandan cohort 16% [7, 8]. These differences likely reflect the predominance of high-pressure cylinder blasts in our population, whereas in other settings, gas burns more often result from slow leaks or cooking accidents. Prior studies in nearby countries reinforce these patterns. In India, LPG burns have been rising in recent decades as LPG usage has increased. Previous studies found that LPG incidents accounted for about 11% of all burns in one year, with 80% due to leakage, mainly from cylinders or pipes. In our series, most LPG burns also arose from gas leaks or cylinder failures; in fact, the majority were caused by cylinder blasts, consistent with the "kitchen bomb" effect described in the literature [6, 10–13]. These comparisons suggest that while LPG is often safer than open fire or kerosene, its misuse or equipment failure can produce far more devastating injuries than typical cooking burns. Current outcomes align

with overall burn trends in Pakistan but highlight the particular danger of LPG blasts. A recent Pakistani burn registry review (all causes) reported an overall in-hospital mortality of $\sim 23\%$, whereas our LPG-specific cohort had substantially higher deaths. Likewise, the national burn center found that burns $>50\%$ TBSA predicted high mortality, a finding evident in our LPG patients, most of whom exceeded that threshold [14]. Inhalation injuries and delayed presentation (common in rural LPG accidents) likely compound mortality. The alarming impact of LPG burns in developing countries calls for urgent preventive action. Experience from other LMICs illustrates effective approaches. For example, the WHO advocates multi-pronged burn prevention strategies: education campaigns, improved stove design, and stringent safety regulations [15, 16]. In Brazil and Japan, for instance, regulatory agencies mandate rigorous cylinder manufacturing standards, regular inspections, and recertification, greatly reducing accidents [17–19]. Public awareness is also crucial. Community-based education in high-burn regions has improved safe cooking practices [20]. In Rwanda, researchers noted that increased LPG adoption (for clean fuel goals) was accompanied by targeted safety initiatives to mitigate burn risk [8]. In Indonesia, simple interventions such as replacing old hoses and promoting periodic equipment checks were recommended after studies showed that most LPG burns stemmed from worn stove parts [7]. Similarly, community outreach programs and "safe stove" distribution in Bangladesh and Nepal have demonstrated modest reductions in home burn incidence. Given our findings, Pakistan could adopt similar policies: enforce quality standards for cylinders and valves, mandate regular cylinder testing or exchange programs, and run public campaigns on LPG safety (e.g., checking for leaks, keeping stoves outdoors). Clinics and burn centers should also educate patients and the public. Environmental interventions, such as designing pressure-relief valves or flame arrestors on cylinders, could further reduce explosions. Importantly, collaborative efforts are needed: government regulation must be paired with community education and industry cooperation to ensure both the supply of safe equipment and informed users [16]. This study has several limitations. It is retrospective and based at a single tertiary care center, so referral bias may over-represent severe cases and limit generalizability. Hospital records may omit some details (e.g., precise leak source or pre-hospital care), and data abstraction relies on chart accuracy. Assessment of burn size (TBSA) and inhalation injury may vary between clinicians, introducing inter-observer variability. The lack of a control group and the absence of long-term follow-up data are additional constraints. Like other registry-based analyses, we could

not capture injuries treated outside our center or long-term quality-of-life outcomes. Despite these limitations, our large cohort provides valuable insight into a relatively understudied injury type in Pakistan.

This study is limited by its retrospective single-center design, which may overrepresent severe cases referred to a tertiary burn facility and restrict generalizability to the broader population. Incomplete documentation and reliance on medical records may have introduced information bias, and long-term functional and psychosocial outcomes were not assessed. Additionally, the absence of multivariable analysis limits identification of independent predictors of mortality. Future prospective, multicenter studies incorporating long-term follow-up, risk factor modeling, and evaluation of preventive interventions are needed to better understand determinants of LPG burn severity and to guide evidence-based safety policies and community education programs.

CONCLUSIONS

This study highlights the extreme severity of LPG cylinder accidents in Pakistan. In our series of patients, the majority sustained large flame burns (often >60% TBSA) and had very high mortality rates, far exceeding those reported in most other countries. These findings underscore the critical need for prevention: enforcing safety regulations on LPG equipment, educating users, and implementing technology fixes. The burden of LPG burns must be urgently addressed through combined policy, educational, and engineering strategies to protect vulnerable households and reduce avoidable burn deaths.

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Authors' Contribution

Conceptualization: ST, SG

Methodology: SG, JM

Formal analysis: ST, MM, AB

Writing and Drafting: ST, SG, MT, AB, JM

Review and Editing: ST, SG, MT, AB, JM, MM, AB

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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