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Accelerant-related burns and drug abuse: Challenging combination

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ABSTRACT

Background: Accelerants are flammable substances that may cause explosion when added to existing fires. The relationships between drug abuse and accelerant-related burns are not well elucidated in the literature. Of these burns, a portion is related to drug manufacturing, which have been shown to be associated with increased burn complications.
Objectives: 1) To evaluate the demographics and clinical outcomes of accelerant-related burns in a Provincial Burn Centre.
2) To compare the clinical outcomes with a control group of non-accelerant related burns.
3) To analyze a subgroup of patients with history of drug abuse and drug manufacturing.
Methods: Retrospective case control study. Patient data associated with accelerant-related burns from 2009 to 2014 were obtained from the British Columbia Burn Registry. These patients were compared with a control group of non-accelerant related burns. Clinical outcomes that were evaluated include inhalational injury, ICU length of stay, ventilator support, surgeries needed, and burn complications. Chi-square test was used to evaluate categorical data and Student's t-test was used to evaluate mean quantitative data with the p value set at 0.05. A logistic regression model was used to evaluate factors affecting burn complications.
Results: Accelerant-related burns represented 28.2% of all burn admissions (N=532) from 2009 to 2014. The accelerant group had higher percentage of patients with history of drug abuse and was associated with higher TBSA burns, ventilator support, ICU stay and pneumonia rates compared to the non-accelerant group. Within the accelerant group, there was no difference in clinical outcomes amongst people with or without history of drug abuse. Four cases were associated with methamphetamine manufacturing, all of which underwent ICU stay and ventilator support.
Conclusions: Accelerant-related burns cause significant burden to the burn center. A significant proportion of these patients have history of drug abuse.

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1. Introduction

Accelerants are flammable substances that may cause explosion when added to existing fires. These substances are dangerous because they tend to be colorless and highly volatile. Indeed, misuse of accelerants is directly related to higher severity of burns [1,2].

The relationships between higher risk behaviors such as drug abuse and accelerant related burns are not well elucidated in the literature. People with drug abuse have been associated with increased length of stay in hospital when corrected for demographics and burn variables [3]. Of these burns, a portion is related to drug manufacturing which typically involves accelerant use such as butane and propane. Methamphetamine is a highly addictive and easily manufactured substance of abuse. Its use has increased dramatically in North America in recent years [4]. Methamphetamine-associated burns have placed heavy burdens on both patients and burn centers. These patients have increased complications, higher incidence of inhalational injuries, and increased length of stay in hospital [5–8]. Another substance of concern in drug related burns is the manufacturing of cannabis [9]. The process of extracting cannabis oil, the higher concentrated form of delta-9-tetrahydrocannibinol (THC), requires ignition of volatile solvent, typically grain alcohol, putting users at risk for thermal burns or injuries from explosions [9].

The objectives of this study were to evaluate the demographics of accelerant-related burns in British Columbia, to compare the clinical outcomes with a control group of non-accelerant burns, and to analyze a special subgroup with history of drug abuse and drug manufacturing.

2. Methods

This was a retrospective case control study. Following ethics approval from the University of British Columbia Clinical Research Ethics Board, patient data associated with accelerant-related burns from 2009 to 2014 were obtained from the British Columbia Burn Registry. This registry contains prospectively collected data of patients admitted to the burn unit in Vancouver General Hospital. The keywords used to identify these patients included accelerant, propane, butane, and gasoline.

The demographics of these patients including age, sex, gender, co-morbidities, and ethnicity were collected. These patients were then compared with a control group of non-accelerant related burns. The control group consisted of all admitted patients from 2009 to 2014 with mechanisms of burns unrelated to accelerant use. These were identified from review of individual cases from the Burn Registry. Clinical outcomes that were evaluated included inhalational injury, ICU length of stay, ventilator support, surgeries needed, and burn complications.

At our institution, pneumonia is defined as either radiological evidence of pneumonia or positive sputum culture, plus at least two clinical signs of increased oxygen utilisation fever, or leukocytosis. In contrast, aspiration pneumonia is defined by right lower lobe opacity on radiograph in addition to an inciting event of aspiration by history.

Graft failure is determined by the clinical assessment of our senior author during ward rounds. It refers to any graft loss with re-operation or extensive conservative management.

A subgroup analysis was performed on those with history of drug abuse and drug manufacturing. Drug abuse was defined as any regular use of illicit substance by history excluding alcohol and cigarette smoking. These substances included but were not limited to amphetamine-type stimulants, cannabis, cocaine, central nervous system depressants, hallucinogens, and opioids.

Chi-square test was used to analyze categorical variables and Student's t-test was used to evaluate mean quantitative data. Statistical significance was set with p-value=0.05. A logistic regression model was used to evaluate factors affecting burn complications.

3. Results

A total of 532 burn patients were admitted during the study period. Of these, accelerant-related burns represented 28.2% of all burn admissions (N=150). The demographics of patients with accelerant versus non-accelerant burns are presented in Table 1. 107 out of 382 patients from the non-accelerant group were excluded from the analysis due to incomplete clinical data. Comparing to the non-accelerant group, the accelerant group had higher proportion of patients with drug of abuse (39.1% vs 17.5%, $p<0.01$) and was associated with higher TBSA burns (15% vs 6.2%, $p<0.01$). Despite having similar age, gender, and ethnicity, the non-accelerant group had more patients with diabetes (15.1% vs 7%, $p=0.03$).

Regarding clinical details (Table 2), there was a higher proportion of patients in the accelerant group who received ventilator support (33.3% vs 17.8%, $p<0.01$) and ICU stay (32% vs 17.8%, $p=0.001$); however, there was no difference in the duration for ICU length of stay or the number of ventilator days. Higher proportion of the non-accelerant group underwent operative interventions (76% vs 61.3%, $p=0.001$).

The accelerant and non-accelerant group had similar rates of inhalational injury but the accelerant group had more pneumonias (16.7% vs 5.1%, $p<0.01$) and aspiration pneumonias (8% vs 1.8%, $p<0.01$). There was no difference in surgical site infections, urinary tract infections, or graft failure between the two groups.

In the accelerant group, there were no differences in clinical outcomes and burn complications among people with or without history of drug abuse (Table 3). Of note, only 128 out of 150 patients had complete data regarding history of drug abuse to be included in data analysis.

From the study period 2009–2014, eight patients were involved in burns related to drug manufacturing; four were manufacturing methamphetamines whereas the others were involved in cooking hash oil (Table 4). All patients within the methamphetamine manufacturing group underwent ICU stay and ventilator support, and there was one mortality (25%). The number of patients within the subgroups was too small to generate meaningful statistical analysis.

Table 1 – Characteristics of study population of adult patients admitted for accelerant-related burns vs non-accelerants from 2009 to 2014.

Characteristics	Accelerant (N=150)	Non-accelerant (N=275)	P-value
Age (yr) (mean±SD)	45.3±17.6	48.7±18.5	0.07
Male	76%	67.3%	0.06
Race			
Caucasian	80.8%	64.5%	
Black	1.7%	1.3%	**0.016**
Asian	14.2%	24.7%	
Hispanic	0	2.6%	
Other	3.3%	6.9%	
TBSA (mean±SD)	**15±17.9**	**6.2±9.2**	**<0.01**
Accelerant types			
propane	20%	N/A	
gasoline	26.7%		
other accelerant	24.7%		
non-specified	28.7%		
Smoker	46.9%	42.7%	0.45
Diabetes	**7%**	**15.1%**	**0.03**
Respiratory disease	10.2%	14.7%	0.23
Unemployed	21.1%	22.3%	0.69
Drug abuse	**39.1%**	**17.5%**	**<0.01**

A logistic regression analysis was performed to identify independent risk factors for burn complications (Table 5). None of the listed factors was found to independently increase the odds ratios for burn complications.

4. Discussion

There is a paucity of burn literature that specifically evaluates outcomes in accelerant-related burns. Our study has demonstrated similar rates of male predominance and TBSA with previous studies on this topic [10]. Comparing to Barillo's study [2] that specifically evaluates gasoline-related burns, our institution has a similar prevalence rates (28.2 vs 23.3%). Accelerant-related burns can be related to explosions in an enclosed space or prolonged flame contact with a volatile substance during the accident; therefore, the higher TBSA involved comparing to non-accelerant related burns is reasonable. The rationale of not using a control group with comparable TBSA burn to identify attributable differences in clinical parameters was the high standard deviation of TBSA in the accelerant group, which made interpretation of the result challenging. Despite having similar rates of inhalational injuries, the accelerant group had higher incidence of pneumonia rates, likely attributed to ventilator associated pneumonia, as there was a higher proportion of patients that received ventilator support in the accelerant group (33.3% vs 17.8%).

To our knowledge, this is the first study that provides insight on the relationship between accelerant-related burns and drug

Table 2 – Clinical details of study population of adult patients admitted for accelerant-related burns vs non-accelerant related burns from 2009 to 2014.

	Accelerant (N=150)	Non-accelerant (N=275)	P value
TBSA (mean±SD)	**15±17.9**	**6.2±9.2**	**<0.01**
Inhalational injury	9.3%	9.5%	0.97
Ventilator support	**33.3%**	**17.8%**	**<0.01**
Ventilator support days	7.6	7.5	0.94
ICU stay	**32%**	**17.8%**	**0.001**
ICU days	10.5	9.3	0.57
Operative interventions	**61.3%**	**76%**	**0.001**
Mortality	3.3%	3.3%	0.97
Burn complications			
Pneumonia	**16.7%**	**5.1%**	**<0.01**
Aspiration pneumonia	**8%**	**1.8%**	**<0.01**
UTI	8.7%	5.8%	0.27
Surgical site infection (deep)	2.7%	2.9%	0.89
Surgical site infection (superficial)	0.7%	1.1%	0.67
Graft failure	10%	5.1%	**0.06**

Table 3 – Clinical details of study population of adult patients admitted for accelerant-related burns with or without history of drug abuse from 2009 to 2014.

	History of drug abuse (N=50)	No history of drug abuse (N=78)	P value
TBSA	16.3±18.5	14.2±17.6	0.5
Inhalational injury	6%	12.8%	0.2
Ventilator support	38%	34.6%	0.7
Ventilator support days	6.5	8.5	0.46
ICU stay	34%	34.6%	0.94
ICU days	9.6	11.4	0.59
Operative interventions	52%	66.7%	0.1
Mortality	2%	5.1%	0.37
Burn complications			
Pneumonia	18%	16.7%	0.85
Aspiration pneumonia	12%	6.4%	0.27
UTI	8%	9%	0.85
Surgical site infection (deep)	0	3.9%	0.16
Surgical site infection (superficial)	2%	0	0.21
Graft failure	10%	10.3%	0.96

Table 4 – Comparison table of adult patients admitted for drug manufacturing from 2009 to 2014.

Outcomes	Non-accelerant (N=275)	MA manufacturing (N=4)	Hash oil cooking (N=4)
TBSA	6.2±9.2	29.1±11.6	25.8±32.7
Inhalational injury	9.5%	0	25%
Ventilator support	17.8%	**100%**	50%
Ventilator support days	7.5	8.3	7
ICU stay	17.8%	**100%**	50%
ICU days	9.3	9	12.8
Operative interventions	76%	50%	75%
Mortality	3.3%	25%	0
Burn complications			
Pneumonia	5.1%	50%	50%
Aspiration pneumonia	1.8%	0	50%
UTI	5.8%	25%	0
Surgical site infection (deep)	2.9%	0	0
Surgical site infection (superficial)	1.1%	0	25%
Graft failure	5.1%	0	25%

Table 5 – Logistic regression model for burn complications from the sample groups 2009-2014.

	Odds ratio for burn complications	Standard error	Z	P> Z	95% CI
Accelerant	0.80	0.28	−0.63	0.53	(0.40-1.60)
Age	1.04	4.19	0	1.02	(1.02-1.06)
TBSA	1.19	0.30	6.97	0	(1.13-1.25)
Respiratory disease	1.21	0.51	0.45	0.66	(0.53-2.78)
Diabetes	2.15	0.92	1.79	0.07	(0.93-4.95)
Smoking	0.77	0.25	−0.80	0.42	(0.40-1.46)
History of drug abuse	1.21	0.49	0.47	0.64	(0.55-2.66)

abuse. Our study showed that 39.1% of patients with accelerant-related burns had history of drug abuse. Although this did not translate into worse clinical outcomes, the burn resources used to manage this special population are high. In addition, disposition planning can be challenging in this population, because there tends to be a higher incidence of drug abuse in patients with complex socioeconomic status such as homelessness [11]. Previous studies have also shown that drug abusers with acute burn injuries have increased length of stay and care expenses [12–14]. Even though we had a small number of patients represented in the drug manufacturing subgroups, we observed that these patients tended to have a higher TBSA involvement and more intensive care needs. The overall burn complications and mortality rates were unclear based on the small numbers in the sample.

Even though the British Columbia Burn Registry is a prospectively collected database operated by a single dedicated data analyst, the retrospective nature of this study may

have under-represented the analyzed subgroups. The registry may not capture keywords that are not physically recorded in the chart. In addition; objective urine toxicology screen was not routinely done in our burn center at the time of this study period. This can be especially challenging in relying on history to capture burn patients with substance abuse; as patients' denial rate can be significant [15]. In the literature; validated drug screening questionnaires have been used to detect history of drug abuse [16]; however; self reported history requires patient cooperation. Similarly; the history around burn cases related to drug manufacturing can be vague and is usually inferred from collateral information. The rates of drug abuse and manufacturing are likely higher than what is reflected in this study.

In conclusion, accelerant-related burns cause significant burden to the burn center. A significant proportion of these patients have history of drug abuse. The burn clinician should be mindful of the local resources available to help guide treatment strategies in this special population. Even though burn complications have not been shown to be higher in patients with history of drug abuse, other aspects of burn management strategies including complex pain and addiction referrals need to be tailored in this population. The implementation of mandatory urine toxicology screen in accelerant-related burns may provide valuable information.

Conflict of interest

The authors declare that there is no conflict of interest.

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REFERENCES

[1] Wibbenmeyer LA, Amelon MA, Loret de Mola RM, Lewis 2nd R, Kealey GP. Trash and brush burning: an underappreciated mechanism of thermal injury in a rural community. J Burn Care Rehabil 2003;24(2):85–9.

[2] Barillo DJ, Stetz CK, Zak AL, Shirani KZ, Goodwin CW. Preventable burns associated with the misuse of gasoline. Burns 1998;24(5):439–43.

[3] Thombs BD, Singh VA, Halonen J, Diallo A, Milner SM. The effects of preexisting medical comorbidities on mortality and length of hospital stay in acute burn injury: evidence from a national sample of 31,338 adult patients. Ann Surg 2007;245(4):629–34.

[4] Maxwell JC, Rutkowski BA. The prevalence of methamphetamine and amphetamine abuse in North America: a review of the indicators, 1992–2007. Drug Alcohol Rev 2008;27:229–35.

[5] Danks RR, Wibbenmeyer LA, Faucher LD, Sihler KC, Kealey GP, Chang P, et al. Methamphetamine-associated burn injuries: a retrospective analysis. J Burn Care Rehabil 2004;25(5):425–9.

[6] Santos AP, Wilson AK, Hornung CA, Polk Jr. HC, Rodriguez JL, Franklin GA. Methamphetamine laboratory explosions: a new and emerging burn injury. J Burn Care Rehabil 2005;26(3):228–32.

[7] Spann MD, McGwin Jr G, Kerby JD, George RL, Dunn S, Rue 3rd LW, et al. Characteristics of burn patients injured in methamphetamine laboratory explosions. J Burn Care Res 2006;27(4):496–501.

[8] Burke BA, Lewis 2nd RW, Latenser BA, Chung JY, Willoughby C, Kealey GP, et al. Methamphetamine-related burns in the cornbelt. J Burn Care Res 2008;29(4):574–9.

[9] Porter CJ, Armstrong JR. Burns from illegal drug manufacture: case series and management. J Burn Care Rehabil 2004;25(3):314–8.

[10] Rainey S, Cruse CW, Smith JS, Smith KR, Jones D, Cobb S. The occurrence and seasonal variation of accelerant-related burn injuries in central Florida. J Burn Care Res 2007;28(5):675–80.

[11] Kramer CB, Gibran NS, Heimbach DM, Rivara FP, Klein MB. Assault and substance abuse characterize burn injuries in homeless patients. J Burn Care Res 2008;29(3):461–7.

[12] Brezel BS, Kassenbrock JM, Stein JM. Burns in substance abusers and in neurologically and mentally impaired patients. J Burn Care Rehabil 1988;9(2):169–71.

[13] Kelley D, Lynch JB. Burns in alcohol and drug users result in longer treatment times with more complications. J Burn Care Rehabil 1992;13:218–20.

[14] Thombs BD, Singh VA, Halonen J, Diallo A, Milner SM. The effects of preexisting medical comorbidities on mortality and length of hospital stay in acute burn injury: evidence from a national sample of 31,338 adult patients. Ann Surg 2007;245(4):629–34.

[15] Tabares R, Peck MD. Chemical dependency in patients with burn injuries: a fortress of denial. J Burn Care Rehabil 1997;18(3):283–6.

[16] Salehi SH, As'adi K, Musavi J, Ahrari F, Nemazi P, Kamranfar B, et al. Assessment of substances abuse in burn patients by using drug abuse screening test. Acta Med Iran 2012;50(4):257–64.