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Epidemiologic Analysis of Burns in Military Hospital

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Purpose: We accessed epidemioloy of 908 acute burns (7 years) in the military, of injuries and propose proper educational programs to suit community.

Methods: We surveyed burn demographics, circumstances of injuries, size, result of treatment.

Results: The mean age was 20.6 years. The flame burns (FB) (325, 35.8%) were most common, followed scald (SB) (305, 33.6%), contact (CB) (219, 24.1%), electric (EB) (45, 5.0%) and chemical burns (ChB) (14, 1.5%). The more occurred during winter (29.7%). SB had mean 3.9% total body surface area (TBSA). The 251 (82.3%) had superficial burns by spillage of hot water/food on lower limbs (45.6%), feet (33.8%) in summer (34.8%), treated with simple dressing (92.8%). Morbidity rate was 5.6%; post traumatic stress disease (PTSD) (0.7%). FB had large wound (9.3% TBSA). The 209 (64.3%) had superficial burns by ignition to flammable oils (31.7%) and bomb powders (29.2%) on head/neck (60.3%), hands (58.6%) in summer (31.7%), autumn (30.2%). They underwent simple dressing (83.4%) and skin graft (16.0%). Morbidity rate was 18.8%; PTSD (10.5%), inhalation injuries (4.0%), corneal injury (3.7%), amputations (0.9%), and mortality rate (1.2%). CB had small (1.1% TBSA), deep burns (78.5%) by hotpack (80.4%) on lower limbs (80.4%). The more (59.8%) underwent skin graft. EB had 6.8% TBSA. The 29 (64.4%) had superficial burns by touching to high tension cable (71.1%) on hand (71.1%), upper limbs (24.4%) in autumn (46.8%). They underwent simple dressing (71.1%) and skin graft (24.4%). They showed high morbidity rate (40.0%); loss of consciousness (13.3%), nerve injuries (11.1%), neuropathy (8.9%), amputations (2.2%), and mortality rate (2.2%).

Conclusions: The cook should wear apron over the boots during work. The lighter or smoking should be strictly prohibited during work with flammable liquids or bomb powders. Don't directly apply hotpack to skin for a long time. Use insulating glove during electric work. Keep to the basic can prevent severe injury and proper education is important.

Keywords: Burn epidemiology; Military; Preventive strategies

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INTRODUCTION

Burn is still remained a global public health problem associated with significant morbidity and mortality [1]. Each year, more than 250,000 deaths occur due to burns on a global scale [2]. And, some victims of burns are suffered from life-long disability, affected the mental health, and imposing a socioeconomic burden. But, all burns are preventable with a little more careful attention. The types and characteristics of burns vary from country to country depending on lifestyle, cultural differences, socioeconomic status, environments and age group. In recent years, the living conditions and awareness of military units have improved so much that only very limited personnel are required to handle water boiling or fire. Also, there are safety regulations. Though they are always trained to be cautious when doing work that poses a risk of burns, but a large number of burns still have occurred annually in the military. We thought the epidemiologic analysis of circumstances of injuries, treatment methods, and morbidity were necessary for each type of burns while treating burned patients for 7 years. We tried to suggest the preventive strategies to reduce burn episodes.

METHODS

We performed retrospective cohort studies with medical records review of 908 acute burn patients admitted to our burn center from January 1, 2010 to December 31, 2016 (7 years). The epidemiologic differences were analyzed by burn type (scald, flame, contact, chemical, and electric). We analysed the differences in the annual and seasonal incidence, circumstances of injuries, affected body parts, size of burns and category, depth, treatment, and morbidity by the types of burns. And, we divided the groups into enlisted man (group 1: n=752, 82.8%) and officers (group 2: n=156, 17.2%), and also investigated the differences between groups.

Statistical computations were conducted with SPSS version 18.0 for Windows (IBM Corp., Armonk, NY, USA). The descriptive analysis, cross tabulation, Chi-square were used to determine statistical significance for comparisons of data from two different groups. Probability value of $p<0.05$ was considered statistically significant.

RESULTS

Gender, age, year, place with group analysis

Of the 908 patients, 905 (99.7%) were male and 3 (0.3%) were female. All women were group 2. The mean age of group 1 was 20.6 years and group 2 was 28.8 years. The group 1 was younger ($p<0.001$). There was no difference in annual incidence between groups ($p=0.476$) (Table 1). group 1 (n=718; 95.5%) was more likely to burn in the

Table 1. Age, year, place with group analysis

	Group 1 (n=752)	Group 2 (n=156)	Total (n=908)	*p*-value
Age (years)	20.6±1.2	28.8±8.2	22.4±5.2	<0.001
Year				0.476
2010	112 (14.9)	15 (9.6)	127 (14.0)	
2011	92 (12.2)	16 (10.3)	108 (11.9)	
2012	101 (13.4)	20 (12.8)	121 (13.3)	
2013	107 (14.2)	22 (14.1)	129 (14.2)	
2014	113 (15.0)	26 (16.7)	139 (15.3)	
2015	119 (15.8)	33 (21.2)	152 (16.7)	
2016	108 (14.4)	24 (15.4)	132 (14.5)	
Place				<0.001
In army base	718 (95.5)	135 (86.5)	853 (93.9)	
Outside	34 (4.5)	21 (13.5)	55 (6.1)	

Values are presented as mean±standard deviation or number (% within group).

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army base than group 2 (n=135; 86.5%) (p<0.001) (Table 1).

Types of burns and season with group analysis

Overall, the flame burns were more common (n=325, 35.8%), followed by scald (n=305, 33.6%), contact (n=219, 24.1%), electric (n=45, 5.0%), and chemical burns (n=14, 1.5%). In group 1, there were more scald burns than flame burns (n=276 vs. n=237), but in group 2, scald burns were significantly less than flame burns (n=29 vs. n=88) (p<0.001). The contact burns were more common in group 1 than group 2 (n= 197 vs. n=22). The electric burns were also more common in group 1 than group 2 (n=30 vs. n=15) (p<0.001) (Table 2).

Seasonally, burns were more common during winter with 270 (29.7%), followed by summer and autumn (n=238, 26.2%, each) and spring (n=162, 17.8%). In Group 2, there was significantly least victims during spring (p=0.002) (Table 2).

The flame burns were more common than scald (n=68 vs. n=64) during spring, near similar (n=103 vs. n=106) during summer and more common (n=98 vs. n=71) during autumn. But, contact burns (n=140) were predominantly common than scald burns (n=64) or flame burns (n=56) during winter (p<0.001) (Table 2).

By the types of burns, scald burns (n=305) were common during summer (n=106, 34.8%) and during autumn (n=71, 23.3%). The flame burns (n=325) were common during summer (n=103, 31.7%) and autumn (n=98, 30.2%). But, during spring, the group 2 (n=8, 9.1%) had significantly less flame burns than group 1 (n=60, 25.3%) (p=0.015). The contact burns (n=219) were significantly more common during winter (n=140, 63.9%) rather than autumn (n=44, 20.1%). There was no seasonal or group difference in the incidence of chemical burns (p=0.626). Electrical burns were common during autumn (n=21, 46.7%) and summer (n=13, 28.9%) (Table 2).

Circumstances of injuries with group analysis

In scald burns, the burns at work-related place (kitchen, work place, outdoor training place) accounted for 225 (73.8%) and at non work-related place (dormitory, bathroom and others) accounted for 80 (26.2%) in total. They were largely caused by hot tap water, hot soup bowls or carriers, water purifiers, instant ramen and cooking oil.

Table 2. Types of burns in Season with group analysis

	Scald (n=305) [33.6]	Flame (n=325) [35.8]	Contact (n=219) [24.1]	Chemical (n=14) [5.0]	Electric (n=45) [5.0]	Total (n=908) [100]
Total	305 (100)	325 (100)	219 (100)	14 (100)	45 (100)	908 (100)
Spring	64 (21.0)	68 (20.9)	22 (10.0)	3 (21.4)	5 (11.1)	162 (17.8)
Summer	106 (34.8)	103 (31.7)	13 (5.9)	3 (21.4)	13 (28.9)	238 (26.2)
Autumn	71 (23.3)	98 (30.2)	44 (20.1)	4 (28.6)	21 (46.7)	238 (26.2)
Winter	64 (21.0)	56 (17.2)	140 (63.9)	4 (28.6)	6 (13.3)	270 (29.7)
Group 1	276 (100)	237 (100)	197 (100)	12 (100)	30 (100)	752 (100)
Spring	61 (22.1)	60 (25.3)	20 (10.2)	3 (25.0)	4 (13.3)	148 (19.7)
Summer	95 (34.4)	72 (30.4)	11 (5.6)	3 (25.0)	10 (33.3)	191 (25.4)
Autumn	67 (24.3)	68 (28.7)	35 (17.8)	3 (25.0)	11 (36.7)	184 (24.5)
Winter	53 (19.2)	37 (15.6)	131 (66.5)	3 (25.0)	5 (16.7)	229 (30.5)
Group 2	29 (100)	88 (100)	22 (100)	2 (100)	15 (100)	156 (100)
Spring	3 (10.3)	8 (9.1)	2 (9.1)	-	1 (6.7)	14 (9.0)
Summer	11 (37.9)	31 (35.2)	2 (9.1)	-	3 (20.0)	47 (30.1)
Autumn	4 (13.8)	30 (34.1)	9 (40.9)	1 (50.0)	10 (66.7)	54 (34.6)
Winter	11 (37.9)	19 (21.6)	9 (40.9)	1 (50.0)	1 (6.7)	41 (26.3)

Values are presented as number (% within group burn type). [ ]: % within total. p-value between types of burns; total <0.001. Within burn type: scald=0.059, flame=0.015, contact=0.052, chemical=0.626, electric=0.296.

Table 3. Circumstances of injuries of scald and flame burns with group analysis

Scald burns	Place				Causes of injuries		
	Group 1 (n=276)	Group 2 (n=29)	Total (n=305)		Group 1 (n=276)	Group 2 (n=29)	Total (n=305)
In army base	272 (98.6)	25 (86.2)	297 (97.4)	Bowl, carrier	176 (63.8)	12 (41.4)	188 (61.6)
Outside of army base	4 (1.4)	4 (13.8)	8 (2.6)	Water purifier	21 (7.6)	6 (20.7)	27 (8.9)
Kitchen	200 (72.5)	12 (41.4)	212 (69.5)	Cooking oil	25 (9.1)		25 (8.2)
Dormitory	55 (19.9)	8 (27.6)	63 (20.7)	Ramen	13 (4.7)	4 (13.8)	17 (5.6)
Bathroom	9 (3.3)	-	9 (3.0)	Coffee pot	12 (4.3)	1 (3.4)	13 (4.3)
Work place	5 (1.8)	2 (6.9)	7 (2.3)	Rice cooker	9 (3.3)	1 (3.4)	10 (3.3)
Training area	3 (1.1)	3 (10.3)	6 (2.0)	Hot tap water	9 (3.3)	-	9 (3.0)
Housing	2 (0.7)	3 (10.3)	5 (1.6)	Boiler	5 (1.8)	4 (13.8)	9 (3.0)
Others	2 (0.7)	1 (3.4)	3 (1.0)	Others	6 (2.2)	1 (3.4)	7 (2.3)
Flame burns	**Group 1 (n=237)**	**Group 2 (n=88)**	**Total (n=325)**		**Group 1 (n=237)**	**Group 2 (n=88)**	**Total (n=325)**
In the army base	226 (95.4)	79 (89.8)	305 (93.8)	Flammable oils	88 (37.1)	15 (17.0)	103 (31.7)
Outside of army base	11 (4.6)	9 (10.2)	20 (6.2)	Bomb powder	55 (23.2)	40 (45.5)	95 (29.2)
Work place	70 (29.5)	54 (61.4)	124 (38.2)	Flammable gas	17 (7.2)	4 (4.5)	21 (6.5)
Training area	92 (38.8)	14 (15.9)	106 (32.6)	Working tools	17 (7.2)	4 (4.5)	21 (6.5)
Kitchen	21 (8.9)	3 (3.4)	24 (7.4)	Fires on field	13 (5.5)	3 (3.4)	16 (4.9)
Instruction site	13 (5.5)	2 (2.3)	15 (4.6)	Mowers	8 (3.4)	2 (2.3)	10 (3.1)
Incinerator	13 (5.5)	2 (2.3)	15 (4.6)	Gas cylinder	5 (2.1)	3 (3.4)	8 (2.5)
Dormitory	11 (4.6)	2 (2.3)	13 (4.0)	Hydrogen gas	3 (1.3)	4 (4.5)	7 (2.2)
Housing	2 (0.8)	7 (8.0)	9 (2.8)	Cooking oil	7 (3.0)	-	7 (2.2)
Restaurant	7 (3.0)	1 (1.1)	8 (2.5)	Fires on House	3 (1.3)	4 (4.5)	7 (2.2)
Others	8 (3.4)	3 (3.4)	11 (3.4)	Others	21 (8.9)	9 (10.2)	30 (9.2)

Values are presented as number (% within group burn type). *p*-value of scald burns: army base=0.004, place <0.001, causes of injuries <0.001; flame burns: army base=0.059, place=0.003, causes of injuries=0.019.

Group 1 was largely caused by food containers (n=176, 63.8%) at kitchens (n=200, 72.5%). But, Group 2 compared to group 1, was more commonly caused by water purifiers (n=6, 20.7%) and ramen (n=4, 13.8%) at dormitory (n=8, 27.6%) (p<0.001, p<0.001) (Table 3).

In flame burns, the burns at work-related place (workplace, training area, kitchen, construction site, incinerator) accounted for 284 (87.4%) at non-work related place(dormitory, home during vacation, restaurant and bar) accounted for 41 (12.6%) in total. They were largely caused by highly flammable oils (solvent, gasoline, thinner, waste oil), bomb powders, and flammable gas (LPG). Group 1 was largely caused by flammable oils (n=88, 37.1%), bomb powder (n=55, 23.2%) at the field/training area (n=92, 38.8%) and the workplace (n=70, 29.5%). Group 2, unlike group 1, was more commonly caused by bomb powder (n=40, 45.5%) at workplace (n=54, 61.4%) (p=0.003, 0.019) (Table 3).

In contact burns, the burns at work-related place (outdoor/training area, kitchen, and others) accounted for 181 (82.6%) and at non-work related place (home, dormitory, medical facility, others) accounted for 38 (17.4%) in total. These were largely caused by hotpack, hot floor (ondol), kitchens, medical hot bags. Group 1 was largely caused by hotpack (n=161, 81.7%) at outdoor/training area (n=156, 79.2%). But, group 2, compared to group 1, was more

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Table 4. Circumstances of injuries of contact, chemical and electric burns with group analysis

Contact burns	Place				Causes of injuries		
	Group 1 (n=197)	Group 2 (n=22)	Total (n=219)		Group 1 (n=197)	Group 2 (n=22)	Total (n=219)
In army base	179 (90.9)	14 (63.6)	193 (88.1)	Hotpack	161 (81.7)	15 (68.2)	176 (80.4)
Outside of army base	18 (9.1)	8 (36.4)	26 (11.9)	Hot floor (Ondol)	11 (5.6)	2 (9.1)	13 (5.9)
Training area	156 (79.2)	13 (59.1)	169 (77.2)	Kitchen utilities	5 (2.5)	2 (9.1)	7 (3.2)
House	11 (5.6)	8 (36.4)	19 (8.7)	Hot bag	7 (3.6)	-	7 (3.2)
Dormitory	12 (6.1)	-	12 (5.5)	Firearms	4 (2.0)	-	4 (1.8)
Hospital	7 (3.6)	-	7 (3.2)	Welding machine	2 (1.0)	1 (4.5)	3 (1.4)
Kitchen	4 (2.0)	-	4 (1.8)	Fireplace	2 (1.0)	1 (4.5)	3 (1.4)
Others	7 (3.6)	1 (4.5)	8 (3.7)	Others	5 (2.5)	1 (4.5)	6 (2.7)
Chemical burns	**Group 1 (n=12)**	**Group 2 (n=2)**	**Total (n=14)**		**Group 1 (n=12)**	**Group 2 (n=2)**	**Total (n=14)**
In army base	12 (100)	2 (100)	14 (100)	Detergents, cleaners	5 (41.7)	-	5 (35.7)
Outside of army base	-	-	-	Battery	3 (25.0)	2 (100)	5 (35.7)
Kitchen	4 (33.3)	-	4 (28.6)	Chemical, acids	2 (6.7)	-	2 (14.3)
Work place	3 (25.0)	1 (50.0)	4 (28.6)	Chemical, alkalies	1 (8.3)	-	1 (7.1)
Vehicle garage	3 (25.0)	1 (50.0)	4 (28.6)	Cement	1 (8.3)	-	1 (7.1)
Dormitory	2 (16.7)	-	2 (14.3)	-	-	-	-
Electric burns	**Group 1 (n=30)**	**Group 2 (n=15)**	**Total (n=45)**		**Group 1 (n=30)**	**Group 2 (n=15)**	**Total (n=45)**
In army base	29 (96.7)	15 (100)	44 (97.8)	High tension cable	19 (63.3)	13 (86.7)	32 (71.1)
Outside of army base	1 (3.3)	-	1 (2.2)	Plug/breakers	11 (36.7)	2 (13.3)	13 (28.9)
Training area	11 (36.7)	6 (40.0)	17 (37.8)	-	-	-	-
Electric pole	9 (30.0)	3 (20.0)	12 (26.7)	-	-	-	-
Dormitory	6 (20.0)	2 (13.3)	8 (17.8)	-	-	-	-
Instruction site	2 (6.7)	2 (13.3)	4 (8.9)	-	-	-	-
Others	2 (6.7)	2 (13.3)	4 (8.9)	-	-	-	-

Values are presented as number (% within group burn type). *p*-value of contact burns: army base=0.001, place=0.001, causes of injuries=0.070; chemical burns: place=0.657, causes of injuries=0.380; electric burns: army base=0.667, place=0522, causes of injuries=0.104.

commonly caused by hotpack (n=15, 68.2%) at home (n=8, 36.4%) (*p*=0.001, *p*=0.070) (Table 4).

In chemical burns, the burns at work-related place (kitchen, workplace, car repair area) accounted for 12 (85.7%) and at non-work related place (dormitory) accounted for 2 (14.3%) in total. These were caused by detergents, cleaner, and battery (calcium hydroxide). There was no difference in place or causes between groups (*p*= 0.657, 0.380) (Table 4).

In electric burns, the burns at work-related place (outdoor/training areas, electric pole, construction sites) accounted for 33 (73.3%) and at non-work related places (dormitory, others) accounted for 12 (26.7%) in total. These were caused by high tension line of electric pole, cable line exposed on the ground, and a low tension line of plug at office. There was no difference in place or causes between groups (*p*=0.522, 0.104) (Table 4).

Affected body part

Body compartment was divided into head/neck, upper limb, hand, lower limb, foot and torso. Only those involved in one compartment were defined as single site

Table 5. Affected body part

	Scald (n=305)		Flame (n=325)		Contact (n=219)		Chemical (n=14)		Electric (n=45)	
	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple	Single	Multiple
Total	193 (63.3)	438 (143.6)	133 (40.9)	623 (191.7)	217 (99.1)	221(100.9)	11 (78.6)	20 (142.9)	28 (62.2)	63 (140.0)
Head/Neck	13 (4.3)	34 (11.1)	48 (14.8)	196 (60.3)	-	-	5 (35.7)	7 (50.0)	3 (6.7)	4 (8.9)
Upper limb	15 (4.9)	51 (16.7)	6 (1.8)	97 (29.8)	2 (0.9)	2 (0.9)	4 (28.6)	6 (42.9)	-	11 (24.4)
Hand	39 (12.8)	71 (23.3)	45 (13.8)	190 (58.5)	10 (4.6)	11 (5.0)	1 (7.1)	3 (21.4)	23 (51.1)	32 (71.1)
Lower limb	67 (22.0)	139 (45.6)	26 (8.0)	92 (28.3)	175 (79.9)	176 (80.4)	1 (7.1)	2 (14.2)	-	5 (11.1)
Foot	52 (17.0)	103 (33.8)	3 (0.9)	11 (3.4)	19 (8.7)	20 (9.1)	-	2 (14.2)	2 (4.4)	5 (11.1)
Torso	7 (2.3)	40 (13.1)	5 (1.5)	37 (11.4)	11 (5.0)	12 (5.5)	-	-	-	6 (13.3)

Values are presented as number (% within group burn type). *p*-value between types of burns <0.001.

involvement.

Single site involvement was more common in contact burns (n=217, 99.1%), followed by chemical (n=11, 78.6%), scald (n=193, 63.3%), electric (n=28, 62.2%) and flame burns (n=133, 40.9%). The site/person ratio was the highest in flame burns as 191.7% (623/325), followed by scald 143.6% (438/305), chemical 142.9% (20/14), electric 140.0% (63/45) and contact 100.9% (221/219). Overall, multiple site involvement was more common in flame burns (n=192, 59.1%) and followed by electric (n=17, 37.8%, scald (n=112, 36.7%), chemical (n=3, 21.4%, and contact burns (n=2, 0.9%) (p<0.001).

The analysis of multiple site involvement showed that the commonly affected sites were lower limb (n=139, 45.6%) and foot (n=103, 33.8%) for scald, head/neck (n=196, 60.3%) and hands (n=190, 58.5%) for flame, head/neck (n=7, 50.0%) and upper limb (n=6, 42.9%) for chemical, and hand (n=32, 71.1%) and upper limb (n=11; 24.4%) for electric burns without group differences (p=0.932, 0.168, 0.280, 0.204, respectively). In contact burns, the most commonly affected parts were lower limb (n=176, 80.4%) and foot (n=20, 9.1%) with group difference (Table 5).

Severity of injuries, size and depth

We defined burns involving less than 10% TBSA as minor, burns involving 10-30% TBSA as moderate and burns involving more than 30% TBSA as major burns. We defined the second superficial degree as superficial burns, the deep second and third degree as deep burns. The combined superficial and deep burns regarded as deep burns

The large number (n=793, 87.3%) of the victims had minor burns, followed moderated burns (n=91, 10.0%), and major burns (n=24, 2.6%). The mean burn size of total patients accounted for 5.3% TBSA. The group 2 had more larger burned area than group 1 (mean; 8.8% vs. 4.6% TBSA) (p<0.001). By the analysis to types of burns, the mean burn size of flame burn was the largest (9.3% TBSA), followed by electric (6.8% TBSA), scald (3.9% TBSA), chemical (3.8% TBSA), and contact burns (1.1% TBSA) (p=0.029).

In scald burns, the minor burns accounted for 282 (92.5%), moderate burns for 22 (7.2%) and major burns for 1 (0.3%). In flame burns, the minor burns accounted for 243 (74.8%), moderate burns for 61 (18.8%) and major burns for 21 (6.5%). The flame burns had more moderate and major burns than scald burns. The Group 2 of flame burns had larger burned area than Group 1 (11.8% TBSA vs. 8.4% TBSA) (p=0.048).

All the contact burns were minor of mean 1.1% TBSA. In chemical burns, the major had minor burns (n=13, 92.9%) except one (7.1%) moderate burns. There was no difference between groups. In electric burns, the minor burns accounted for 36 (80.0%), moderate burns for 7 (15.6%) and major burns for 2 (4.4%). The electric burns had more moderate and major burn than scalds (Table 6).

In analysis of burn depth, of the total 908, the superficial burn accounted for 549 (60.5%), deep burns for 355 (39.1%), soft tissue involved burns for 2 (0.2%) and bone involved burns for 2 (0.2%). In scald burns, superficial burns accounted for 251 (82.3%) and deep burns for 54 (17.7%). In flame burns, superficial burns accounted

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Table 6. Severity of injuries, size and depth of burns

	Scald (n=305)	Flame (n=325)	Contact (n=219)	Chemical (n=14)	Electric (n=45)	Total (n=908)	*p*-value
Size							
Mean (% TBSA)							0.029
Total	3.9±3.8	9.3±12.7	1.1±0.3	3.8±3.9	6.8±17.2	5.3±9.4	
Group 1	3.8±3.7	8.4±11.3	1.0±0.2	3.9±4.2	4.6±11.5	4.6±7.6	
Group 2	4.7±5.0	11.8±7.6	1.3±0.7	3.0±1.4	11.3±24.9	8.8±14.8	
Category (% TBSA)							<0.001
<10	282 (92.5)	243 (74.8)	219 (100)	13 (92.9)	36 (80.0)	793 (87.3)	
10-19	20 (6.6)	49 (15.1)	-	1 (7.1)	6 (13.3)	76 (8.4)	
20-29	2 (0.7)	12 (3.7)	-	-	1 (2.2)	15 (1.7)	
30-39	1 (0.3)	8 (2.5)	-	-	-	9 (1.0)	
40-49	-	6 (1.8)	-	-	-	6 (0.7)	
50-59	-	2 (0.6)	-	-	-	2 (0.2)	
60-69	-	1 (0.3)	-	-	1 (2.2)	2 (0.2)	
70-79	-	2 (0.6)	-	-	-	2 (0.2)	
>90	-	2 (0.6)	-	-	1 (2.2)	3 (0.3)	
Depth							<0.001
Superficial	251 (82.3)	209 (64.3)	47 (21.5)	13 (92.9)	29 (64.4)	549 (60.5)	<0.001
Deep	54 (17.7)	115 (35.4)	171 (78.1)	1 (7.1)	14 (31.1)	355 (39.1)	<0.001
Soft tissue	-	-	1 (0.5)	-	1 (2.2)	2 (0.2)	
Bone	-	1 (0.3)	-	-	1 (2.2)	2 (0.2)	0.157

Values are presented as mean±standard deviation or number (% within burn type).
TBSA: total body surface area.

for 209 (64.3%), deep burns for 115 (35.4%) and bone involve burns for 1 (0.3%).The flame burns had more deeper burns than scalds (p<0.001). In contact burns, superficial burns accounted for 47 (21.5%), deep burns for 171 (78.1%) and soft tissue involved burns for 1 (0.5%). The more contact burns hand deeper burns than flame burns. Most (n=13, 92.9%) chemical burns were superficial. There was no difference between groups (p=0.672). In electric burns, the superficial accounted for 29 (64.4%), deep burns 14 (31.1%), soft tissue involved burns for 1 (2.2%) and bone involved burns for 1 (2.2%). The electrical burns showed near similar tissue damage to flame burns (Table 6).

Treatments

A simple debridement of burned wound was excluded in analysis. In scald burns, 283 (92.8%) underwent simple dressings, 22 (7.2%) underwent skin grafts. The flame burns underwent 271 (83.4%) and 52 (16.0%), respectively. The contact burns underwent 85 (38.8%) and 131 (59.8%), respectively. The electrical burns underwent 32 (71.1%) and 11 (24.4%), respectively. All chemical burns were healed by only simple dressing.

The flap surgery was performed in six patients (0.7%). These were 3 (1.4%) for contact burns, 2 (4.4%) for electric burns and 1 (0.3%) for flame burns. There were 2 (0.2%) minor amputation for flame burns. There were 3 (0.3%) major amputations, in total. These were one for flame (0.3%), for contact (0.5%), for electrical burn (2.2%).

Overall, the higher proportion of contact burns underwent surgery (grafting, flap, and amputation), and followed electrical, flame and scald burns (p<0.001). The post burn wound hypertrophy accounted for 60 (6.6%).

Table 7. Comparison of treatments method

Treatment	Scald (n=305)	Flame (n=325)	Contact (n=219)	Chemical (n=14)	Electric (n=45)	Total (n=908)
Dressing	283 (92.8)	271 (83.4)	85 (38.8)	14 (100)	32 (71.1)	685 (75.4)
STSG	21 (6.9)	52 (16.0)	126 (57.5)	-	10 (22.2)	209 (23.0)
FTSG	1 (0.3)	-	5 (2.3)	-	1 (2.2)	7 (0.8)
Flap surgery	-	1 (0.3)	3 (1.4)	-	2 (4.4)	6 (0.7)
Fasciotomy	-	-	-	-	2 (4.4)	2 (0.2)
Minor amputation	-	2 (0.6)	-	-	-	2 (0.2)
Major amputation	-	1 (0.3)	1 (0.5)	-	1 (2.2)	3 (0.3)
Respiratory care	-	4 (1.2)	-	-	-	4 (0.4)
Dermal regenerative graft	-	4 (1.2)	-	-	-	4 (0.4)
Skin rehabilitation	4 (1.3)	25 (7.7)	-	-	2 (4.4)	31 (3.4)

Values are presented as number (% within group burn type). *p*-value between types of burns <0.001.
STSG: split thickness skin graft, FTSG: full thickness skin graft.

Among them, 31 (3.4%) received skin rehabilitation therapy. These accounted for 25 (7.7%) for flame, four (1.3%) for scald burns. The four (1.2%) of flame burns underwent dermal degenerative graft surgery by burn wound hypertrophy. The inhalation injuries accounted for 13 (4.0%) among flame burns. The four (1.2%) among them, needed intensive respiratory care (Table 7).

Morbidity

Of the total, 101 (11.1%) patients encountered 167 (18.4%) cases of associated injuries or complications. Morbidity rate was more higher for electric burns (28 cases; 62.2% in 18 patients; 40.0%), followed by flame (114 cases; 35.1% in 61 patients; 18.8%), chemical (1 case; 7.1% in 1 patient), scald (19 cases; 6.2% in 17 patients; 5.6%), contact burns (5 cases; 2.3% in 4 patients; 1.8%) (p=0.002).

The case/person ratio was the highest for flame burns as 1.9, and followed by electric (1.6), contact burns (1.3) and scald burns (1.1).

The 60 (6.6%) patients presented post burn wound hypertrophy in total. These were 41 (12.6%) for flame burns, 16 (5.2%) for scald burns, 2 (4.4%) for electric burns and 1 (0.5%) for contact burns. The 38 (4.2%) patients presented post traumatic stress disease (PTSD) in total. These were 34 (10.5%) for flame burns, 2 (0.7%) for scald burns, one for electric burns (2.2%) and contact burn (0.5%). There were 14 cases (1.5%) of corneal injuries. They were common with flame burns (n=12, 3.7%). There were 13 cases (4.0%) of inhalation injuries in flame burns. One among them died. The morality rate of inhalation injuries was 7.7%. Other associated injuries seen in flame burns were chondritis, testicular injury, vocal cord injury, and nasal bone fracture. There were rhabdomyolysis and zygoma fracture in contact burns. The common associated injuries were loss of consciousness (LOC) (n=6, 13.3%), nerve injuries (Median, Ulnar, Radial, Peroneal, paraplegia) (n=5, 11.1%), neuropathy (n=4, 8.9%). fractures (C-spine, Lumbar, Patellar) (n=3, 6.7%) in electric burns.

There were 2 (0.6%) minor amputations in flame burns. There were 3 (0.3%) major amputations in total. These were one for flame (0.3%), contact (0.5%) and electric (2.2%) burns, respectively. The mortality rate was 0.5% (n=5) of all patients. These were 4 (1.2%) for flame burns and 1 (2.2%) for electric burns. There were 2 deaths in group 1 (0.8%) and in group 2 (2.3%), each, in flame burns. The group 2 had higher mortality rate than group 1 in flame burns (Table 8).

DISCUSSION

There are not many epidemiological studies on burns

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Table 8. Morbidity of burns

	Scald (n=305)	Flame (n=325)	Contact (n=219)	Chemical (n=14)	Electric (n=45)	Total (n=908)
Patient	17 (5.6)	61 (18.8)	4 (1.8)	1 (7.1)	18 (40.0)	101 (11.1)
Cases	19 (6.2)	114 (35.1)	5 (2.3)	1 (7.1)	28 (62.2)	167 (18.4)
Case/patient	1.1	1.9	1.3	1.0	1.6	1.7
Burn wound hypertrophy	16 (5.2)	41 (12.6)	1 (0.5)	-	2 (4.4)	60 (6.6)
PTSD	2 (0.7)	34 (10.5)	1 (0.5)	-	1 (2.2)	38 (4.2)
Corneal injuries	1 (0.3)	12 (3.7)	-	1 (7.1)	-	14 (1.5)
Inhalation injuries	-	13 (4.0)	-	-	-	13 (1.4)
LOC	-	-	-	-	6 (13.3)	6 (0.7)
Nerve injury[a]	-	-	-	-	5 (11.1)	5 (0.6)
Fracture[b]	-	1 (0.3)	1 (0.5)	-	3 (6.7)	5 (0.6)
Neuropathy	-	-	-	-	4 (8.9)	4 (0.4)
Burn scar contracture	-	2 (0.6)	-	-	1 (2.2)	3 (0.3)
Major amputation	-	1 (0.3)	1 (0.5)	-	1 (2.2)	3 (0.3)
Minor amputation	-	2 (0.6)	-	-	-	2 (0.2)
Mortality	-	4 (1.2)	-	-	1 (2.2)	5 (0.6)
Others[c]	-	4 (1.2)	1 (0.5)	-	4 (8.9)	9 (1.0)

Values are presented as number (% within burn type).
PTSD: post traumatic stress disease, LOC: loss of consciousness.
[a]Nerve injury: radial, ulnar, median, peroneal, paraplegia.
[b]Fracture: nasal bone, zygoma, cervical spine, lumbar, patellar.
[c]Others: condritis, Testicular injury, tympanic membrane perforation, vocal cord injury, epidural hematoma, deep vein thrombosis, alopecia, *p*-value between types of burns=0.002.

worldwide. The National Burn Repository (NBR) was first published in 2002 by the American Burn Association after 15 years of preparation. Since then, in 2009, the more centers had participated and systematically reported the results of 127,016 patients treated at 79 centers from 1999 to 2008. The revision has been conducted annually to improve the outcome of treatment [3]. The Tokyo Burn Unit Association of Japan reported 6,988 results from 13 burn units in Tokyo for 20 years (1983-2003) [4]. Chien et al. [5], Tung et al. [6] of Taiwan and Song and Chua [7] of Singapore published epidemiological papers based on years of experience.

Unfortunately, Korea still lacks on efforts to set up the nation-wide registry of burns. Han et al. [8] reported the results of 19,157 patients treated at Hangang Sacred Heart Hospital for 18 years (1986-2003). In Hanil Hospital, Song et al. [9] reported the results of 4,321 burns and Song et al. [10] reported the results of 1,451 electric burns treated for 10 years (1966-2005). Shin et al. [11] reported the epidemiologic characteristics of death by burn injury from 1991 to 2001.

There are some limitations in comparisons with the epidemiologic outcomes of civilian hospitals. Our analysis is mostly for men aged 20-40 years, excluding children, women, and elderly patients. And, they are soldiers who performed their tasks in confined areas. Nonetheless, we think the characteristics of military epidemiologic investigations can suggest the strategies to reduce burn episodes.

All epidemiologic reports mentioned the flame burns were the most common in adults. By the NBR, flame burns were the most common as 46.2% in 20-29.9 years [3]. Han et al. [8] also reported that, in adult, the leading causes of burns were flame (57.3%), electrical (16.2%) and scalds (13.1%). Our analysis also showed the flame

burns (35.8%) were more common than scalds (33.6%). For contact burns, NBR reported as 5.4% of total patients in 20-29.9 years [3]. Song et al. [9] reported as 9.3%. However, our data showed the contact burns were significantly common (24.1%). This was probably due to the frequent application of portable hotpack during outdoor activities in winter. For chemical burns, NBR was reported as 3.7% in 20-29.9 years [3]. Song et al. [9] reported as 2.1%. But our data showed relatively rare (1.5%). For electric burns, NBR was reported as 5.4% in 20-29.9 years [3]. Han et al, [8] reported as 9.5%. Our analysis showed similar incidence (5.0%).

Chien et al. [5] reported the burns were common during spring (26.4%). Han et al. [8] reported burns were common in July. But, Song and Chua [7] and Song et al. [9] reported there was no seasonal difference. Our data showed the burns were common during winter (29.7%) rather than summer (26.2%), autumn (26.2%), and rare during spring (17.8%). It was believed that there were many contact burns by hotpack in winter.

By the NBR, burns had occurred commonly in the home (65.5%). The 65.0% of cases of injury were identified as accident, non-work related. Only 15.2% were work related accident [3]. Chien et al. [5] reported that burns had occurred in the home (48.1%), 30.8% by work related, 29.4% by domestic activities. But our results showed burns had occurred mainly in the military base as work related accidents.

In the case of scald burns, Song et al. [9] reported that the main causes were direct contact with hot tab water (32.9%) or spilling of hot soup (28.1%), boiling water (13.8%), ramen and instant food (10.3%) in the housing (87.4%). Our results showed the main causes were dropping and spillage of bowl/carrier contents (61.6%), water purifier (8.9%), cooking oils (8.2%), ramen (5.6%) as accident worked related (73.8%).

In the case of flame burns, Song et al. [9] reported that the main causes were flammable oils (29.3%), flammable gas explosion (18.9%) in the kitchen/dining room, and large fire (14.0%) in the housing (43.7%) or work place (23.5%). Our results showed, differently, the main causes were flammable oils (31.7%), bomb powder (29.2%) as accident worked related (87.4%).

In the case of contact burns, Song et al. [9] reported that the main causes were motor vehicles (9.0%), sauna (4.5%), hot objects (25.8%), lying one hot floor (16.9%) and medical hot bag (11.2%) in the house (56.5%) or work place (16.9%). Our results showed, differently, the mains causes were hotpack (80.4%) as accident worked related (82.6%).

In the case of chemical burns, Song et al. [9] reported that they were caused by acids (43.8%) and alkalies (11.2%) in the factory workshop (49.4%) or home (39.3%). Notably, 32.6% of the patients were caused by acetic acid (15.7%) and herb medicine (16.9%) for treatment of Tinea pedis. Our results showed, the mains causes of chemical burns were detergent or cleaner (35.7%), battery (calcium hydroxide) (35.7%) as accident worked related (85.7%).

NBR reported that most electric burns were work related accidents (63.2%) that occurred at an industrial setting (43.6%). The non-work related accidents were 28.3% and 24.5% occurred in the home [3]. Song et al. [10] also reported that the main causes were high tension current (63.3%) and low tension current (36.7%) in work places/substations (60.6%) and housing (39.4%). Our results showed, the main causes were touching to high tension current lines (71.1%) or low tension plug or breaker (28.9%) as accident worked related (73.3%).

Chien et al. [5] reported that the average number of sites of burns for each patient was four. The most frequently injured areas were the lower limbs, upper limbs, hands and head. Han et al. [8] reported that multiple site burns represented 74.3% of the total. Isolated head and neck burns represented 6.1% of the total whilst isolated upper limb and lower limb represented 9% and 8.6%, respectively. In our analysis, the percentage of multiple site burns was lower than other reports. Multiple site involvement was highest in flame burns (59.1%) and followed electric (37.8%), scald (36.7%), chemical (21.4%) and contact burns (0.9%). The commonly affected sites were lower limbs (45.6%) and feet (33.8%) for scald, head/neck (60.3%) and hands (58.5%) for flame, lower limbs (80.4%) and feet (8.7%) for contact, head/neck (50.0%) and upper limbs (42.9%) for chemical and hands (71.1%) and upper limbs (24.4%) for electric burns.

NBR reported that the mean total burn size for all cases was 14.0% TBSA. For full thickness burns, the mean size was 5.4% TBSA. For partial thickness burns, it was

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8.0% TBSA. About 67% of total burns sizes were less than 10% TBSA. Nearly 75% of the full thickness burns were under 10% [3]. Han et al. [8] reported that burns involving <10% of body surface was the most common (46.9%), followed by 10-19% (20.5%), and then 20-29% (9.7%). And, they reported that in burns involving <10% of body surface, scalds were most common cause (35.1%). In burns between 10 to 20% TBSA, scalds and flame had similar numbers. In our analysis, mean % TBSA was 3.9% for scald, 9.3% for flame, 1.1% for contact and 6.8% for electric burns. The minor burns were 92.5% for scald, 74.8% for flame, 100% for contact and 80.0% for electric burns. The moderate and major burns were 7.5% for scald, 25.2% for flame and 20.0% for electric burns. Therefore, flame burns had more moderate and major burn than electric and scald burns. Overall, compared to other reports, there were fewer major burns in the military than civilian hospitals.

By the analysis of burn depth, in our analysis, most patients had superficial burns. The 82.3% of scald, 64.3% of flame, 21.5% of contact, 92.9% of chemical and 64.4% of electric burns had superficial burns. The deep burns (including soft tissue and bone involvement) accounted for 17.7% of scald, 35.7% of flame, 78.5% of contact, 7.1% of chemical, and 35.6% of electrical burns. The depth of electric burns were near similar to that of flame burns, and were deeper than scald burns. Characteristically, the contact burns had more deep burns than others.

Chien et al. [5] reported that 64.1% of patients underwent surgical procedures (operation), the average number of operation for person was 1.8 times. The types of operations included escharotomy (5.9%), debridement (37.3%), skin grafting (46.2%) and amputation (4.0%). Song et al. [9] reported that the 86.3% of scald, 68.6% of flame, 54.2% of contact, and 71.9% of chemical burns were treated only with simple dressing. Skin grafts were performed in 33.5%, 27.0%, 43.0% and 31.5% respectively. The flap surgery was performed in 1.2%, 0.2%, 7.2% and 7.9%, respectively. In our analysis, only simple dressing was performed in 75.4% of total (scald 92.8%, flame 83.4%, contact 38.8%, electric 71.1%). Skin grafts were performed in 23.8% of total (scald 7.2%, flame 16.0%, contact 59.8%, electric 24.4%). The flap surgeries were performed in 0.7% of total (flame 0.3%, contact 1.4%, electric 4.4%). Overall, less advanced treatments (skin graft, flap surgery, or amputation) were performed in scald or flames burns compared to civilian. This was because the burn sizes of scald and flame burns were relatively small and depth of injuries were more superficial. But, in contact burns, more patient underwent skin grafts in the military. The dermal degenerative graft operation was performed 1.2% of flame burn. It was rare than that of NRB (2.4%) [3].

There are not many reports on associated injuries. In our analysis, the morbidity rate was more higher for electric burns as 40.0% rather than flame (18.8%), scald (5.6%), contact burns (1.8%). The case/person ratio was more higher for flame burns as 1.9 rather than electric (1.6), contact (1.3), scald burns (1.1). The 6.6% of total presented post burn wound hypertrophy (flame 12.6%, scald 5.2%, electric 4.4%, contact 0.5%). The 4.2% of total presented PTSD (flame 10.5%, electric 2.2%, scald 0.7%, contact 0.5%). The associated injuries commonly seen in electric flame burns were LOC (13.3%), nerve injuries (11.1%), neuropathy (8.9%), fractures (6.7%), similar to report of Song et al. [10].

NBR reported that inhalation injury was one of the most lethal morbidity of burn victims. Deaths increased with advancing age and burn size, and presence of inhalation injury [3]. Song et al. [9] reported that the incidence of inhalation injury was 8.9%, the mortality rate of inhalation injuries was 22.3%. In our analysis, the incidence of inhalation injuries were 4.0% and mortality rate was 7.7%. These were quite lower than other reports. It was because there were less closed-space fire accidents.

Song et al. [9] and Song et al. [10] reported the minor amputations rate was 1.2% for contact, 6.7% for chemical, and 8.1% for electric burns. The major amputation rate was 0.1% for flame and 8.3% for electric burns. In our analysis, the minor amputation rate was 0.6% for flame burns. The overall major amputation rate was 0.3% for flame, 0.5% for contact and 2.2% for electric burns. The major amputation rate for electric burn was lower than other report [10].

The NBR reported the overall mortality rate was 5.5%. The leading causes were burn shock, respiratory failures and multiple organ failure. Death from burn injury increased with advanced age and burn size, and presence of

inhalation injury [3]. Mortality was proportional to the extent of body surface area, reaching 55.1% in 70-79%, 70.6% in 80-99%, and 82.6% over 90% TBSA [11-13]. Han et al. [8] reported the overall mortality rate was 8.2%. The high risk group for mortality could be identified as middle-aged male patients, burnt by flame accident, who suffer from more extensive injury and expire within 48h after admission. The mortality rate within 48 hours was 86.8%. The mortality was proportional to the extent of body surface area of burns. Song et al. [9] and Song et al. [10] reported the mortality rates was 0.04% for scald, 5.6% for flame and 0.2% for contact, 1.7% for electric burns. In our analysis, The overall mortality was 0.6% (5 cases). The mortality rate was 1.2% for flame (4 cases), 2.2% for electric burns (1 case). All the victims suffered from extensive injury (44% with inhalation, 70%, 92%, 96%, and 97% TBSA). The causes of death were burn shock or respiratory failure within 6 days of accident (post burn day; 2, 6, 4, 3, 1, respectively), Though the mortality rate was lower than others, the causes and date of death were similar to other reports.

In summary, the scald burns were largely resulted from dropping bowl or carrier and flowing hot water or soup into boots, in summer. The commonly affected sites were lower limbs or feet. The mean size was 3.9% TBSA. The 82.3% of them had superficial burns. Most of them (92.3%) were treated with simple dressing. The morbidity rate was 5.6%.

The flame burns (35.8%) were largely resulted from ignition of clothes by burning on lighter for smoking during handling the flammable oils or bomb powder in outdoor workshop or a training ground, in summer or autumn. The commonly affected sites were head/neck and hands. The mean size was large as 9.3% TBSA. The 64.3% of them had superficial burns. They underwent simple dressing for 83.4%, skin graft for 16.0% and skin rehabilitation for 7.7%. The morbidity rate was 18.8%.

The contact burns were largely resulted from direct applying the hotpack to skin under the socks for a long time (over night) during outdoor activities in winter. The commonly affected sites were lower limb. The small lesion had deep burns. The more (59.8%) underwent skin grafts. The morbidity rate was 1.3%.

The chemical burns were largely caused by detergents/cleaners and batteries. The commonly affected sites were head/neck and upper limbs. The mean size was 3.8% TBSA. Most of them (92.9%) had superficial burns. All were treated with simple dressing.

The electric burns were largely resulted from touching the high tension cable in the workplace, by misuse of home appliance (low tension currency) with their bare hands, in autumn. The commonly affected sites were hands and upper limbs. The mean size was 6.8% TBSA. The only 64.4% of them had superficial burns. They underwent simple dressing for 71.1%, skin graft for 24.4% and skin rehabilitation for 4.4%. The morbidity rate was high as 40.0%.

CONCLUSION

In order to implement a successful burn injury prevention program, it is important to focus on selected issues. The cook should wear the apron over the boots during cooking at the dining room. The lighter or smoking should be strictly prohibited during work by flammable liquids or bomb powders. Pay attention in dealing with bomb powders. Don't directly apply hotpack to skin for a long time and should change the position frequently. The hight tension live line is always very dangerous. Use the insulating gloves during electric work.

Keep to the basic can prevent the severe injuries. The proper education is important. All burns are preventable.

Our ongoing efforts are to promote and support prevention programs and look for changes in the incidence of burnt injury. In addition, we want to study further implications of changes in management protocols and policies on the outcome of our treatment.

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