

Joanne G. Parks,<sup>1</sup> M.D.; Thomas T. Noguchi,<sup>2</sup> M.D.; and Edward C. Klatt,<sup>3</sup> M.D.

## The Epidemiology of Fatal Burn Injuries

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**REFERENCE:** Parks, J. G., Noguchi, T. T., and Klatt, E. C., "The Epidemiology of Fatal Burn Injuries," *Journal of Forensic Sciences*, JFSCA, Vol. 34, No. 2, March 1989, pp. 399-406.

**ABSTRACT:** The paper retrospectively reviews 80 burn fatalities from accidents or attempted suicides with patients admitted to the LAC-USC Medical Center from 1983 to 1987 to determine demographic factors, etiology of the burn injury, and existence of predisposing risk factors. The average age of fatal burn victims was 44 years; 74% were males, 39% were Caucasian, 35% were black, 21% were Hispanic, and 5% were of Asian descent. Blacks and Caucasians were overrepresented and Hispanics underrepresented in relation to all autopsy cases. Major etiologic factors included suicide, falling asleep while smoking, accidents while working with volatile solvents, housefires, scalds, cooking accidents, and accidents involving motor vehicles. Gasoline was the commonest solvent involved with burn fatalities. Significant risk factors for burn fatality were substance abuse (25% of cases) and impaired mental function (19% of cases).

**KEYWORDS:** pathology and biology, burns (injuries), epidemiology, demography

Previous studies have described the epidemiology of burn injuries in a community [1-13]. This study concerns burn fatalities that occurred at a large, acute-care hospital, one of three burn centers in Los Angeles County, California. By examining various demographic factors, causes for burn injury, and the existence of predisposing risk factors, we characterized those persons at increased risk for burn fatality and suggest ways that fatalities from burns can be avoided.

### Materials and Methods

The authors reviewed the autopsy records which included abstracted clinical histories of 80 burn fatalities occurring from 1983 to 1987, all patients admitted to the Los Angeles County-University of Southern California (LAC-USC) Medical Center burn unit. Demographic and clinical data obtained included age, sex, race, history of tobacco use, history of alcohol consumption, history of drug use, psychiatric history, physical examination, and medications prescribed before the burn injury. The cause and the circumstances of each burn injury were reviewed to determine how the circumstances at the scene of injury related to demise of the victims. Conditions evaluated for predisposition to burn fatality were alcoholism, substance abuse, and psychiatric diagnosis antedating the burn injury. The mode of

Received for publication 18 April 1988; accepted for publication 13 May 1988.

<sup>1</sup> Research fellow in pathology, Los Angeles County-University of Southern California Medical Center, Los Angeles, CA.

<sup>2</sup> Professor of clinical pathology (forensic), University of Southern California, Los Angeles, CA; formerly, chief medical examiner-coroner, County of Los Angeles, Los Angeles, CA.

<sup>3</sup> Deputy medical examiner, County of Los Angeles, chief of autopsy, LAC-USC Medical Center, and assistant professor of pathology, University of Southern California, Los Angeles, CA.

death in all 80 cases was either accident or suicide; there were no cases of homicide in this study (these were all performed at the Forensic Science Center, Los Angeles County).

## Results

Age ranges, ethnic group, and sex of burn fatalities are detailed in Table 1. Of the 80 patients who died from burn injuries, 59 (74%) were males and 21 (26%) were females. Of the female victims, 50% were over the age of 50, while 42% of the male victims were 16 to 35 years of age. In addition, 33% of the male victims were 46 to 65 years old. Mean age of all fatalities was 44 years (range 8 months to 94 years). There were 7 victims under age 5, and 57% of these were Hispanic. Hispanics also were the majority of the 5 victims between ages 16 and 20.

Overall, we found that 39% of victims were Caucasian, 35% black, 21% Hispanic, and 5% of Asian descent. In all groups, males were the majority of victims, ranging from 65% of the Hispanic population to 100% of the Asians. There were no female Asian burn fatalities. For the period 1983 to 1987, there were 2160 total autopsy cases within the age range of the burn fatality cases, of which 43% were Caucasians, 24% blacks, 30% Hispanic, and 3% Asian. Of these 2160 cases, 70% were males and 30% females.

Table 2 details burn deaths by cause of fire and preexisting psychiatric or neurologic diagnosis. Nine causes of burn injury were present among the eighty victims. These included suicide, falling asleep while smoking, motor-vehicle accidents, use of volatile solvents, housefires not related to smoking, scalding accidents, cooking accidents, outdoor fires, and other miscellaneous accidents. We correlated each cause for burn injury with age of the victim. Of victims less than 5 years old, 57% were involved in noncigarette-related housefires that they may have started; 60% of the 16- to 20-year-old victims were in fires related to motor vehicles, either traffic accidents with fires or accidental fires while repairing automobiles. Working with volatile chemicals posed a significant threat to 57% of the 21- to 25-year olds who died of their burns.

Each group of fatalities by cause of burn injury is detailed below.

### *Suicide*

Sixty percent of the suicide victims were males, forty percent females. The method of suicide differed by sex. Males were much more likely to pour flammable liquid on themselves and ignite it, whereas women tended to light a fire and involve themselves secondarily in that fire. There were no burn suicide fatalities among Hispanics. Of the suicide fatalities 50% were between the ages of 26 and 40 years. Of the suicide victims 50% had previous psychiatric histories and 20% had a history of alcohol abuse.

### *Smoking*

At least 26% of all burn fatalities in this study were documented smokers. Of the victims who fell asleep while smoking, 67% (eight) were male and 33% (four) were female. None of the victims who fell asleep smoking were Hispanic or Asian. Eight (67%) of the victims had histories of alcohol abuse or intravenous drug abuse, and four had documented psychiatric deficits including schizophrenia, dementia, and alcohol-related blackouts.

### *Motor Vehicles*

Of the victims 90% (9) were male and 10% (1) were female. Of the victims 50% (5) were Caucasian with an average age of 47 and a range of 25 to 65. The 2 black victims were 19 and 54 years old. The only Asian victim was 59 years old. The majority of these victims were in

TABLE 1—Burn cause and ethnic group related to age.<sup>a</sup>

Age	Sex	Suicides		Smoking		Automobiles		Solvents		Housefire		Scalding		Cooking		Outdoor Fire		Other														
		CB	HA	CB	HA	CB	HA	CB	HA	CB	HA	CB	HA	CB	HA	CB	HA	CB	HA													
	M																															
0-5	4							1			1																					
6-15	0										3																					
16-20	4																															
21-25	7					1	2		1																							
26-30	8	1	1					1											1													
31-35	6	1				1																										
36-40	1	1																	1													
41-45	0																															
46-50	2		1																													
51-55	4																															
56-60	8	1																	1													
61-65	6	1				3													1													
66-70	1	3																	1													
71-75	3	1																	1													
76-80	3	1																	1													
81-85	2		1																1													
86-90	0																		1													
90+	0																		1													
Total	59	21	6	2	0	7	5	0	4	3	2	1	2	4	5	0	3	4	5	0	2	2	2	0	0	2	1	0	4	2	1	1

<sup>a</sup>C = Caucasian, B = black, H = Hispanic, A = Asian.

TABLE 2—Risk factors related to etiology of burn injury by sex.

Burn Cause	No Previous Psychiatric History	Psychiatric History Unknown	Psychosis/ Schizophrenia	Affective Disorder	+ Psychiatric		Seizure Disorder	Dementia/ Blackouts	Substance Abuse
					Diagnosis Unknown	History			
Suicide: male	1	2	1	1		1			1
female	2		2						1 <sup>a</sup>
Smoking in bed: male	5	1						2	6
female	2		1					1	2
Automobile: male	5	3							1
female	1								
Solvent related: male	10	1							2
female									
Housefire: male	8							1	2
female	2								
Scalding: male	3	1	1					1	1
female									
Cooking: male	3	1							2
female	2							1	
Outdoor fire: male	5								
female			1				1 <sup>b</sup>		
Other cause: male	5								2
female	1						1		
Total male	42	9	2	1		1	0	4	17
female	13	0	4	0		0	2	2	3

<sup>a</sup>Patient also had history of psychosis.

<sup>b</sup>Patient also had history of schizophrenia.

traffic accidents, but 2 of them were involved in unexplained fires that occurred while they were working on the engines.

#### *Volatile Solvents*

There were eleven burn fatalities from volatile solvents, all males. One victim was a four-year-old Caucasian child who poured "water" into the tank of his toy car, which accidentally ignited. Eight (73%) of the victims were sixteen to thirty-five years old. Two of the victims had a history of alcohol abuse, and one of these two men was also an intravenous drug user. Three of the victims smoked cigarettes.

#### *Housefire*

Of the 12 victims of noncigarette related housefire 83% (10) were males and 17% (2) were females. Four of the victims were less than five years of age and three of these children were Hispanic, while one was black. Only 2 of the victims of housefire were over the age of 35: a 76-year-old Caucasian man with a history of organic brain syndrome and a 94-year-old Hispanic woman with no previous psychiatric history. Two of the victims had a history of chronic alcoholism (including the patient with organic brain syndrome).

#### *Scalding*

The six victims, all adults, were evenly divided between males and females and also among Caucasians, blacks, and Hispanics. One of the victims had a diagnosis of Alzheimer's disease and a history of alcohol abuse, and another victim was psychotic. Two of the fatalities were nursing-home residents who were alone when they entered a scalding bathtub or shower and were unable to get out.

#### *Cooking Accidents*

Of the victims 57% (4) were male and 43% (3) were female. One of the victims was 9 months old, and the remainder ranged in age from 35 to 85 years (mean 68 years). Two of the fatalities were alcohol abusers, one was an intravenous drug user, and one had a deficit in short-term memory. Another patient was being treated with librium for an unknown reason before admission.

#### *Outdoor Fires*

One of the three victims of outdoor fire was male, the other two female. One victim was a three-year-old child who was incinerated when her father used gasoline on the family barbecue and it splashed. One of the remaining two victims was a transient whose clothes caught fire as he was warming himself over a burning barrel, and the other victim had a history of schizophrenia and an unspecified seizure disorder.

#### *Other Causes of Fatal Burns*

In this category were 7 (78%) males and 2 (22%) females. Of these 9, 4 had an unidentified cause for burn injury. One of the victims turned on the natural gas in a suicide pact with his wife and was accidentally burned when he lit a last cigarette. A 63-year-old man whose substance abuse and psychiatric histories were unknown placed a flaming cigarette lighter in his shift pocket and ignited his clothes. An elderly man was found unconscious on a sidewalk

with burns to his legs from the hot pavement, and the last victim was working at an oil refinery when he was caught in an explosion and fire caused by another worker.

### Discussion

For the period of this study, the sex ratio of burn fatalities (2:8 male to female) was similar to that of all other autopsy cases within the same age range (2:3 male to female). Caucasians and Hispanics were slightly underrepresented (by 4 and 9%, respectively) and blacks were overrepresented (by 11%). Males were more likely to incur a fatal burn injury at a younger age than females. Males were also far more likely to be involved with automobile and solvent-related fires (Tables 1 and 2).

We found two predisposing risk factors that were overrepresented in the burn fatalities relative to the remainder of the population: substance abuse and impaired mental function from psychiatric disorders or neurologic disease (Table 2). Both intravenous narcotism and alcoholism contributed to the occurrence of burns in several ways, as has been previously documented [1-5, 9]. In our study, twenty patients (25%) habitually used one or more drugs, including alcohol, and in several other patients occasional alcohol use was seen. A preexisting neurologic disease or psychiatric problem was present in fifteen cases (19%). Psychosis was a factor in at least three of the suicides, and psychotic patients were also involved in scald burns and burns from outdoor fires. One suicide patient was suffering from major depression and another had a five-year psychiatric history with diagnosis unknown. Dementia as a result of Alzheimer's disease and organic brain syndrome were contributing factors to burns, especially in smokers. Two patients had seizure disorders.

By examining the etiology of burn injuries in our study, we found implications for prevention of some injuries. Though we may not be able to influence the frequency of some etiologies for burn injuries, such as housefires, suicides, or industrial accidents, we may be able to modify rate of injuries in situations in which human error plays a significant role and by our ability to identify certain populations that might be at increased risk for burn injury. From our results, several suggestions can be made in the effort to decrease burn fatalities caused by human error.

Previous publications have come to general agreement about which groups are at increased risk for burn injuries [1, 2, 4, 5]. Substance abuse can disturb consciousness and slow reaction time; judgment can also be impaired. Crikelair et al. noted that alcoholism influenced burn injury outcome, increasing the crude death rate by three times [6]. According to MacArthur and Moore, "alcohol looms so large in these data as to make it clear again that the ingestion of alcohol is the leading drug problem in this country today. Alcohol and tobacco are often indulged in together, and the combination leads to severe burns because the drug reduces awareness and the flame ignites hair, clothing, or furniture" [4]. Obviously, there is also increased risk for burn injury whenever smoking products are used.

Psychiatric and neurologic deficits also may affect consciousness, memory, and perception. Lyngdorf found 83% of burn fatalities in his series were in patients with a previously established psychiatric diagnosis [9]. It is also clear that advanced age places persons at increased risk, both by the increased possibility of physical illness and weakness which can decrease a victim's ability to respond in case of burn and by the possibility of memory deficits.

It is important to recognize that many of the victims in this study had severe limitations because of their mental status. Those patients with dementia who fell asleep with cigarettes or forgot about lit cigarettes clearly needed to have some sort of supervision while smoking, as did the elderly. Cooking accidents in the elderly also contributed to burn fatalities. Whenever these patients live alone in buildings with several other occupants, the risk from fire is great. Nursing home personnel or home helpers can potentially be life-saving in these circumstances. Alcoholics and intravenous drug users also need to be warned about the use of

cigarettes when under the influence. Unfortunately, it is unlikely that their behavior patterns can be influenced.

Gasoline played a significant role in both suicides and accidental fires. It is doubtful that anything can be done to discourage suicidal/mentally ill patients from self-immolation with gasoline, but perhaps the incidence of accidental deaths involving this fuel can be diminished by discouraging its use for any other purpose than its intended role as an engine fuel. These abuses include using gasoline as a cleaning solvent or fire starter. Katcher reported that in males 15 to 30 years old, "the negligent or reckless use of gasoline is the single most frequently cited cause of burns. In many cases these burn patients are intoxicated at the time of their injury and cigarettes are a common source of ignition" [10]. In our study, gasoline was the principal volatile solvent being used when a fatal fire occurred.

Several victims caused fires from ignorance of proper handling of gasoline. Warning labels or cautionary information that accompany the sale of gasoline into any container other than a motor vehicle fuel tank might decrease both solvent accidents and fires due to pouring gasoline on barbecues. In addition, gasoline storage in the home should be in approved, childproof containers in a safe place, out of reach of children. Even older children rarely appreciate the dangers of flammable solvents, and the potentially lethal properties of these substances justify every precaution [6].

Scald accidents in most studies are one of the most prevalent causes of burns and are common in children. In our study, it was not a major cause of fatality and no children died from scald injuries. Katcher et al. reported that the scald patients with the worst prognosis were the elderly/disabled who entered a scalding tub or shower and were unable to get out [10]. Indeed, three (38%) of our scald deaths occurred under these conditions, two of them in nursing homes. For this reason, assistance needs to be made easily available when an elderly person or nursing home resident enters tub or shower.

## Conclusion

In a study of burn fatalities at the LAC-USC Medical Center during the five-year period from 1983 to 1987, we found substance abuse and impaired mental function to be significant risk factors predisposing to burn fatality. Gasoline was the commonest solvent to be involved with fatal fires.

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Address requests for reprints or additional information to  
Edward C. Klatt, M.D.  
Room 2520, General Hospital  
LAC-USC Medical Center  
1200 N. State St.  
Los Angeles, CA 90033