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Accidental Fire Deaths

The 5-year Metropolitan Dade Country Experience from 1979 until 1983

A. R. Copeland

1050 N.W. 19th Street, Miami, Fl 33136, USA

Summary. Accidental fire deaths that occurred in Metropolitan Dade County, encompassing Miami, Fla., USA, during the years from 1979 until 1983 were studied. A total of 108 cases were collected, representing 6.1% of the nontraffic-related accidents during this 5-year period, and analyzed as to the age, race, sex, cause of death of the victim along with the blood alcohol content at autopsy, toxicologic analysis, location of the fire, and how the fire started.

Essentially, the victims ages cluster in the 0–5 years and does 70 years, although other age groups are evenly distributed. A white male population predominates.

The cause of death is listed as either smoke inhalation or thermal injury. Most toxicologic analyses were not performed due to the high rate of fire rescue intervention and at least emergency room hospitalization prior to death. Caboxyhemoglobin levels, when analyzed, ranged from less than 20% to over 80%. In a smaller group of cases, cyanide was analyzed for and was found negative (or none detected) in the majority of the cases. More fires occurred in residences and started due to cigarette smoking or electric malfunction.

Key words: Accidents, fire deaths – Fire deaths

Zusammenfassung. In der vorliegenden Arbeit werden die Todesfälle durch Einwirkung von Feuer im Stadtgebiet von Miami, Florida, USA (Dade County), über die Jahre von 1979 bis 1983 untersucht. Die 108 Fälle des 5jährigen Untersuchsungszeitraums stellen 6,1% der Unfälle dar (nicht Verkehrsunfälle); sie wurden nach Alter, Rasse, Geschlecht, Todesursache, Blutalkoholkonzentration, toxikologische Daten, Ursache und Lokalisation des Feuers aufgeschlüsselt.

Die Altersverteilung der Unfallopfer zeigt Schwerpunkte bei 0–5 Jahren sowie 70 Jahren und älter, alle anderen Altersgruppen sind gleichmäßig verteilt; weiße, männliche Unfallopfer dominieren.

Die Todesursache ist entweder Rauchgasvergiftung oder Verbrennung. Für die meisten Fälle liegen keine toxikologischen Daten vor, was auf Notfallmaßnahmen am Unfallort oder in der Klinik zurückzuführen ist. CO-Hämoglobinwerte liegen, wenn sie bestimmt wurden, im Bereich von 20% bis über 80%. In einem kleinen Kollektiv wurden Cyanidanalysen vorgenommen, wobei in den meisten Fällen negative Werte erhalten wurden. Meistens brach das Feuer in Wohnhäusern aus und entstand durch Zigaretten-Rauchen oder Kurzschluß.

Schlüsselwörter: Verbrennung – Feuer, Unfälle

Accidental death due to fire is a source of concern to all. In the forensic field, several articles have appeared recently reporting the nature of such fatalities. In other parts of the United States [1] and in other countries [2–5] there have also been general review articles on the subject of forensic fire investigation [6].

This article seeks to present the phenomenon of accidental fire death as it occurred in Metropolitan Dade County, Fla., USA, during the past 5 years and to offer comparison to studied performed elsewhere [1–5].

Material and Methods

Metropolitan Dade County is a growing community of 2,000 square miles and an estimated population of 1,600,000 inhabitants in 1980. It is comprised of some 200,000 houses and 10,000 apartments. The county government along with smaller city governments, the largest being the City of Miami, provide fire fighting services to the community. It is estimated that during the 5-year period from 1979 until 1983 an estimated 31,313 fires (approximately 6261 fires/year) occurred in buildings, vehicles, and boats of serious potentials for fatalities [8].

Table 1. Age distribution of fire victims

Age (years)	No. of cases	(%)
0– 5	15	13.9
6–10	2	1.9
11–15	2	1.9
16–20	6	5.6
21–25	2	1.9
26–30	3	2.8
31–35	5	4.6
36–40	7	6.5
41–45	7	6.5
46–50	5	4.6
51–55	9	8.3
56–60	10	9.2
61–65	7	6.5
66–70	6	5.6
Over 70	22	20.4

The Office of the Medical Examiner is empowered by statuatory law to investigate those deaths which occur within the county of a violent unnatural or unexpected means. Some 3,500 cases are investigated annually and of these approximately 2,800 are autopsied. For this study, all cases in which fire (either by smoke inhalation, carbon monoxide, thermal injury, or their complications) primarily or contributorily caused death, with the manner of death, accidental, were collected over a 5-year period (1979–1983). A total of 108 cases of 758 non-traffic accidents were collected and analyzed as to age, race, sex, cause of death listed, blood alcohol content at autopsy, drugs detected at autopsy, carbon monoxide blood level at autopsy, the geographic location of the fire, and how the fire started. Additionally, in 26 of the cases, cyanide levels in blood were noted, and in four of the cases, benzene levels in blood were also noted.

Results

Table 1 gives the age distribution of the victims. There is a roughly even distribution among the ages, although children of less than 5 years of age and adults of over 70 years of age are common.

The race and sex distribution is noted in Table 2. There is a white male preponderance. The cause of death listed on the death certificate is shown in Table 3.

Either smoke inhalation, thermal injury, or carbon monoxide intoxication is noted singly or in combination. In large measure, this represents personal preference on the part of the Forensic Pathologist performing the autopsy once it has been ascertained that it is a fire death. This is pointed out since in the majority of fire deaths, while carbon monoxide and soot in peripheral airways can be documented, the degree of burning that occurred before or after death can be problematic. Realize, however, that in some cases thermal injury alone may play a role when carbon monoxide or smoke inhalation effects have been minimized by therapy.

Table 4 shows the blood alcohol content determined at autopsy. In approximately half of the cases this was not ascertained. In some measure this reflect the number of cases receiving fire rescue intervention and/or emergency room therapy in which a blood alcohol result or other toxicologic analysis would

Table 2. Race distribution of victims

Race	No. of cases	(%)
Black	29	26.9
White	78	72.2
Oriental	1	0.93

Sex distribution of victims

Sex	No. of cases	(%)
Male	65	60.2
Female	43	39.8

Table 3. Cause of death listed on death certificate or victims

Cause of death	No. of cases	(%)
Smoke inhalation	42	38.9
Thermal injury	37	34.3
Smoke inhalation and thermal injury	12	11.1
Carbon monoxide intoxication	1	0.93
Smoke inhalation and carbon monoxide	1	0.93
Burns, carbon monoxide, and smoke inhalation	1	0.93
Conflagration	4	3.7
Acute myocardial infarction and burns	1	0.93
Carbon monoxide and alcohol	2	1.9
Pneumonia or sepsis due to smoke inhalation or thermal burns	6	5.6
Pulmonary embolism due to body burns	1	0.93

Blood alcohol content	No. of cases	(%)
Not ascertained	53	49.1
Negative	26	24.1
0.01 up to 0.1%	2	1.9
0.1% or higher	27	25.0

Table 4. Blood alcohol content defected at autopsy

Drugs detected	No. of cases	(%)
Not ascertained	86	79.6
Negative	12	11.1
Positive	10	9.3
Type of drug	**No. of cases**	
Secobarbital	1	
Benzodiazepines	2	
Cocaine and morphine	1	
Methaqualone	1	
Opiates	2	
Cocaine + benzodiazepines	1	
Ethchlorvinyl + diazepam	2	

Table 5. Drugs detected at autopsy using Urine Emit drug screen (or other methods where applicable)

be meaningless. However, with respect to those cases who did have a blood alcohol analysis, there is a roughly even distribution between negative and high alcohol levels of 0.1% or more.

Table 5 depicts the drugs detected at autopsy. Commonly, this represent a urine drug screen by Emit Methodology although other methodologies (e.g.,

gas chromatography) is also used where indicated. Here again, there is a large majority of cases where it was not done. However, in those in which it was done, it is evenly divided between negative and positive screens.

Table 6 gives the carboxyhemoglobin data for the series and in a smaller number of cases the cyanide and benzene levels. (Methodologies include co-oximeter, ion-specific Electrode, and gas chromatography.) With respect to carboxyhemoglobin, some 40% are not ascertained reflecting the number of cases with fire rescue intervention including intubation and/or cardiopulmonary resuscitation and accordingly in which a carboxyhemoglobin level would be meaningless given its short half-life. In those in which it was ascertained, there is an even distribution among low and high values. The cyanide levels are interesting in that the majority of this small subset of cases are negative (or are not detected). The benzene data is noted but with four cases should be viewed as only preliminary.

Table 6. Carboxyhemoglobin levels (% of total) (108 cases)

CoHb (% total)	No. of cases	(%)
Not ascertained	44	40.7
0%– 20%	16	14.8
20%– 40%	15	13.9
40%– 60%	8	7.4
60%– 80%	13	12.0
80%–100%	12	11.1
Cyanide levels (μg/ml) (26 cases)		
Cyanide (μg/ml)	No. of cases	(%)
Not detected	19	73.1
Trace	1	3.8
0–1	0	0
1–2	1	3.8
2–3	3	11.5
Over 3	2	7.7
Benzene levels (μg/ml) (4 cases)		
Benzene	No. of cases	(%)
Not detected	1	25.0
Trace	0	0
0–1	2	50.0
1–2	1	25.0
Over 2	0	0

Table 7. Location of the fire

Locale	No. of cases	(%)
Residence	86	79.6
Type: House	54	50.0
Apartment	17	15.7
Hotel – efficiency	5	4.6
Trailer	4	3.7
Shack	2	1.9
Yard	1	0.93
Abandoned car	1	0.93
Nursing home	2	1.9
Boat	4	3.7
Car (non-traffic-related)	1	0.93
Plane	8	7.4
Job site	5	4.6
Bar/club/lounge	2	1.9
Grocery store	1	0.93
Store	1	0.93

Table 8. Origin of the fire

Origin	No. of cases	(%)
Cigarette/lighter-related	22	20.4
Electric "short", wires overheated	20	18.5
Playing with matches or lighter	9	8.3
Pot on stove or cooking-related	6	5.6
Explosion, not otherwise specified	6	5.6
Airplane crash	5	4.6
Kerosene space heater/gas heater	4	3.7
Candles	3	2.8
Gas stove ignited	2	1.9
Oxygen tank for emphysema ignited	1	0.93
Gasoline + moped fumes (smoke motorbike)	1	0.93
Car fire (equipment malfunction)	1	0.93
Torch used to clear gas line	1	0.93
Propane lighter	1	0.93
Pilot light ignited gasoline	1	0.93
Machines + fumes	1	0.93
Food caught on fire ("Flaming Cherry Jubilee")	1	0.93
Unknown	23	21.1

Table 7 gives the geographic location of the fire. Essentially, as with much of forensic pathology, most lethal fires occur at home with houses and apartments being most prevelant.

Table 8 gives the results of the investigation on how the fire started. In approximately 20% of the cases, this is unknown. When noted, the more common causes are cigarette-related reasons (e.g., "smoking" in bed) and electrical "short" or appliances/wire overheating. However, children playing with matches or lighters are also frequent.

Discussion

As with any study, certain limitations are apparent and should be pointed out to the reader prior to any conclusions that may be drawn from it.

First, this writer is limited to discuss those fires in which there was a fatality. This is a very small percentage of even serious fires—not even counting smaller rubbish or field fires in which a life was not in immediate jeopardy. However, this limitation is useful in another sense, in that it reflects the degree of fire prevention and protection given in this jurisdiction. The projected "fatality per fire" or "fire death rate" is respectively 1 in 300 serious fires, and averages approximately 1.35 per 100,000 population per year. This latter rate is comparable to other published rates for the United States [6, 9], although other states in "America" are even higher in their rate of fire death [6]. Internationally, the Federal Republic of Germany has been reported as having a rate close to this [6].

Noteworthy, also, is the limitation in toxicologic analyses imposed by vigorous fire-rescue intervention and/or cardiopulmonary resuscitation. Ultimately, for society this is good and assists in prevention of fire deaths. However, caution should be used in interpreting the blood alcohol, the drugs by urine Emit, drug screen, carboxyhemoglobin detected, cyanide levels detected, and benzene levels detected.

The implications of this study are interesting in several aspects, First, if one is dealing with a bimodal (i.e., children and elderly) white male population, fire prevention should be directed at those who look after such people or in designing programs for watching over these people. In other words, among elderly populations, have neighborhood watch/alert programs with neighbors periodically visiting elderly tenents. Among children, advise families to get babysitters, preferable adults, when parents are absent. A second implication of this study is that not only cigarette smoking causes fires, electrical "shorts"/ wiring malfunctions also contribute significantly. While curtailing cigarette smoking may meet with limited success, investigating and inspecting wiring (e.g., building codes/standards on wires, outlets, etc.) can be done.

A comparison of this study to other cultures can also be made. Even with respect to other segments of the Unites States [1], differences are noted. Specifically, the death rate in this study is much lower than that of Baltimore, MD, USA [1]. The reasons for this could range from the number of fires that occur in the geographic area to the caliber of fire rescue intervention. However, the

other study [1] does not give the number of fires that occur in their jurisdiction or any estimate of delayed deaths and hence the degree of fire rescue intervention.

Secondly, the other study [1] only evaluates house fires and does not consider other types of fires that can also be lethal. Exact comparison is therefore problematic. However, the origin of the fires (i.e., cigarette smoking and faulty electrical apparatus) are similar in the two studies, although this study has a slightly higher percentage of fires of electrical origin.

As compared to other countries, several points of interest can be made. Denmark's fire death rate [2] is higher than in this study. Also, in Denmark [2] no childhood fatalities were reported. This seems noteworthy given the tendency of children to play with matches, and as compared to their frequency in this study. There are similarities, however, between the two countries in that homes are the frequent location, cigarettes and electric problems are common origins, roughly half the victims survive for a period of time, and in those cases in which alcohol was analyzed, half have a blood alcohol concentration of 0.1% or more. The Denmark study [2], however, does not give carboxyhemoglobin levels and/or drugs detected at autopsy data.

A major fire study was performed in Glasgow, Scotland [3–5]. Comparison to that study reveals a much higher death rate in Glasgow [3] than in Metropolitan Dade County, (Fla., USA). However, there are similarities in that a bimodal age pattern (children and elderly) is noted. The Scotland study has a higher proportion of female victims, and no racial breakdown is noted [3–5]. Furthermore, most of the victims in the Scotland study [3] are dead at the scene. This may reflect less fire rescue intervention in Scotland. In the Scotland study [3–5], no mention of the origin of the fires was done. This is unfortunate and may answer why the fire death rate is so high in that area.

Finally, the Scotland study gives elaborate toxicologic data [4, 5]. In comparison, however, this study shows a roughly even distribution of carboxyhemoglobin levels, not a bimodal distribution as previously reported [4]. As far as cyanide levels are concerned this study, albeit with a smaller number of cases, has approximately 20% of cases (six of 26 cases sampled) in which cyanide was noted (e.g., 31% of cases cyanide significant [5]). No mention of benzene was made by the Scottish group [4, 5].

Several points should be made with respect to areas of future study. First, the rate of fire deaths in industrialized western countries seems constant. Second the origin of these fires are in homes and they result from cigarette smoking of faulty electric wiring or "shorts" (overheating, etc.). Third, the child and the elderly are at risk.

While fires, per se, may be unavoidable, fatalities should be prevented by directing research and other efforts to these points in common. Furthermore, advances in fire rescue intervention should be made if any reduction in death is to occur.

References

1. Mierley M, Baker S (1983) Fatal house fires in an urban population. JAMA 249:1466–1468
2. Trier H (1983) Fire fatalities and deaths from burns in Denmark in 1980. Law 23:116–120
3. Anderson R, Watson A, Harland W (1981) Fire deaths in the Glasgow area. I. General considerations and pathology. Med Sci Law 21:175–183
4. Anderson R, Watson A, Harland W (1981) Fire deaths in the Glasgow area. II. The role of carbon monoxide. Med Sci Law 21:288–294
5. Anderson R, Harland W (1982) Fire deaths in the Glasgow area. III. The role of hydrogen cyanide. Med Sci Law 22:35–40
6. Eckert W (1981) The medicolegal and forensic aspects of fires. Am J Forens Med Pathol 2:347–357
7. Metropolitan Dade County Planning Department, personal communication (1983)
8. Metropolitan Dade County Management Information System, personal communication (1984)
9. Levin B (1982) Fire deaths and toxic gases. Nature 300:18

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