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PAPER

PATHOLOGY/BIOLOGY

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Self-Inflicted Burns: The Value of Collaboration Between Medicine and Law

ABSTRACT: Self-inflicted burns are rare in France, but they lead to major, often life-threatening complications. The authors reviewed medical data for patients hospitalized in a burn center from January 2004 to December 2008. Thirty-eight cases of self-inflicted burns were compared with 220 accidental burns. Women were predominantly affected (57.9%, $n = 22$). A psychiatric history (71%, $n = 27$) was more frequent in this population. The mean age of the victims was 38 years. The leading method of suicide was flame (94%, $n = 36$) associated with gasoline used as an accelerant (77.7%, $n = 28$). Mean total burn surface area (41.5%) and mortality (36.9%) were higher in the self-inflicted burn population. By recognizing epidemiological characteristics and patients at risk, we can better classify lesions related to self-immolation. It is important for the forensic physician to consult survival details to correlate these data with the results of autopsy.

KEYWORDS: forensic science, self-inflicted burns, suicide, law, clinical forensic science

Self-inflicted burns account for about 4% of admissions to burn centers worldwide (1) and can be considered as a complex method of suicide (2,3). Published findings are contradictory with regard to the epidemiological characteristics of self-inflicted burns, in particular as to the sex ratio, age of occurrence, existence of a psychiatric history, and extent of injury (4). Burns with suicidal intent may wrongly be considered as accidental because they were sudden, unexpected, and the circumstances surrounding the incident may be obscure (5). Moreover, the mortality of burn patients has greatly diminished over the past decades, thanks to advances in resuscitation techniques, and in the Western world, it has decreased to 5–6% (6,7). In acute burn units, resuscitation procedures and the natural course of the burn alter the initial appearance of the injuries. Medico-legal autopsy is imperative when death is sudden, unexpected, suspicious, or unnatural in manner and it also aims to discover associated traumatic lesions and to establish the causal link between the burn and death (8). Interpretation of the anatomical, toxicological, and pathological findings at autopsy may be limited by the forensic specialist's difficulty in gaining access to antemortem biographical information on the deceased patient and by the lack of any description of the circumstances of death (9). It takes some time for the magistrate to organize seizure of the medical records and their handing over to the forensic specialist. The initial reasoning of the forensic specialist can only rely on the findings of the initial inquiry, based on evidence given by those close to the victim or on notes taken by nonspecialized personnel. This is why, in our institution, a forensic physician who is also an intensivist and anesthetist experienced in the management of burn patients enables a holistic approach to analysis of the medical records and increases the medical team's vigilance when dealing with these patients in circumstances where legal proceedings may ensue (10). A greater understanding of complications during resuscitation and of pathophysiological mechanisms of death would benefit both intensivists and forensic physicians, as well as all those with whom they work and who are involved with such cases. The study analyzes epidemiological characteristics and outcomes between the self-inflicted burns group and the accidental burns group.

Materials and Methods

We conducted a 5-year (2004–2008) retrospective review of the medical records of patients admitted to the acute burn unit of our institution. This unit is the reference center for the Midi-Pyrenees region of France, which has 2.8 million habitants. The patients who were included in the study met the criteria of gravity of the French national burn society (Table 1). We excluded electrical and chemical burns, as well as thermal burns extending to <10% of body surface area. Patients were divided into those with accidental burns and self-inflicted burns, according to questioning of patients when they were conscious, interviews with their family and friends, the results of the judicial investigation, and the medical report of the emergency services.

Data were entered using Microsoft Excel and analyzed with STATA software, version 8 (Stata Corp LP, College Station, TX). In accordance with the recommendations of the literature, the following data were collected: sex, age, family status, substance abuse, mental health history, length of hospital stay, severity of injury including burned body surface area, mortality, bronchial inhalation injuries, need for assisted ventilation under general

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TABLE 1—*French national burn society: criteria of gravity of the burned patient.*

Burns covering more than 10% of body surface area
Comorbid conditions
Burns of the face, neck, hands, or perineum
All deep burns
Burns because of an explosion, fire in a confined space, road traffic accidents
Suspected abuse

anesthesia, and length of hospital stay. Categorical variables of interest including gender, family status, mental health history, presence/absence of substance abuse, of bronchial inhalation injuries, or need for assisted ventilation under general anesthesia, and mortality were compared using either chi-squared or Fisher exact tests. Differences in continuous variables including age, length of hospital stay, and severity of injury including burned body surface area were analyzed using the *t*-test. p values of 0.05 or less were considered statistically significant.

Results

During the study period, 258 patients were included, of whom 38 (14.7%) had self-inflicted burn injuries (Table 2). All medical records were studied by the forensic physician.

Gender and Age

Among self-inflicted burns, women predominated (57.9%, $n = 22$), whereas the majority of patients with accidental burns were men (68.2%, $n = 150$). The average age of victims of self-inflicted burns was 38 years (95% CI 33.5; 42.6) compared with 47.6 years (95% CI 44.9; 50.41) for accidental burns. Patients with deliberate self-inflicted burns were thus significantly younger than those with accidental burns ($p = 0.0068$).

Marital Status

In self-inflicted burns, 65.8% of the victims were married, as were 55.5% of victims of accidental burns (nonsignificant difference, $p = 0.235$).

Methods of Self-Inflicted Burns

Flame was the principal method of injury (94.7%, $n = 36$). One schizophrenic patient attempted to burn himself by attaching himself to an electric cooking hob, and another patient scalded himself with boiling water as a purification rite. Gasoline was the most common accelerant used (77.7%, $n = 28$), followed by flammable solvents (22.2%, $n = 8$), which included perfume (5.6%, $n = 2$) and methylated spirits (16.6%, $n = 6$), which is a mixture of 90% ethanol and 10% methanol used for domestic and industrial purposes as a cleaning and diluting agent and which is on unrestricted sale in specialized stores. With regard to accidental burns, the majority was caused by fires in the home or the workplace (30.4%, $n = 67$). The other most frequent domestic accidents were because of careless handling of petrol during barbecues or burn-beating (25%, $n = 55$), burns from hot water and steam (17.3%, $n = 38$), projection of boiling oil (7.73%, $n = 17$), burns from contact with a hot object (5.45%, $n = 12$), accidents when handling gas (4.55%, $n = 10$), poorly defined causes (6.82%, $n = 14$), and burns sustained in addition to injuries in road traffic accidents (2.72%, $n = 6$).

TABLE 2—*Demographic and injury characteristics of self-inflicted and accidental burns.*

Characteristics	Self-inflicted Burns ($n = 38$)	Accidental Burns ($n = 220$)	p value
Demographics			
Mean age, years	38	47.6	0.0068
Female gender, %	57.9	31.8	0.002
Single, %	34.2	44.5	NS
Psychiatric history, %	71	16.8	$<10^{-5}$
Injury			
Mean TBSA, %	41.5	22.7	$<10^{-5}$
Third-degree surface, %	27.1	10	$<10^{-5}$
Mortality, %	36.9	9.5	$<10^{-5}$
Inhalation injury, %	44.7	28.7	0.0048
Intubation, tracheotomy, %	42.1	27.7	NS
Mean length of hospital stay, days	44.4	22.5	$<10^{-5}$
Alcohol alone or associated with médicament (%)	34.21	18.63	0.037

TBSA, total burn surface area; NS, nonsignificant.

Environment of Attempted Suicide by Self-Inflicted Burns

Self-immolation was generally attempted at home (79%), while five patients (13%) ignited themselves in a public place and three patients (8%) during a hospital stay.

Psychiatric History

Analysis of medical records revealed a significant difference in psychiatric history between the two groups ($p < 10^{-5}$). Of the patients with self-inflicted burns, 41.66% ($n = 15$) were followed for depression, of whom 10 had previously attempted suicide by another means, nine had been diagnosed as psychotic, and three as having a personality disorder. For 11 patients, this was the first suicide attempt. Psychiatric assessment of the surviving patients is continuing and it is as yet too soon to establish a definitive diagnosis.

Toxicological Analysis

Routine toxicological screening carried out at admission included determination of serum levels of benzodiazepines, carbamates, barbiturates, tricyclic antidepressants, and paracetamol. Lethal serum levels of these medications were not found in either group. However, blood alcohol, alone or in combination with medications, was positive in 13 (34.21%) patients in the self-inflicted burns group, which is a statistically significant difference compared with the 41 (18.63%) positive patients in the accidental burns group ($p = 0.037$).

Severity of Injury

Patients with self-inflicted burns sustained more severe injuries than those with accidental burns. Intentional burns led to higher mortality (36.9%) than accidental burns (9.5%) ($p < 10^{-5}$). The mean total burn surface area (TBSA) of patients with self-inflicted burns was 41.5% (95% CI 32.5; 50.4), including 27.1% (95% CI 17.6; 36.7) third-degree burns, compared with 22.7% (95% CI 20.3; 25.2) TBSA, including 10% (95% CI 7.9; 12) third-degree burns, for patients with accidental burns ($p < 10^{-5}$).

In the self-inflicted burn group, 44.7% of patients sustained inhalation injury, a significantly higher figure than in the accidental

burns group (28.7%) ($p = 0.0048$). Although the difference was not statistically significant, we noted that 42.1% of patients with self-inflicted burns required intubation or tracheotomy and ventilatory support under general anesthesia, versus 27.7% in the accidental burn group. Mean length of hospital stay for self-inflicted burns was 44.4 days (95% CI 30.4; 58.2), and for accidental burns, it was 22.5 days (95% CI 19; 26), a significant difference ($p < 10^5$).

Discussion

It is in the interests of public safety and of proper functioning of the legal system that every case of suicide should be confirmed and unambiguously differentiated from natural death, homicide, or accident (11). For the forensic physician, it is important to consult survival details and to be aware of the course of the initial injuries in order to correlate these data with the results of autopsy. This is why it is necessary to make police officers more aware of the importance of transmitting to the forensic physician the medical records that may be seized during the judicial process. This awareness is not yet integral to usual judicial practice, and it is one of the aims of collaboration between physicians and those involved in justice. On the other hand, our colleagues in intensive burn care units stress the difficulties they meet in assessing such medico-legal situations, even though they are well trained in burn management (12). Such collaboration is important as in the event of death, autopsy results can be more easily compared with antemortem clinical data in order to fulfill the ultimate goal of the forensic specialist's mission, which is "*to bring the truth to light*." With this aim in mind, we discussed with our colleagues in intensive burn care centers the value of early collaboration, as soon as such patients are admitted, to create an alert on the peculiar nature of these cases. This attitude makes medical teams in burn centers more aware of the medico-legal implications of the decisions they may make later. How could such collaboration be organized? First, by attempting to identify the epidemiological factors of self-inflicted burns in our region, factors that would suggest whether the cause was accidental or by intent. This appears necessary in view of the rarity of suicidal burns in Europe and in Western culture in general, unlike some parts of the world where violence is a major cause of extensive burns and consequently of burn-related deaths (1).

In our study, women predominated among suicides and this is in accordance with several previous works (13,14), but a gender predominance is not always found. The suicide rate is often higher in men in relation to serious economic difficulties and social responsibilities (9). However, the suicide rate appears to be moderated by cultural differences and local traditions, differing according to country (1,15). The age of suicide victims varies in the literature. Some studies found that victims were of similar mean age (16,17), whereas others did not consider age as a discriminant epidemiological factor (15–18).

With regard to the setting where intentional immolation takes place, it has been reported that confined spaces are generally chosen by those attempting suicide in order to prevent the arrival of help. Attempts in public places, where the aim is to attract attention, are rarer (19). It should not be forgotten that most accidental burn deaths occur in the home, but so do most homicidal deaths (13). This method of suicide by burning is a violent and tragic one. It is difficult to set fire to a living individual, and patients use accelerants in order to ignite clothing. Patient histories show that gasoline is the flammable agent most commonly used (20) and is in fact the easiest to obtain.

In the self-inflicted burns group, 71% had a history of psychiatric disorder, with a diagnosis of depression, psychosis, and borderline personality disorder, which is in agreement with the literature (19,21). Alcohol, a known risk factor for suicide, homicide, and natural death, is also a recognized risk factor for intentional burns (22) and this was also true of our study. However, toxic serum levels of medications were not found during toxicological screening on admission to the burn center. If psychotropic medications are found in the samples taken, it is not possible to determine whether this is the result of additional substance abuse or merely of observance of a previously prescribed treatment (Table 2). Toxicological observations, while they are of primary importance for the forensic specialist, serve a different purpose for the intensivists of the burn center, who need to identify any toxic substances present when the patient is admitted in order to avoid interactions with anesthetic agents used in resuscitation and to adjust monitoring. The forensic physician should be aware of antemortem abuse of alcohol or other toxic substances, as the possibility of postmortem changes must be discussed in the autopsy report (23), in particular the diffusion, after death, of ethanol across the gastric bowel wall, which can occur even if the body is intact (24). As previously suggested (3), we agree that concomitant use of drugs and/or medications should not be considered as a complex method of suicide. However, postmortem measurements of toxic substances should be carried out with particular care, as under-diagnosis is especially prevalent in women (25,26).

Hanging, suicides by firearms, and drowning may be classified among the violent and rapidly fatal suicide methods whose consequences are irreversible. Firearms are readily available in many households and this method is the most frequent in the United States (27), facilitated by the firearms laws, whereas it ranks third in Europe, although differences exist between countries. Hanging is the most common suicide method in Europe and notably in France (45%), and also in Saudi Arabia and Hungary where it accounts for 50% of suicides. This frequency is lower in Nordic countries such as Denmark and Norway where hanging accounts for 25% of suicides (28). This high frequency may be explained by ready accessibility (29) even if there is considerable international variability. With the exception of Ireland (30), drowning is rare in Europe compared with some regions of the west coast of India (9) and is related to the proximity of rivers and lakes that facilitate acting out. In Europe, poisoning by drugs is the second most common suicide method, whereas in many Asian, African, and Latin American countries, and in rural areas, pesticide poisoning is frequent (31). This method is classified as less lethal by Spicer et al. (32) and can be explained by the availability of toxic substances, ease of the method, and absence of pain. Although self-poisoning, whatever the toxic product used, remains dependent on the dose–effect curve, it has, however, showed higher mortality than accidental ingestion (33).

Self-immolation is rare in Western countries when compared with the Indian subcontinent where immolation by fire has a ritual connotation, although it is becoming rarer (9). The rarity of this method in France underlines the importance of collaboration between forensic physicians and intensivists especially in view of the high mortality and morbidity, with the ultimate aim of preventing a second attempt. This method of suicide is considered as violent but less lethal than hanging (32). Similar to the dose–effect correlation in voluntary intoxications, the fatal outcome of immolation by fire remains dependent on the body surface area burned. Three major risk factors for death have been identified: age over 60 years, TBSA over 40%, and inhalation injury (6,34). In suicides by immolation, burns are deeper and more extensive than in accidental burn patients. After ignition, there is generally a period of

panic that makes inhalation injury more likely. The burn surface area is extensive, indicating severity, and is worsened by the occlusive effect of clothing that maintains the progression of the burn and increases its depth. These risk factors are the immediate cause of the unfavorable course in these patients. In Western Europe, the reported extent of self-inflicted burn injuries ranges from 14% to 44% TBSA (10,34). In our sample, there was no difference in burn distribution between the two groups.

Age and sex are helpful as a guide to suicidal behavior. Positive alcohol results tend to be associated with self-inflicted burns, as is psychiatric history. When there is a doubt as to how the burn was sustained, close collaboration founded on history taking, clinical examination, and the patient's medical record may suggest that the injuries were not accidental. Such collaboration between physicians of various specialities is an integral part of continuing management of the patient and it begins with the intervention of the emergency services and police investigators, when it is of the utmost importance to preserve the clothing for later scientific tests and identification of the flammable agent, to assist the investigation. There are such great inter-individual variations and also such differences between regions and traditions that in spite of the studies on the subject, when a patient is admitted to an intensive care unit, it is impossible to state categorically whether the case is suicide or accidental. Physicians need to make a synthetic assessment of all available information, from questioning of a conscious patient to examination of the medical records, and without forgetting the report of the emergency services, who are generally the first to intervene in the treatment pathway. Resuscitation procedures and treatments, as well as the natural course of the burn, in fact alter the initial appearance of the injuries.

Limitations and Conclusion

In summary, this study describes the characteristics of self-inflicted burn injuries in a burn unit, which is the reference center for the Midi-Pyrenees region of France, and it provides antemortem data that may help distinguish accidental and suicidal burns. To the best of our knowledge, this is the first time that a forensic physician has collaborated with intensivists in examination of the records of adult burn patients. The present study has several limitations, some of which point to future directions for additional work in this area. While attempted immolation is the main suicide mechanism, the serum and urine toxicological tests that can help to guide medical resuscitation should incite the intensivist to look for previous prescriptions for psychotropic treatments with the aim of preventing a second attempt and of ensuring specialized psychiatric follow-up after discharge. The number of medico-legal autopsies is declining (35), and autopsy remains subject to a magistrate's order. In our series, the findings of the initial police enquiry at the scene, the course of patients in the intensive burn care unit and external examination of the body after death, compared with the data of the medical records, were sufficient to conclude the judicial enquiry. It was possible for the forensic specialist to summarize the medical findings and the results of examination and so to answer the magistrate's questions on the cause of death and the causal link between suicidal intention and the burn, and also to exclude the intervention of any third party in the mechanism of death.

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