

## CASE REPORT

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# Suicide by Electrocution with Low-Voltage Current

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**ABSTRACT:** Three cases of suicide by electrocution with low-voltage current were observed in five years (1994–1998) by medical clinical forensic examiners of an Emergency Forensic Unit of the Paris suburb among 2000 external death examinations. The cases involved one woman, aged 72 and two men, aged 38 and 41. In the last two cases, electric burns were retrieved under bared electric wires, placed on the arms or fingers in order to realize a hand-to-hand electric circuit involving the heart muscle. In the other case, the electric circuit between mouth and foot also involved the heart muscle.

Household low-voltage current delivered (220 V in France) had a sufficient strength to induce local muscular paralysis and heart fibrillation. In the three cases, blood samples taken have retrieved very high levels of muscular enzymes (CPK, LDH) correlated to the mechanism of electric death. The rareness of suicide by electrocution and its forensic characteristics are detailed in order to help the clinical forensic examiners, prosecutors, and police officers concerned by such death examinations.

**KEYWORDS:** forensic science, electrocution, suicide, low-voltage, external examination, biochemistry, electric burn, emergency forensic unit

Violent methods of suicide are mostly used by male suicides and consist of jumping from a height, self-immolation, railway collision, hanging, firearms, and electrocution. The most potentially painful/disfiguring methods of suicide including jumping from a height, self-immolation, and railway deaths seem to be favored by young and middle-aged people, while drowning, stabbing and cutting and electrocution are more common among older people (1). If hanging, jumping from a height and railway collision are really frequent in our urban experience (2), other violent means of suicide remain very rare, as suicide by stabbing of the throat (3).

A review of the literature, using Medline database, permits to find the rare cases described in the past decade (4–9). In cases of electrocution in the bathtub, 19/48 published cases were established as suicides, with a sex ratio of 1:3 in favor of females with a frequent foam at the mouth and the nostrils, or in the air passages and rare electricity burning marks (4). In these cases, authors explain that the mechanism of electrocution in water was superimposed by drowning to finally cause the death (4,5).

In another case of suicide, a 28-year-old male was found dead on a bed in a hotel with two electric wires, the ends of which were fastened to two coins, one attached to a left hypochondrial region and another to the left side of the chest. The other ends of the wires were connected to a time switch connected to a plug top: 100 V, 60 Hertz (Hz), and alternating current. But the man had also used commercially available hypnotic (bromvalerylurea) to commit his suicide (6). In fact, the literature analysis to date only retrieves two cases of suicide by pure electrocution, using household supply (7,8). In the first one, electrocution was realized by a 35-year-old woman, using a timer (7) and in the second one, a 34-year-old laborer of the Electricity Board, committed suicide using 220–240 V domestic electricity supply (8). In the cases where 220 V current was involved, i.e., the calculated amperage was about 100 to 250 milli-Amperes (mA), which means that ventricular fibrillation occurred within a few seconds.

We present three cases of suicide by electrocution, in one old female and two males, observed during five years (01-1994 to 12-1998) by the medical clinical forensic examiners, among a mean of 400 death examinations per year, in a department of the nearest Paris suburb, with 2.5 million inhabitants.

### Case One

A 72-year-old woman was found lying on the floor of her bedroom with a bedside lamp near her face and mouth, with no bulb but the two bare metallic edges for electric contact (Fig. 1). An electric 220V current was involved. The external examination found a dark brown plaque with characteristic appearance of electric burn touching the lips and the end of the tongue (Fig. 2).

A line of burning necrosis was found above the right ankle on its internal side, ankle touching a metallic part of the bed of the deceased (Fig. 3).

No other clinical sign was retrieved, in particular, no evidence of any violence.

The aged woman had a psychiatric history and had committed in the past years some suicide attempts (by drug massive intoxication) which had led her to be hospitalized in psychiatric institution for a while. She had left a sort of hand-written intention letter and some manuscripts, all typical of a psychosis in a delirious phase. Blood samplings found no alcohol (using gas-phase chromatography) but very high levels of creatine phosphokinases (CPK) 14 600 IU (normal values under 200 IU) and lactates 52 IU (normal values under 2.4 IU).

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FIG. 1—Part of the body of the old woman lying on the floor and bedside lamp two metallic edges for electric contact left bare near her face.



FIG. 2—Dark brown of the lips and the end of the tongue plaque with characteristic aspect of electric burn.



FIG. 3—A line of burning necrosis above the right ankle on a part touching a metallic part of a bed.



FIG. 4—Adhesive tape with external black burn underlying bare electric wire all around the right arm muscle of the deceased.

#### Case Two

A 38-year-old man, technical engineer at the National Electric Company (Electricité de France), was found lying on his bed with an adhesive tape on each arm, partially burned and hiding bare electric metallic wires. The wires were both connected to an electric timer itself plugged in an electric 220 V current device.

The external examination of the right arm found an adhesive tape with external black burn (Fig. 4) underlying bare electric wire all around the arm muscle with a major burn black plaque measuring 40 cm in circumference and less than 2 cm wide with typical aspect of electric burn, white around a necrotic center (Fig. 5). The external examination of the left arm found the same type of adhe-



FIG. 5—Typical aspect of electric burn, white around a necrotic center at the circumference of the right arm.

sive tape underlying bare electric wire all around the arm muscle and making a sort of loop with a fine electric burn line measuring 40 cm in circumference and only 2 mm in width (Fig. 6).

Neither any disorder nor any sign of violence was present. The victim had currently separated from his wife before a divorce in the coming weeks. He had bought, the day of his act, the electric timer as proven by a cash ticket found. He had left explicative letters, indicating the reasons for his act and some details on his suicidal means, including the use of some tranquilizers before his act (five pills of flunitrazepam 2 mg).

Screenings for benzodiazepines in the urine samplings, using one-step manual qualitative immunochromatographic test (Syva<sup>®</sup> RapidTest BZO, Behring Diagnostics Inc.) that employs a solid-phase immunoassay technology with a cut-off level of 300 ng/mL of oxazepam for benzodiazepines, were positive over the cut-off level. No other drug was found in the urine (barbiturates, opiates, and cannabinoids), using a similar detection method. Blood samplings found no alcohol (using gas-phase chromatography) but very high levels of creatine phosphokinases (CPK) 12,300 IU (normal values under 200 IU) and lactates 38 IU (normal values under 2.4).

### Case Three

A 41-year-old man, working as an electric technician, was found by his young wife on a Sunday morning, lying on the ground of his kitchen where he had entered a quarter of an hour before to prepare breakfast. The wife had heard a shout and the sound of a fall on the ground. She discovered the body with bare metallic wires around the right and left second fingers, wires coming from long white electric equipment connected to a plastic button for on and off switching, the end of the device plugged into an electric 220 V wall-socket. The bare ends of the electric wires had been tightly rolled as rings around the second fingers (Fig. 7). After their removal, dark external black electric burns appeared roughly mimicking the rings of electric wire on the second fingers (Fig. 8). The external examination also found two brown electric burns on the sternum, corresponding to the place of the fingers on the undressed chest when the body was retrieved and examined (Fig. 9).

The rigor mortis was particularly important on the body. Similar to the previous cases, neither any disorder nor any sign of violence was retrieved but only a bottle of whisky, incompletely emptied, on the kitchen table near the body. The victim had no psychiatric history, but some couple problems and they had just discussed the possibility of a separation in the future. He left a farewell letter to explain his suicide act. The electric equipment had been bought the Saturday before his suicide.

Screenings for benzodiazepines, barbiturates, opiates, cannabinoids, and cocaine in the urine samplings, using qualitative immunochromatographic test (Syva<sup>®</sup> RapidTest BZO, Behring Diagnostics Inc.) were negative under the cut-off levels. Blood alcohol level was measured at 0.4 g/L using gas-phase chromatography. Once again, very high levels of CPK, i.e., 13,800 IU (normal values under 200 IU) and lactates 42 IU (normal values under 2.4) were retrieved.

### Discussion

It is known that electrocution by low-voltage can result in death, with currents distributed in the home at 110 to 240 V (10,11). Even very low currents, at voltage under 80 V have been involved in electrocution deaths in some cases in electric welders (12).

With alternating currents, the generated current vacillates from positive to negative every 20 msec, when a 50 Hz frequency is the norm as in Europe (10). Alternating current (50 Hz) is a very efficient way to depolarize cells since every 20 msec the electron density changes from high to low (10). The electrical burns are observed if contact is prolonged and over a small area, as observed in the three cases presented (10). Neither pulmonary edema nor petechiae are seen, again as observed in our three cases (10). Furthermore, rigor mortis can be accelerated in the affected muscle groups, as was obvious in the Case 3 (10).

The effects of various amounts of alternating current vary from a barely perceptible tingle (1 mA) to muscular paralysis (20 mA) and ventricular fibrillation (100 mA) (10,13). If a common house fuse blows at 20 amps, a human with 500 ohms of resistance carries 44 mA on a 220-volt circuit, which obviously does not melt a fuse but can generate a muscular paralysis in a human being (10,13). One of the main determinants of current flow is the resistance of the human body which may vary from 100 ohms for moist thin skin or mucous membranes (mouth in Case 1) to over 1 million ohms for dry calloused skin (10,13). In the third case, with electrocution in the kitchen, it has been established that the hands had been put under water before the victim had tightened the elec-



FIG. 6—Bare electric wire all around the arm muscle and making a sort of loop with a fine electric burn line at the circumference of the left arm, after the removal of a circular adhesive tape.



FIG. 7—Bare ends of electric wires tightly rolled as rings around the second fingers and part of the electric equipment used.

tric wires around his fingers. In all the cases, the current path to the heart was short (mouth to heart, upper part of arms to heart, and fingers to heart). In Cases 2 and 3, the men had prepared their lethal installation to realize an electric arc from left arm to right arm, passing by the heart and very susceptible to produce heart fibrillation—cause of electric death. It is well known that the electric cur-

rent is particularly dangerous when it uses one of the circuits involving the heart muscle (head to hand, hand to hand, hand to foot and head to foot) (13). In Case 1, the woman had achieved a head-to-foot electric circuit between her mouth and the lower part of one of her legs touching a metallic part of her bed.

In a published series, electrocution with low voltage current re-



FIG. 8—Dark external black electric burns mimicking the rings of electric wire after their removal from the second fingers.



FIG. 9—Two brown electric burns on the sternum, corresponding to the place of the fingers on the undressed chest when suicide by electrocution was committed.

mains less frequent (47/155 cases, 30%) compared with high-voltage electrocutions (79/155, 51%) (11). Moreover, in the former series, circumstances of low-voltage electrocutions were exclusively accidental, including water-related accidents (9/47), use of defective tools or wiring (9/47) and contact with electric current associated with intoxication (mainly alcoholic) (11).

The analysis of medical literature confirms the rarity of suicide by electrocution with low-voltage current, especially when the people do not die in a bathtub (1,5–9). But even if suicide by electrocution is very rare, some homicide authors still try to disguise their murder in suicide by electrocution with household-voltage (13,14). In one published case, the husband, anesthetist, claimed he has assisted the suicide of his wife at her request with an injection of anesthetic prilocaine by lumbar puncture before the electrocution, evidenced by typical electric lesions on wrists (14).

Some authors of this paper (B.M., M.G.) have previously published a case of familial homicide attempt by electrocution where the victim, subreptiously drugged, was awakened by an electric tingle, making him jump from the bed where he was lying, disconnecting the electric circuit (13). In this case, the electric circuit was going from an ankle to the other one, using electric wires rolled over wet face cloths (13).

Erythematous and oedematous electric circular burns were retrieved afterwards, with a small necrotic part on one of the ankles (13). Creatine phosphokinases (CPK) sampled 12 h after the electrocution were increased (over five times the normal value) but lactate values were normal in the survivor (13).

Findings on this surviving man, less important than those found on the three victims after their suicide by electrocution, confirm that electric household current, at low voltage, can induce electric burns. Forensic physicians have to look for evidence of these burns during the external examination of the body. These burns are more pronounced in electric deaths than in electric wounds.

Clinical examination needs to be assessed by a technical examination of the electric disposal, including the knowing of resistance, strength, frequency, and voltage of the delivered current as

well as the characteristics of electric device used. Pathologic effects can be correlated to the current characteristics (10,13). The type of electric circuit and the involvement of the heart muscle in the circuit path is of first importance to explain the mechanism of death.

Blood values of muscular enzymes such as creatine phosphokinases and lactate dehydrogenases, measured in samples issued from the right heart cavity, are particularly high in the electric deaths, including suicides by electrocution.

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