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# Lesions Induced by Tasers of Type Taser®

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**Abstract** Electrical impulse guns (Les pistolets à impulsion électrique, PIE) are increasingly used in Europe in recent years, the most famous being the model Taser®. Scientific knowledge about PIE and their potential effects remains limited. We conducted a literature review to assess the potential implications of their use in terms of safety, morbidity and mortality. A unique exhibition in a healthy individual can generally be considered somewhat dangerous. Subjects at risk of complications are individuals exposed to multiple shocks, people under the influence of psychoactive substances, those who show signs of extreme agitation, or individuals with medical comorbidities. The range of complications that can occur during exposure is broad and includes injuries caused by the impacts of the electrodes, the injuries to the fall induced transient paralysis or cardiovascular complications. In this context, those exposed should be examined carefully, and any injuries should be excluded.

*Keywords:* Conducted electronic weapon, Incapacitating device, Electronic control device, Taser®, Forensic science.

## 1 Introduction

Electrical impulse guns (PIE) belong to the category of weapons called "stun" or "reduced lethality," as well as rubber bullets or tear gas. By inducing a temporary work disability, the IEP can neutralize individuals by limiting the risk of injury to themselves, their immediate surroundings or for law enforcement, by comparison with the use of firearms or to physical restraint [1,2]. Despite the controversy that exists, especially in the media, regarding their safe use [3], their use in the workplace (police, army, prison service or security agencies) or private (self-defense ) is increasing dramatically during recent years.

PIE raise many questions about their side effects, in terms of morbidity, but mainly because of their potential involvement in the occurrence of certain death. The debate, promoted especially by media coverage of the case the most dramatic and commitment of organizations such as Amnesty International [4], and goes well beyond the framework of the scientific and medical community, however, attempts to provide the answers more reliable to questions about risks to health from the use of PIE [5-7].

This article presents the current knowledge related to the use of PIE, describes the potential impacts to expect in terms of morbidity and mortality, and has the support principles in emergencies exposed patients.

## 2 Techniques

PIE brand best known is the Taser® (Thomas Appleton's, Swift's Electrical Rifle, Taser®, Scottsdale, Arizona). The Taser® was invented in the 1960s by Jack Cover, an American nuclear physicist, amid upsurge in hijackings. The aim then was to offer an alternative to firearms, including flight employment showed significant risks, both for passengers and the aircraft itself. [8] The first Taser® was marketed in 1974 in the US, and this device currently dominates the [3] market.

Taser® the most used is the X26 model (Fig. 1), the first version was made in 2003 [9]. This is a gun-shaped device using compressed nitrogen cartridges for propelling two darts (electrodes) barbed (Fig. 2) at a maximum distance of 10.6 m [10]. These darts, measuring 9 mm, are connected to the gun by insulated conductors son. The mechanism of action requires most of the time the penetration of the skin, but the electrode may also transmit an electrical pulse through the clothes. [11]

The TASER® the usual discharge lasts for 5 seconds and consists of a pulsed pulse at 19 Hz. The approximate average voltage supplied to the subject is estimated at 1 200 V and the intensity of the current to 2.1 mA [12]. The pulse is designed to inhibit the alpha motor neurons of skeletal muscle fibers, stimulating the presynaptic component of muscle nerve [13,14]. Although the mechanism of action is only partially known, failure induced due to an uncontrollable contraction of skeletal muscles, preventing voluntary movement and causing secondary falling by loss of muscle tone. The Taser® can also be used by direct contact with the target, "after touching" without the darts are fired. The principal effect of such use then is the induction of major painful stimulation [14,15].

Civilian versions TEWL were developed (C2 Taser® particular, by a longer discharge time up to 30 seconds) with models increasingly discrete and compact. To date, only one study has been conducted with these devices civilians, involving 12 volunteers and their safety remains to be demonstrated[16].

Figure 1. Taser® X26. The device propels two barbed darts connected to the gun by insulated conductors son, transmitting the electrical discharge (photo CEMCAV-CHUV)

Figure 2. Barbed Darts: enlargement (photo CEMCAV CHUV)

## 3 Epidemiology and State of Knowledge

The development of PIE has been particularly rapid in recent years. Thus, in 2012, more than 17 000 military agencies or law enforcement forces were equipped with Taser® in over 100 countries. [17] More than 260 000 devices were also sold to individuals. [18]

Nearly half of the uses identified were in volunteers, as part of training or induction courses. [11] The number of applications in real conditions on the ground was estimated in 2013 to more than 1.9 million worldwide; in various contexts, such as escape attempts, resistance during apprehension, physical confrontations, severe poisoning with state of agitation, the refusal to comply with a police order or to stop an assault or hostage taking[19,20]. The majority of applications were for young men [19,21], willingly alcohol, under the influence of psychoactive substances [21,22], or psychiatric comorbidities [21]. About 20% of them were in possession of a firearm during the use of Taser® [22]. When using darts mode, only one landfill was issued by the Taser® in about half of cases[21-23]. The most commonly affected areas illustrate the rules of engagement and involve the chest and back [21-24], although any place can be affected, including sensitive areas (head, face, neck: 1.4%) or genitals (0.2%). [22] In "point blank", the most commonly affected areas are the limbs and the back [22] and some individuals are seen to apply ten successive discharges [7.22].

## 4 Regulation and Use

In most European countries, the use of Taser® is governed by precise rules of use, giving it a proportionate

method of engagement, as a last resort before the gun use. The Taser® also been médicoéthiques thoughts, especially about its use on vulnerable populations. [25]

MEI are regarded in France as weapons of fourth class or handguns that are not for military use. These weapons require obtaining a use permit and a specific training training[26]. The use of a PIE is equivalent to use of force, and therefore its use is strictly regulated (self-defense, absolute necessity, apprehension of the perpetrator of a flagrant crime, overcome resistance). Since 2004, PIE equip the army, the National Police and the French Gendarmerie. After several decrees and cancellations, a decree of Prime Minister Francois Fillon and a ministerial decree authorized since 2010 for use by municipal police. [26] Sale to individuals is prohibited in France. [27]

In order to limit abuses and document their jobs, Taser® X26 of the French police are equipped with an integrated camera recording images when the PIE is armed. The electrifying settings are also saved. In 2011, the French National Police has identified 823 deployments Taser® this figure includes not only the distance shots, but shooting without deployments and contacts "point blank". [28]

## 5 Morbidity

The effects of PIE on humans are multiple and result from direct or indirect trauma associated with their use, but also for the consequences of the passage of electrical current through the body. The level of evidence about the potential risks of EIP is limited and is based in part on studies with obvious conflicts of interest from the manufacturers. Medical knowledge on the subject and come from case reports describing complications related to the use of CIP, but also prospective studies on humans. These volunteer studies were conducted mostly using pliers "crocodile" or electrodes, and only a minority of them used an actual exposure pulling away with [23] Darts. Finally it should be noted that the majority of studies on volunteers were conducted by the same group of investigators and were funded by the manufacturers or by the US federal funds [14,23]. An analysis showed that the studies whose authors were affiliated with the manufacturer Taser® or funded by the same company were significantly more likely to conclude that the safe use of these devices. [29]

Table 1. Possible complications of traumatic tasers (adapted from Pasquier et al. [23]).

| Injuries caused by the darts | Fall injuries |
|---|---|
| Wounds / superficial burns | Contusions/dermabrasions |
| bone penetration (Fingers, skull) | Lacerations, hematomas |
| Intra-Spiking | Fractures |
| Eye damage | Intracranial hemorrhage |
| Lesion of the pharynx | Facial bone fracture |
| Pneumothorax | Dental lesions |
| Testicular torsion | 1.858 |

## 6 Injury

This type of injury can be consecutive to direct injury induced by darts (Table 1) or result from a possible fall secondary to the paralysis induced by the electrical discharge. By analogy that may be encountered in the event of seizure, vertebral fractures induced muscle contractures are possible[23]. Ingestion of dart has also been described [23]. Burns caused by ignition of flammable materials are theoretically possible. Applying the precautionary principle, the manufacturer of Taser® and states that flammable or explosive liquids can catch fire if a Taser® enabled nearby.

## 7 Cardiovascular Effects (Except Cardiac Arrest)

The various studies on healthy volunteers exposed to PIE highlight a discrete elevation in heart rate [23], the effect on blood pressure itself being variable [23]. Studies with monitoring heart rate after exposure showed only rare anomalies, as non-specific modifications of the ST segment on the electrocardiogram, of sinus arrhythmia, or decrease a physiological PR interval in part of a tachycardia [23]. No changes to the QRS, QT or corrected QT was found. [23] Blood samples after exposure have uncovered cases of non-specific increase in troponin [23]. A reported case described the presence of atrial fibrillation in a teenager in the aftermath of an intervention with a commitment PIE without the causal relationship has clearly been demonstrated [23].

The rhythm analysis by ECG is not feasible during discharge PIE because of interference related to the pulse, some teams have made echocardiograms simultaneously, looking for possible arrhythmias. These tests showed that 66% of patients had sinus rhythm during electrification. Other examinations were uninterpretable because of the movements induced by the electric discharge, and no arrhythmia and has been objectified. [23]

The impact of a PIE discharge in patients with a pacemaker or an implanted defibrillator remain unknown. One reported case reports, after analysis of the pacemaker, with a rapid ventricular response induced by a discharge PIE, showing that a myocardial capture phenomenon is

possible. [30] After using a PIE, the analysis of cases of pacemakers and defibrillators through animal studies or case reports, however, never objectified of sustained ventricular arrhythmia or dysfunction of the device or need to reprogram [30-33]. It has been shown against implanted defibrillators could interpret a pulse PIE as ventricular tachycardia without inducing defibrillation, taking into account the usually very short exposure time [31,32]. In case of longer discharge, and as demonstrated in animals, inappropriate defibrillation is possible [34].

## 8 Other Effects

Available at The studies confirmed that the respiratory activity of individuals exposed to a discharge PIE was preserved. [23] Metabolically, within minutes after exposure, some studies have shown a slight decrease in pH and an increase in blood lactate [23], with a maximum value reached 17.3 mmol / l result an extended 30 seconds [23] exhibition. However, aside from this case, changes in pH or lactate were limited and below the variations observed during intense physical activity. [23] If elevated muscle enzymes (creatine kinase or myoglobin) could be observed in volunteers [23], it is difficult to criminalize the PIE described in rare cases of rhabdomyolysis, given the significant number of other factors potentially contributing (such as extreme agitation, physical stress or taking toxic) [21,35,36].

Finally, exposure to a discharge PIE has been mentioned as a potential etiologic factor in cases of miscarriage, an episode of seizures and a stroke [23,37].

## 9 Mortality

If the risk of death indirectly from the use of PIE is real (fall or drowning if used near a body of water), controversy exists as to the existence of a direct link between the use of PIE in the field and some deaths. In the absence of accurate data, both the number of deaths occurring during use of PIE that the exact number of CIP applications in the world, an assessment of the number of cases of death or mortality risk still difficult to formally assess.

## 10 PIE as a direct and sole cause of death

The risk of inducing cardiac arrest through a ventricular fibrillation (VF) if discharge PIE seems extremely low [23,38], especially when you put into perspective, in suspected cases, the period found between the use of PIE and the occurrence of death [4,39]. In a series of 56 cases died within 15 minutes after exposure to a PIE, the presence of VF could not be documented in only four patients (7%), and only one case has been considered compatible with this scenario in a patient exhibiting neither pre-existing heart disease or substance abuse. [40] The direct risk of inducing VF with a discharge PIE as single dominant cause of death seems extremely limited. The appearance of a malignant arrhythmia, however, could be more common in individuals carrying a heart disease and / or under the influence of toxic psychostimulants [41,42] as well as during prolonged or repeated exposure [43] .

Two articles - whose conclusions differ significantly - have recently reviewed and analyzed the deaths occurred early after use of PIE. An article published in 2012 [43] concluded that exposure to PIE could induce myocardial capture phenomenon and cause cardiac arrest on tachycardia or VF. The author - a priori independent of the manufacturer or the police - therefore advocates use in full knowledge of the PIE, avoiding as much as possible the impacts in the torso, monitoring the individual exposed and being ready, if necessary, to perform cardiopulmonary resuscitation (ie defibrillation). [43] In 2014, other authors-related interests that both PIE-makers have concluded that the risk of cardiac arrest induced PIE was extremely low, even zero, and that the causal link was at best speculative [44].

## 11 PIE as potential contributing factors to death

Exposure to PIE is sometimes cited as a contributing factor in some potential for death [4,23,45], especially in subjects intoxicated, highly agitated [46] or carriers of a preexisting cardiomyopathy [47]. The retrospective study of deaths occurring after use of PIE illustrates the difficulty in establishing a causal link because of the many confounding factors, readily present in individuals who may be exposed. Thus, over 50% of deceased subjects had underlying cardiovascular disease [42,46], and over 75% were under the influence of psychostimulant [42,46]. Notably, the average discharge time on these subjects was also 17 to 25 seconds [15], a period well beyond the recommendations of use.

A review of 37 cases of death within 24 hours after the use of PIE has shown that 76% of subjects experienced an extreme state of agitation, called English excited delirium. [46] This syndrome, recently described in this journal [48], is characterized by a major confusion, agitation, pain tolerance, unusual force, hyperthermia, hostility, paranoid state and hyperactive behavior [23,48]. Factors contributing to the deaths of these patients are still unknown but could include positional

asphyxia related to physical stress, hyperthermia, toxicity of illegal substances or fatal arrhythmia induced peak of catecholamines [49]. While the cause of death in patients with an excited delirium remains hypothetical and probably multifactorial, the contributory role of the use of PIE in these patients is at present difficult to measure [50]. It should also qualify the risk recalling that in these patients, the PIE is an alternative to physical stress measurements or even a potentially lethal firearms commitment. [51] Caution remains in order, pending clarification on the impact on mortality of the various factors contributing to the death of these individuals.

## 12 Medical treatment after exposure to PIE

The management of a patient exposed to PIE includes extraction electrodes if they are still stuck in the body. The darts must be removed by applying online traction, and tetanus immunization status should be checked. If penetration of sensitive areas such as the eyes, face, genitals or skull, an examination by a specialist is recommended. Clinical examination should also include careful research of injuries may have been caused by muscle contractions (including vertebral fractures, joint dislocations) or by [23] falls; review appropriate to repeat in some cases when the patient no longer under the influence of psychoactive substances.

In 2009, a review concluded - while acknowledging the low level of evidence Disposition- that adult subjects with sinus rhythm after exposure to PIE did not require cardiac rhythm monitoring or other cardiological investigation [52] . More recently, in 2010, a position taken by the American Academy of Emergency Medicine was issued to clarify the record to achieve in patients presenting to the emergency in the aftermath of exposure to PIE [53]. The proposed approach is not routinely conduct of ECG, laboratory or special monitoring exams in conscious subjects, asymptomatic and have been exposed to a discharge of less than 15 seconds[53]. Achieving non-systematic- of a ECG or laboratory tests must consider the patient's history (including heart), the presence of symptoms (chest pain, dyspnea, palpitations, myalgia), and the time of exposure (greater than 15 seconds). [53] Despite the lack of reliable data concerning holders of a pacemaker or an implanted defibrillator, it seems reasonable to control these devices for exposure of the subject to a discharge PIE [23].

In potentially high-risk patients (state of agitation, acute poisoning, multiple exposures, arrest or strong compression, symptoms may evoke an excited delirium), a full assessment is required in particular for the presence of hyperthermia, d an acidosis, rhabdomyolysis, signs of intoxication and traumatic injuries, especially in the brain, chest and spine [23,53].

## 13 Conclusion

Scientific knowledge about PIE-use security are relatively limited and weak evidence. The field use of these PIE is generally required for subjects at high risk of complications (including extreme agitation) than in experimental studies in healthy subjects. The medical care of an individual has been exposed to a discharge PIE depend on the patient's comorbidities, symptoms present, but also the exposure time (often difficult to specify). In all cases, careful clinical examination should be performed, especially in search of traumatic injuries. Complications related to the use of PIE can be numerous and sometimes specific, appropriate knowledge is desirable on the part of professionals likely to support these patients. Good coordination with the police also allows to anticipate complications and provide the necessary resources to support the patient after his arrest.

## Conflict of interest

The authors declare that no conflict of interest, whether commercial, financial or any other kind concerning the topic related in this article, in accordance with recommendations of the International Committee of Medical Journal Editors (ICMJE). They have in particular no link with Taser® and prepared and drafted the text independently of any relationship with the police.

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