
The possible pain experienced during execution by different methods

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Received 21 January 1992, in revised form 29 June 1992

Abstract. The physiology and pathology of different methods of capital punishment are described. Information about this physiology and pathology can be derived from observations on the condemned persons, postmortem examinations, physiological studies on animals undergoing similar procedures, and the literature on emergency medicine. It is difficult to know how much pain the person being executed feels or for how long, because many of the signs of pain are obscured by the procedure or by physical restraints, but one can identify those steps which are likely to be painful. The general view has been that most of the methods used are virtually painless, and lead to rapid dignified death. Evidence is presented which shows that, with the possible exception of intravenous injection, this view is almost certainly wrong.

1 Introduction

In 1989 execution was carried out by shooting in 86 countries, hanging in 78, stoning in 7, beheading in 6, and electrocution, intravenous injection, and gassing in the United States only (Amnesty International 1989, pp 265–268). These methods are legally prescribed, but a great many more prisoners die of starvation, torture, dehydration, and illness during their incarceration—these deaths will not be dealt with here. Two aspects of execution will be addressed: first the physiology and pathology of the different methods, and second the pain attendant upon each method.

2 Physiology and pathology in different methods of execution

2.1 *Shooting*

This may be carried out either by a single soldier or policeman at short range who fires from behind the condemned person's occiput towards the frontal region, or by a firing squad of up to thirty soldiers who stand or kneel opposite the blindfolded prisoners. Sometimes the soldiers aim at the chest, since this is easier to hit than the head (Amnesty International 1989, page 56). The intention of shooting at short range is to destroy the vital centres of the medulla, as happens when a captive bolt is used for slaughtering cattle. A firing squad aiming at the head produces the same type of lesions as that produced by a single soldier, but bullets fired at the chest rupture the heart, great vessels, and lungs so that the condemned person dies of haemorrhage. A bullet, especially of high velocity, produces a cavity which has a volume several hundred times that of the bullet (Owen-Smith 1981). Cavitation is probably due to the heat dissipated when the impact of the bullet boils the water and volatile fats in the tissue which it strikes. Persons hit by bullets feel as if they have been punched—pain comes later if the victim survives long enough to feel it (Beecher 1949; Melzack et al 1982). The Royal Commission on Capital Punishment (1953, para 710) discussed shooting as a possible alternative to hanging, but rejected it on the grounds, inter alia, that "it does not possess even the first requisite of an efficient method, the certainty of causing immediate death". Those giving evidence to the Commission frequently emphasised their belief that any method of execution that they recommended should be rapid, clean, and dignified.

2.2 *Hanging*

This method was last used in Britain in 1964—the death penalty was abolished in 1973. It would probably be used again if Parliament were to vote to reintroduce capital punishment. In execution by hanging the prisoner is weighed the day before the execution, and a rehearsal is done using a sandbag of the same weight as the prisoner. This is to determine the length of 'drop' necessary to ensure a rapid fracture-dislocation of the neck (Royal Commission on Capital Punishment 1953, para 703). Immediately before the execution, the prisoner's hands and legs are pinioned, he or she is blindfolded and the noose is placed around the neck. The execution takes place when a trapdoor is opened and the prisoner falls through. The prisoner's weight causes a rapid fracture-dislocation of the neck, unless the condemned person has strong neck muscles, is very light, the 'drop' is too short, or the noose has been wrongly positioned (Pierrepoint 1974). In all cases the face becomes engorged and then cyanosed. The tongue protrudes and violent movements of the limbs occur which are usually attributed to spinal reflexes. The prisoner may micturate and defaecate. The heart may continue to beat for up to 20 min after the drop (Royal Commission on Capital Punishment 1953, para 714).

This was the procedure used in Britain, but in most other countries hanging is a much less sophisticated procedure—executions are often carried out in front of crowds, and the bodies are often left dangling to deter others contemplating the same misdemeanour (Amnesty International 1989, pages 27–70).

At postmortem the noose under the chin is found to have caused hyperflexion of the neck with rotation, and fracture of the junction between the body and the pedicle of the axis, anterolateral on the side of the noose, and posterolateral on the other side. The spinal cord is transected, the medulla is avulsed, and there are extensive lacerations and bruising of the spinal cord (Wood-Jones 1913; Roaf 1976). Similar lesions are seen in rats killed by cervical dislocation for biochemical experiments—their hearts continue to beat for approximately 7 min after dislocation (Feldman and Hillman 1969).

It is always assumed that fracture-dislocation causes instantaneous loss of sensation. Certainly sensory pathways from below the neck must be ruptured rapidly, but the sensory signals from the skin above the noose and from the trigeminal nerve probably continue to reach the brain until hypoxia blocks them.

If the fracture-dislocation is not rapid, death results from asphyxia. Death by asphyxia is much slower than by fracture-dislocation because in asphyxiation the noose only occludes the jugular veins and carotid arteries but the vertebrae protect the vertebral and spinal arteries which also supply blood to the brain.

2.3 *Stoning*

Stoning is used in Iran, Mauritania, Pakistan, Saudi Arabia, Sudan, the United Arab Emirates, and Yemen (Amnesty International 1989, pages 265–268). There is remarkably little literature describing its occurrence, physiology, or pathology, but eight people were executed in this way in Iran in 1986 (Amnesty International 1987). The men or women have their arms and legs bound, and are buried up to their necks in sand. Their heads are covered by sheets. Article 119 of the Islamic Codes of Iran (1980) states "In the punishment of stoning to death, the stones should not be too large, so that a person dies on being hit by one or two of them; they should not be too small either that they could not be defined as stones." (Islamic Codes of Iran 1980). The 'injured parties' and bystanders pelt the prisoners with stones until they judge, by the absence of cries and movements and the blood on the sheets, that the condemned person is dead. He or she is then buried.

By analogy with serious head injuries sustained in road traffic accidents, it may be supposed that the condemned persons die of massive extracranial and intracranial haemorrhage (Hayward 1980; Vinken et al 1990). In the circumstances of the execution, they are very likely to suffer severe pain, distress, dehydration, and, perhaps, heat exhaustion. This form of execution is likely to result in the slowest death of any of the methods used.

2.4 *Beheading*

Beheading is practiced in Congo, Mauritania, Qatar, Saudi Arabia, the United Arab Emirates, and Yemen (Amnesty International 1989, pages 265–268). It may be done by repeated sword cuts to the neck, by an axe wielded by a strong man, or by the weighted blade of the guillotine. The skin, muscles, and vertebrae of the neck are tough, so that beheading does not always result from a single blow. It may be presumed that the prisoner becomes unconscious within a few seconds, but not immediately after, the spinal cord is severed. The eyes of small rodents move for a few seconds after biochemists have guillotined them (unpublished observations). Anaesthetised sheep lose the flash-evoked responses of their electrocorticographs about 14 s after *both* carotid arteries are severed, and 70 s after one carotid artery and one jugular vein are cut (Gregory and Wotton 1984). Dogs become unconscious 12 s after the blood supply to their brains is occluded (Roberts 1954). It has been calculated that the human brain has enough oxygen stored for metabolism to persist about 7 s after the supply is cut off (McIlwain and Bachelard 1985). However, the brain could well derive some of its energy from substrate in the scalp and facial and neck muscles (Geiger and Magnes 1947). It may be presumed that a beheaded person dies from anoxia consequent upon haemorrhage.

2.5 *Electrocution*

The electric chair was first used in 1890 in New York, after an extensive investigation of the methods then being used in the United States and Europe (Macmillan 1888). The New York Commission was concerned about the indignity and unreliability of the methods in use at that time, and was impressed by the suddenness of death by electrocution in the many cases which had occurred as a result of accidents with the recently introduced domestic electricity (Beichman 1963; Bernstein 1975; Jones 1990).

For execution by the electric chair the prison is shaved. A metal skullcap-shaped electrode is attached to the scalp and forehead over a sponge moistened with saline—the sponge must not be too wet or the saline short-circuits the electric current, nor too dry as it would then have a very high resistance. Additional curved electrodes are moistened with conductive jelly and bound to the prisoner's legs. He or she is strapped into the electric chair and blindfolded. After the witnesses—which include doctors—have withdrawn to the observation room, the warder pulls a handle to connect the power supply. The 'jolt' of 6–12 amps at 2000–3000 volts lasts a few seconds. The current surges and is then turned off, at which the body is seen to relax. The doctors wait a few seconds for the body to cool down and then auscultate the heart. If it is still beating, another 'jolt' is applied (McDonald 1892; Klein 1914; DeParle 1986). The prisoner's hands grip the chair and there is violent movement of the limbs which may result in dislocations or fractures. The tissues swell. Micturition and defaecation occur. Steam or smoke rises and there is a smell of burning (Brennan 1985; Wikberg 1990; Sawyer 1991).

At postmortem, third degree burns with blacking between the electrodes and the skin of the scalp and legs are seen. The swollen tissues may have burst. The brain under the electrode is hot and congested; it may be denatured and it is often charred. The other viscera are hot and reddish. Histology of the brain shows minute circular lesions which are probably bubbles (Spitzka and Radash 1912; Critchley 1914; Hunt

et al 1976). These lesions are similar to those seen after severe accidental burns (Cunningham 1899; Sances et al 1979; Hartford 1983).

Death from electrocution could be due to asphyxia caused by paralysis of respiration, and to ventricular fibrillation (Bernstein 1975). If so, several seconds or minutes could elapse during which the condemned person could be conscious. Death is unlikely to be due to *immediate* denaturation of the respiratory muscles or heart, which are close to the electrode, or of the respiratory centre, which is farther away, since respiration and the heart may restart after the first 'jolt' (Sawyer 1991). One must not confuse electrical conduction of the sensation of pain with conduction of the heat (see below); the former is very rapid but the latter is slow. The electric current only denatures tissue when it heats it.

The electrical conductivity of the skin is very low, and its capacity is high, whereas the deeper tissues have a much higher conductivity (Henriques and Moritz 1947; Lawrence and Bull 1976; Davies 1982). The surface of the brain has been found to be at a temperature of up to 60° 10–12 min after electrocution, and the charring of the brain (McDonald 1892; Spitzka and Radash 1912) makes it likely that the condemned person dies of heat denaturation of the respiratory centre in the medulla. This heat results from the conduction of the current through the highly resistant skin: the current travels along the scalp, partly through the diploic vessels, and through the orbits, nasal cavities, external auditory meatuses, and the foramen magnum—which are all low-resistance pathways—to the vital centres in the medulla (Cohen 1976).

2.6 Gassing

This was first used in Nevada in 1921 (Amnesty International Medical Commission and Marange 1989). For execution by this method, the condemned person is strapped to a chair in front of a pail of sulphuric acid, in an airtight chamber. The warders withdraw and the chamber is closed. A lever on the outside of the chamber is used to drop crystals of sodium cyanide into the pail. The prisoner is instructed to "take a whiff". Most prisoners try to hold their breath, and some struggle (Ferretti 1990). It is not known what sensation is felt, but the signs and symptoms of accidental cyanide poisoning are giddiness, headache, dyspnoea, vomiting, ataxia, hyper-ventilation, and collapse (Arena 1988; National Poisons Treatment Service 1991). Death is due to anoxia, consequent upon inhibition of cytochrome oxidase, which is a key respiratory enzyme (Dixon and Webb 1979).

2.7 Intravenous injection

Execution by intravenous injection was first introduced in the United States in 1977 (Amnesty International Medical Commission and Marange 1989). When this method is used the condemned person is bound supine to a trolley and a trained nurse or technician cannulates the vein in the angle of the elbow. If the prisoner's veins are difficult to cannulate, for example if he or she does not cooperate, if there is phlebitis due to injection of addictive drugs, or if there is scarring due to previous attempts to slash the arm, the procedure becomes very fraught. After the cannula has been passed successfully into the vein, three substances are injected: sodium thiopentone—a rapidly acting anaesthetic, pancuronium bromide—a muscle relaxant to paralyse respiration, and potassium chloride—to stop the heart (Amnesty International 1989, page 176; Smith 1983; Paterniti 1985). The subject becomes unconscious within 10–15 s. Death results from anaesthetic overdose and respiratory and cardiac arrest while the condemned person is unconscious. A doctor does not have any part in the execution, but afterwards one will certify that the person is dead, as enjoined by the Declarations of the House of Delegates (American Medical Association 1984), following the recommendations of the World Medical Association (World Medical Association 1981; Cascells and Curran 1982).

3 The assessment of pain during execution

There is an extensive literature on the psychiatric aspects of long periods of waiting for execution (Cohen 1954; Bluestone and McGahee 1962; Gallemer and Panton 1972; Johnson 1981) but these aspects will not be considered here.

In everyday life, a person in severe pain shouts or screams, perspires, has dilated pupils, withdraws from the noxious stimulus, moves the limbs violently, contracts the facial muscles, micturates, and defaecates. The ability to detect each of these signs in the circumstances of each of the different methods of execution is indicated in table 1. Examination of this table leads to the following conclusions: (a) it is not known whether or not many of these signs occur and some could not be seen if they did; (b) physical restraint prevents some of them occurring; (c) some of them, such as dilation of the pupils, contraction of the facial muscles, and micturition commonly occur

Table 1. Signs of severe pain or distress in persons executed by shooting (Sh), hanging (H), stoning (St), beheading (B), electrocution (E), gassing (G), and intravenous injection (IV). + indicates that the sign is often seen, - that it is not seen, * that the sign can either not be made or not be seen, and ? that there is no information.

Signs	Method of execution						
	Sh	H	St	B	E	G	IV
Shouting or screams	?	*	+	+	*	+	-
Perspiration	?	?	*	?	+	?	?
Dilated pupils	*	?	*	?	*	?	+
Withdrawal from stimulus	*	*	*	*	*	*	*
Violent movements	?	+	*	*	*	*	-
Contraction of facial muscles	*	+	*	?	*	+/-	-
Micturition	?	+	?	?	+	?	?
Defaecation	?	+	?	?	+	?	?

Table 2. Factors occurring in execution which are likely to cause pain. Intensity of likely pain is graded as little (+), moderate (++), severe (+++), or not known (?). The likely duration of the sensations is not known.

Method of execution	Pain		
	Cause	Sensation	Intensity
Shooting	rupture of skin	sting or punch	+ or ++
	fracture of bone	cracking	?
Hanging	stretch of skin	burning, stretching	+++
	fracture-dislocation of vertebrae	dislocation, fracture	+++
	asphyxia	suffocation, distress	+++
Stoning	lacerations of skin of head	sharp pain	+++
	multiple injuries	sensory deprivation, exhaustion	+++
Beheading	stretch of skin prior to cut	burning	+++
	lacerations of skin	sharp pain	+++
Electrocution	heat	heat	+++
	skin burns	burning	+++
	asphyxia	suffocation	+++
Gassing	tracheal irritation	burning	+++
	asphyxia	suffocation	+++
Intravenous injection	missing or going through the vein	intramuscular injection	+

as a result of fear, electrical stimulation, or dying (Hillman 1974), as well as being signs of severe pain. In addition, the extreme stress of the circumstances surrounding execution may well either mask or enhance pain.

A person being stoned shouts and screams, but one cannot know whether any of the other signs occur. Nor does one know for how long and how severely a decapitated head feels. There are substantial areas of ignorance, so that one cannot know for certain the extent of pain in respect of a particular method. However, one can examine the stages at which it is likely to occur (table 2), and the evidence for these predictions (table 3).

It is important to appreciate that reaction times—which include the time that motor signals take to go from the brain to the periphery—are maximally up to 1 s (Chase 1984; Posner 1986), whereas the blood and oxygen supply last several seconds (Geiger and Magnes 1947; Roberts 1954; Gregory and Wotton 1985; McIlwain and Bachelard 1985). Thus there will always be a finite, if variable, number of seconds during which a condemned person feels before he or she becomes unconscious. It is also possible that the pain may be so severe that the person faints from it.

The stages at which pain probably occurs are shown in table 2. It should be noted that—with the exception of intravenous injection—all the methods of execution produce the same sort of lesions as conditions for which patients are rushed to accident and emergency departments, where they may be deemed to require powerful analgesics. With the certain exception of intravenous injection and the possible exception of shooting, all the procedures are likely to produce severe pain; the reasons for believing this are given in table 3. The advocates and practitioners of hanging, electrocution, and gassing believe that these procedures are painless, or that the pain lasts such a short time that the condemned person does not suffer for long, or that he or she deserves such pain for the heinous crime of which the prisoner has been found guilty.

Table 3. Evidence for pain being likely during execution.

Method of execution	Evidence
Shooting	Evidence of victims of gunshot wounds (Beecher 1949; Owen-Smith 1981; Melzack et al 1982)
Hanging	Dislocations are painful (Watson-Jones 1976), fractures are painful (Wu 1987)
Stoning	Skin lacerations are painful; operations on skin are carried out under anaesthetic
Beheading	Skin receptors are active until sensory pathways are hypoxic (Donald-Hatcher 1965; Safar et al 1982), amputations are carried out under general anaesthetic
Electrocution	Defibrillation is painful (Kowey 1988), electric burns are painful (Hunt et al 1976; Sances et al 1979; Goodenough and Burke 1983; Hartford 1983), electricity is used for torture (Dylre-Poulsen and Rasmussen 1977; Amnesty International Medical Commission and Marange 1989), an experimenter tried it on himself (Leduc 1903), a survivor of the electric chair felt pain (Francis 1946), domestic electric shocks are painful
Gassing	Symptoms of cyanide poisoning include headache (Arena 1988; National Poisons Treatment Service 1991)
Intravenous injection	No pain reported with successful cannulation

4 Conclusion

All of the methods used for executing people, with the possible exception of intravenous injection, are likely to cause pain. The perceived absence of the normal signs of severe pain is often due to these signs being masked by the procedure, or to the condemned person being physically restrained from demonstrating them, or to their being similar to those seen during dying. Therefore, the absence of signs of severe pain does not provide sufficient evidence for us to decide whether or not it occurs. However, evidence brought to bear from knowledge of physiology, and comparisons with accidental and emergency medicine, that nearly all execution procedures are likely to be attended by pain to the condemned person. Nevertheless, despite the evidence presented above, it is widely asserted that executions are humane and painless (Supreme Court 1890; Purchase 1953; Berns 1980; Sawyer 1991), although no evidence to this effect appears to have been published.

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