Biomedical Engineers and Participation in Judicial Executions: Capital Punishment as a Technical Problem

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In past centuries, the technologies used in judicial executions were crude and rudimentary at best, consisting of various brutal methods such as stoning, drowning, burning at the stake, hanging, mutilation, and so on.

In 18th century France, such a state of affairs was repugnant to the famed physician Dr. Guillotin, who was among the first individuals to advocate the use of technology to achieve more "humane" executions. While Dr. Guillotin was personally opposed to the death penalty, he nevertheless saw his proposal as a step towards its abolition, and as a member of the French Constituent Assembly Dr. Guillotin successfully proposed that the nation develop a uniform method of “humane” execution that would replace the brutal methods then in common use [1].

In the USA, a nation even more enthusiastic than the French about scientific innovation, technological developments such as the electric chair, the gas chamber (which delivers cyanide gas to the occupant) and lethal injection served as uniquely American answers to Dr. Guillotin's plea for "humane" executions.

Of interest, although Dr. Guillotin was a physician, modern physicians have been generally reluctant to follow in his footsteps, preferring to leave the task to other professionals (or amateurs). Indeed, many codes of medical ethics, such as the Code of Ethics of the American College of Physicians, explicitly or implicitly forbid physician involvement in capital punishment.

A frequently stated basis for this position is that physicians are entrusted to work for the benefit of their patients and that this trust is destroyed when medical expertise is used to facilitate judicial executions, assist with suicide attempts, or aid in the termination of human life in other ways.

For instance, the American Medical Association Council on Ethical and Judicial Affairs states [2]:

> *An individual's opinion on capital punishment is the personal moral decision of the individual. A physician, as a member of a profession dedicated to preserving life when there is hope of doing so, should not be a participant in a legally authorized execution.*

Such rules leave a hiatus in need of filling. If physicians cannot be involved in developing better methods of capital punishment, who then should lead the initiative? A case can be made that engineers, especially biomedical engineers, would be a logical choice.

For example, in 1887 Thomas Edison, arguably America’s best known inventor/engineer, held a public demonstration where a high-voltage Westinghouse AC generator was used to terminate a number of unlucky animals, giving rise to the new word "electrocution" to describe death via electricity. Perhaps Edison’s best known animal execution was conducted on January 4, 1903. Edison captured the event on film; he did invent the movie camera, after all. The victim in this instance was an elephant named Topsy with the Forepaugh

Circus at Coney Island's Luna Park. (Topsey was sentenced to death for having killed three men, at least one who had been abusive to her). Edison, later released his film of the execution under the title “Electrocuting an Elephant”; it can be viewed online http://www.youtube.com/watch?v=RnHXSL5jW-c

Experiments such as these naturally lead to the development of an “electric chair” for use on humans, and Thomas Edison was one of the best-known advocates of replacing the then popular method of hanging with electrocution, arguing that it constituted a more reliable means of capital punishment [3]. (Until biomechanics experts empirically developed the “hanging formula” whereby the length of the “drop” in feet should be 1,260 divided by the weight of the victim in pounds [4], decapitation from excessive force or slow, agonizing strangulation from insufficient force was regrettably common).

The first man to be judicially executed electrically was William Kemmler, who was electrocuted on August 6, 1890 using a system employing Westinghouse generators. (George Westinghouse and others tried to stop the execution on the legal grounds that it constituted cruel and unusual

punishment (and obviously bad publicity for the Westinghouse Corporation) but was unsuccessful). Unfortunately for Kemmler, despite prior successful testing using a horse as a test subject, the execution went badly, and Kemmler's body caught fire, presumably from ignited body fat. Westinghouse later lamented: "They would have done better using an axe." A reporter witnessing the event commented that it was "an awful spectacle, far worse than hanging." Fortunately for Edison, this particular execution was not filmed.

Even a century later, death by electrocution can be gruesome. For instance, here is an eyewitness account of the electrocution of John Louis Evans carried out in Alabama on April 12, 1983 [5]:

> *At 8:30 p.m. the first jolt of 1900 volts of electricity passed through Mr. Evans' body. It lasted thirty seconds. Sparks and flames erupted from the electrode tied to Mr. Evans' left leg. His body slammed against the straps holding him in the electric chair and his fist clenched permanently. The electrode apparently burst from the strap holding it in place. A large puff of greyish smoke and sparks poured out from under the hood that covered Mr. Evans' face. An*

overpowering stench of burnt flesh and clothing began pervading the witness room. Two doctors examined Mr. Evans and declared that he was not dead.

The electrode on the left leg was refastened. At 8:30 p.m. Mr. Evans was administered a second thirty second jolt of electricity. The stench of burning flesh was nauseating. More smoke emanated from his leg and head. Again, the doctors examined Mr. Evans. The doctors reported that his heart was still beating, and that he was still alive.

At that time, I asked the prison commissioner, who was communicating on an open telephone line to Governor George Wallace to grant clemency on the grounds that Mr. Evans was being subjected to cruel and unusual punishment. The request for clemency was denied.

At 8:40 p.m., a third charge of electricity, thirty seconds in duration, was passed through Mr. Evans' body. At 8:44, the doctors pronounced him dead. The execution of John Evans took fourteen minutes.

In more recent times a key player in the development of technologies for capital punishment was a self-trained engineer named Fred A. Leuchter. Leuchter was president of Fred Leuchter Associates, a consulting engineering firm that specialized in the design and construction of prototype hardware. One of his first consulting jobs relating to execution technology involved the design, construction, repair and installation of electric chairs. One of his innovations was to develop a three electrode system involving two ankle electrodes rather than the usual one; such an arrangement reduced the current density through each leg to reduce the potential for complications such as tissue burning. Later, he diversified into the design and construction of machines for lethal injection as well as gas chambers and gallows. Some of the technical reports that he produced as a byproduct of this work are available on the Internet [6].

Some individuals who are against capital punishment on principle still have no problem being involved in efforts to make capital punishment into a more humane process, just like Dr. Guillotin in earlier times. For instance, Jack F. Hildebrand, writing about the prohibition of physician involvement in judicial executions in the Rapid Responses

section of the British Medical Journal, expresses things this way [7]:

Let me make it clear: I am opposed to the death penalty. But the fact remains that the death penalty does still exist in this country. I understand that certain physicians want nothing to do with the executions that result from this policy.

But, on the other hand, one of the duties, and desires, of a physician is to provide comfort and relieve pain and suffering. While capital punishment is legal, capital torture is not. I feel that we have a duty, once someone has been ordered executed, to ensure that the execution takes place in as "humane" a fashion as possible. The records are ripe with stories of botched executions. Once we have made the ignominious decision to end a convict's life, we have a huge responsibility to bring this event about in as "efficient" a manner as possible, and that is where the role of the physician comes in.

Enthusiasm for that role is not required, but I just do not see how physicians can walk away from what is, albeit unfortunately, a dirty job that somebody has to do.

A central question in this essay is whether or not a similar sentiment might exist amongst biomedical engineers.

In the USA, execution by lethal injection is the most commonly employed technique of capital punishment. It is usually accomplished using three drugs: thiopental, pancuronium and potassium chloride. The thiopental is given to ensure unconsciousness. The pancuronium paralyses all skeletal muscle, with the result that breathing ceases. The potassium stops the heart.

There is evidence, however, that execution by lethal injection is often done haphazardly. In a study by Koniaris et al. [8] the authors found that in executions performed in Texas and Virginia, the executioners administered drugs remotely without monitoring for unconsciousness. In addition, neither data collection nor peer-review was done, activities ordinarily carried out when process quality is sought. Also, toxicology data obtained "showed that post-mortem concentrations of thiopental in the blood were lower than that required for surgery in 43 of 49 executed inmates" and that 21 inmates actually had concentrations consistent with being awake.

Issues such as this has led some technically-inclined individuals to consider whether, like Dr. Guillotin, they might be able to propose methods of execution superior to existing methods. A more practical and humane method, for example, might be to employ a sealed transparent hood encapsulating the head to which is delivered pure nitrous oxide. Such an arrangement should lead to painless unconsciousness in a few minutes, but since no oxygen is being administered it will also quickly lead to anoxia and cardiac arrest.

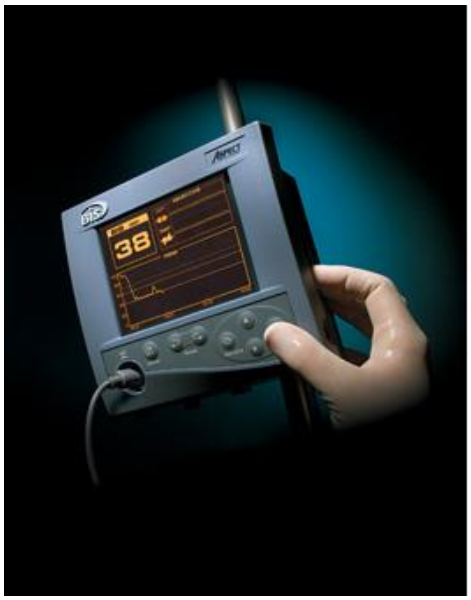
Another concern that has been addressed by individuals against capital punishment as currently implemented is the possibility of unintended consciousness at the time that the pancuronium is administered. Since in many settings executioners administer drugs without monitoring for unconsciousness, it has been proposed that an electroencephalographic (EEG) level of consciousness monitor might be developed for such purposes (Figure 1).

It is interesting to ask: "If execution using such improved systems might be more humane, why is there no movement in this direction?" The likelihood is that while most experts would agree that such a technique would be expected to work, very few would want to be involved in its promotion,

either because they are philosophically against capital punishment (as I am) or for reasons related to professionalism and discretion.

Regardless, engineers individuals concerned that capital punishment be carried out competently and humanely are faced with an ethical dilemma: their desire to reduce pain and suffering in the execution process will not only be in direct conflict with the established ethical position of the medical establishment, which takes an clear and unambiguous position against participating in any way in capital punishment, but is likely to be held in low regard by many in the engineering professions as well.

Introducing the BIS *LI*, the latest in Aspect Medical Systems' innovative series of depth of conscious monitors



While earlier versions of Aspect Medical Systems' Bispectral Index Monitors such as the BIS XP and BIS Vista were designed for monitoring the depth of general anesthesia during surgery, their latest product, the BIS *LI*, has been designed specifically for use in judicial executions involving lethal injection.

This latest innovation from Aspect Medical Systems was developed at the request of the Department of Justice to help ensure that the lethal injection process is carried out humanely. In particular, the BIS *LI* has been engineered to help avoid instances of unintended "cruel and unusual" punishment that occasionally occurs when a death row prisoner still remains conscious following thiopental administration and is then inadvertently given pancuronium and potassium while awake, a misadventure claimed by detractors of execution by lethal injection to occur frequently.

Use of the BIS *LI* is especially easy for prison officials to use as a result a new simple-to-use sensor placed on the patient's forehead. The BIS LI uses special needle electrodes that replace the less reliable surface electrodes used in previous clinical models. The result is a reliable low-impedance electrical connection that is easily obtained 100% of the time.

In operation, The BIS *LI* measures the electrical activity in the brain and translates it into a number between 100 (wide awake) and zero (absence of brain electrical activity). When used in a lethal injection setting, the operator waits for the BIS value to fall under 50 following intravenous thiopental administration before administering any pancuronium or potassium. An automatic trigger option is also available for prisons wanting to automate the lethal injection process.

Figure 1: A hypothetical marketing brochure for a hypothetical level of consciousness monitor for use in humane executions. Not a real product!

References

[1] Donegan CF. Dr. Guillotin--reformer and humanitarian. J R Soc Med. 1990 Oct;83(10):637-9.

[2] American Medical Association Council on Ethical and Judicial Affairs. Code of Medical Ethics of the American Medical Association: Council on Ethical and Judicial Affairs, Current Opinions with Annotations, 2006-2007 AMA Bookstore, 2006. (ISBN 1579477771)

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[4] Hanged by the neck until dead! The processes and physiology of judicial hanging. Retrieved August 21, 2008 from http://www.capitalpunishmentuk.org/hanging2.html

[5] John Louis Evans. Retrieved August 21, 2008 from http://en.wikipedia.org/wiki/John_Louis_Evans

[6] See, for example, the following:

- http://www.angelfire.com/fl3/starke/hanging.html
- http://www.angelfire.com/fl3/starke/injection.html
- http://www.anenglishmanscastle.com/archives/003542.html
- http://ct-mtwt.50megs.com/Tools%20of%20Corrections/1ExecutionByLethalInjection.html
- http://users.bestweb.net/~rg/execution/Protocol%20Gas%20Chamber.htm

[7] Hildebrand JF. Condemned people need our help too. Accessed August 21, 2008 from http://www.bmj.com/cgi/eletters/325/7371/1026#27584

[8] Koniaris LG, Zimmers TA, Lubarsky DA, Sheldon JP. Inadequate anaesthesia in lethal injection for execution. Lancet. 2005; 365(9468):1412-4.