Inadequate anaesthesia in lethal injection for execution

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Anaesthesia during lethal injection is essential to minimise suffering and to maintain public acceptance of the practice. Lethal injection is usually done by sequential administration of thiopental, pancuronium, and potassium chloride. Protocol information from Texas and Virginia showed that executioners had no anaesthesia training, drugs were administered remotely with no monitoring for anaesthesia, data were not recorded and no peer-review was done. Toxicology reports from Arizona, Georgia, North Carolina, and South Carolina showed that post-mortem concentrations of thiopental in the blood were lower than that required for surgery in 43 of 49 executed inmates (88%); 21 (43%) inmates had concentrations consistent with awareness. Methods of lethal injection anaesthesia are flawed and some inmates might experience awareness and suffering during execution.

Since 1976, when the death penalty was reinstated, 959 people have been executed in the USA.[1] Lethal injection has eclipsed all other methods of execution because of public perception that the process is relatively humane and does not violate the Eighth Amendment prohibition against cruel and unusual punishment. US courts recognise "evolving standards of decency that mark the progress of a maturing society", and prohibit punishments that "involve the unnecessary and wanton infliction of pain", "involve torture or a lingering death", or do not accord with "the dignity of man".[2]

Lethal injection usually consists of sequential administration of sodium thiopental for anaesthesia, pancuronium bromide to induce paralysis, and finally potassium chloride to cause death.[3] Without anaesthesia, the condemned person would experience asphyxiation, a severe burning sensation, massive muscle cramping, and finally cardiac arrest. Thus, adequate anesthesia is necessary both to mitigate the suffering of the condemned and to preserve public opinion that lethal injection is a near-painless death. By contrast with its medical applications, however, anaesthesia in execution has not been subjected to clinical trials, governmental regulation, extensive training of practitioners, standardisation, or the supervision of peer-review and medicolegal liability. Furthermore, the American Medical Association and American Nurses Association strictly oppose participation of their members in executions. We postulated that anaesthesia methods in lethal injection might be inadequate.

To assess anaesthesia methods, we sought protocol information from the states of Texas and Virginia, where 45·4% of executions are done, by a combination of statutory records requests to the Texas Department of Criminal Justice and the Virginia Department of Corrections, along with personal interviews and sworn testimony of corrections officials involved in executions. We noted that: neither state had a record of the creation of its protocol (Texas Department of Criminal Justice Assistant General Counsel, January and February, 2004; and Virginia Department of Corrections Director of Communications, December, 2003; written communications); executioners—typically one to three emergency medical technicians or medical corpsmen—had no training in anaesthesia (Virginia Department of Corrections Director of Communications, written communication; and personal interview of a former senior Texas corrections official who witnessed 219 Texas executions: hereafter "personal interview");[4] after placement of one or two intravenous lines, executioners stepped behind a wall or curtain and remotely administered drugs to the conscious inmate (personal interview);[4] no direct observation, physical examination, or electronic monitoring took place for anaesthesia (personal interview);[4] and there was no data collection, documentation of anaesthesia, or post-procedure peer review (Virginia Department of Corrections Director of Communications, written communication; and personal interview). No assessment of depth of anaesthesia or loss of consciousness was done; apparently anaesthesia is assumed because a relatively large quantity of thiopental is specified (usually 2 g) compared with the typical clinical induction dose of 3–5 mg/kg, immediately followed by 1–1·5 mg/kg per min for maintenance; this dose equates to 270–450 mg for induction and 90–135 mg/min maintenance for a 200 lb man.

The assumption that 2 g thiopental assures anaesthesia is overly simplistic, however. First, technical difficulties or procedural errors by poorly trained executioners might hinder administration of the total dose. Second, if thiopental anaesthesia were maintained at standard infusion rates, the total dose for a 10-min procedure in a 100 kg man would be 1·3–2·0 g. Thus the dose used is not excessive for the average time from injection to death (8·4 min, SD 4·7) and might be inadequate if the process took longer.[5] Third, a person anticipating execution would be fearful, anxious, and hyperadrenergic, and would need a higher dose of thiopental than would a premedicated surgical patient. Fourth, inmates with histories of chronic substance misuse problems might have high tolerance to sedative hypnotics and would need increased doses of anaesthetic.

Because no documentation of anaesthesia in the execution chamber existed, the only available objective data were postmortem concentrations of thiopental. Texas and Virginia refused to provide such data, but we obtained autopsy toxicology results from 49 executions in

Arizona, Georgia, North Carolina, and South Carolina. Toxicology reports were generated by MedTox Laboratories (St Paul, MN) for Arizona and are available in Beardslee versus Woodford, No C-04-5381 (Northern District of California, 2004). Data from the Division of Forensic Sciences Georgia Bureau of Investigation are available in State versus Nance, Superior Court Indictment No 95-B-2461-4. North Carolina reports were obtained directly from the Office of the Chief Medical Examiner. South Carolina Law Enforcement Division Toxicology Department reports were obtained by attorney David Barron, Kentucky Department of Public Advocacy Capital Post-Conviction Unit (personal communication) and are available in Hill versus Ozmint, No 2:04-0489-18AJ (District of South Carolina, 2004). Although the protocols of all four states are similar to those of Texas and Virginia, and specify that 2 g thiopental is used, concentrations of the drug in the blood ranged from only trace amounts to 370 mg/L (median 15·5 mg/L; figure 1). Thiopental concentrations did not fall with increased time between execution and blood sample collection (data not shown), consistent with data showing that thiopental is quite stable in stored human plasma.[6]

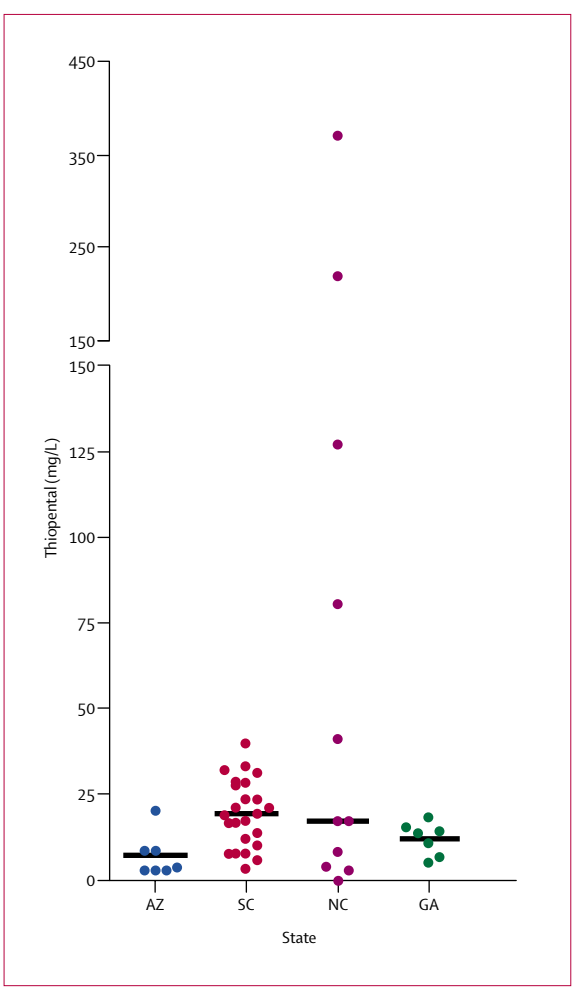

Figure 1: **Individual post-mortem thiopental concentrations in blood by state**
Lines show medians. Note different scales. GA sampled several sites in five individuals; the highest values are shown. GA values were reported as plus or minus 25%. AZ and SC did not report site of blood sampling. NC results were each from a single site, including subclavian artery, jugular vein, femoral vein, or vena cava.

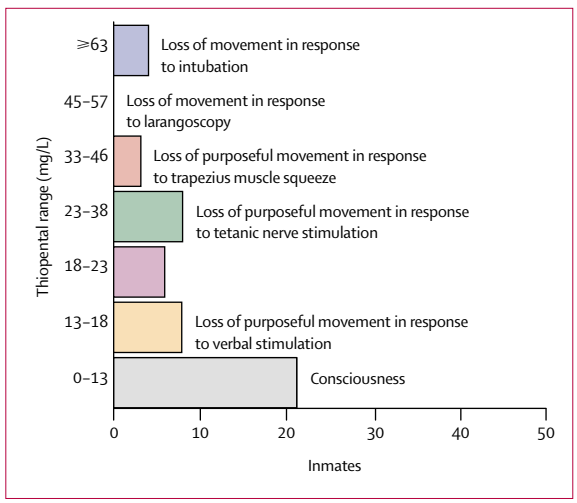

Figure 2: **Number of executed inmates with post-mortem thiopental concentrations within range for indicated clinical endpoint**
Ranges are 95% CI of the Cp50 for the stimuli.

Extrapolation of antemortem depth of anaesthesia from post-mortem blood thiopental concentrations is admittedly problematic. To estimate concentrations of thiopental in the brain from concentrations in the blood in life, details of the rate and duration of drug administration are needed. Unfortunately, such details are usually not specified in lethal injection protocols. Furthermore, no data about post-mortem distribution of thiopental are available. However, a large range of blood concentrations resulted from nearly identical protocols across and within individual states—from 8·2 mg/L to 370 mg/L in North Carolina for the same sampling site (subclavian artery) and similar collection times (same day or next day, respectively). This finding suggests substantial variations in either the autopsy or anaesthesia methods. Contrasting the expertise of state medical examiners with the relatively unskilled executioners, however, would strongly suggest that the variation is probably due to differences in drug administration in individual executions.

If post-mortem thiopental concentrations are taken as a surrogate marker of concentrations in the blood during life, most of the executed inmates had concentrations that would not be expected to produce a surgical plane of anaesthesia, and 21 (43%) had concentrations consistent with consciousness (figure 2). In a careful study in which actual serum thiopental concentrations were measured against clinical endpoints, the steady state serum concentration needed to produce a 50% probability of no

muscle response (Cp50) after intubation was defined as 78·8 mg/L (SD 2·9).[7] The Cp50 for movement after trapezius muscle squeeze, a stimulus equivalent to skin incision, was 38·9 mg/L (3·3). Remarkably, 43 of the 49 inmates had blood thiopental concentrations below this level. Most worryingly, 21 inmates had concentrations less than the Cp50 for repression of movement in response to a vocal command. In view of these data, we suggest that it is possible that some of these inmates were fully aware during their executions. We certainly cannot conclude that these inmates were unconscious and insensate. However, with no monitoring and with use of the paralytic agent, any suffering of the inmate would be undetectable.

With little public dialogue about protocols for killing human beings, it is pertinent to consider recommendations from animal euthanasia protocols. The American Veterinary Medical Association (AVMA) panel on euthanasia specifically prohibits the use of pentobarbital with a neuromuscular blocking agent to kill animals,[8] and 19 states, including Texas, have expressly or implicitly prohibited the use of neuromuscular blocking agents in animal euthanasia because of the risk of unrecognised consciousness.[2] Furthermore, AVMA specifies that "it is of utmost importance that personnel performing this technique are trained and knowledgeable in anaesthetic techniques, and are competent in assessing anaesthetic depth appropriate for administration of potassium chloride intravenously. Administration of potassium chloride intravenously requires animals to be in a surgical plane of anesthesia characterized by loss of consciousness, loss of reflex muscle response, and loss of response to noxious stimuli".[8] The absence of training and monitoring, and the remote administration of drugs, coupled with eyewitness reports of muscle responses during execution, suggest that the current practice of lethal injection for execution fails to meet veterinary standards.[3]

Our data suggest that anaesthesia methods in lethal injection in the USA are flawed. Failures in protocol design, implementation, monitoring and review might have led to the unnecessary suffering of at least some of those executed. Because participation of doctors in protocol design or execution is ethically prohibited, adequate anaesthesia cannot be certain. Therefore, to prevent unnecessary cruelty and suffering, cessation and public review of lethal injections is warranted.

Contributors

L G Koniaris and J P Sheldon conceived the study. J P Sheldon collected the protocol information. J P Sheldon and T A Zimmers collected the toxicology data. D A Lubarsky, L G Koniaris, and T A Zimmers assessed the protocol information and toxicology data. All authors participated in the writing and editing of the manuscript. L G Koniaris and T A Zimmers contributed equally to the work.

Conflict of interest statement

JS is an attorney who represents inmates sentenced to death. None of the other authors has a conflict of interest.

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