G43 The Development of a Model to Assess the Effects of Conducted Electrical Weapons in a Stressful State

Amanda O. Esquivel, MS, and Cynthia Bir, PhD, Wayne State University, 818 West Hancock, Detroit, MI 48201*

This presentation will educate attendees on the safety of conducted electrical weapons (CEWs) that are used in a physiologically stressful state by examining their effects on swine that are hyperthermic, tachycardic, hypotensive and have elevated catecholamine levels.

The research findings presented will impact the forensic science community in guiding policy related to the use of CEWs in given operational scenarios. In addition, knowledge related to the physiological effects of CEW use in compromised individuals is useful to emergency medical personnel for determination of proper medical treatment and the development of treatment protocols.

Although the effects of CEWs on healthy, anesthetized swine appear to be transient, persons that are subjected to repeated exposures of a CEW are most likely in an agitated or combative state. This stimulation could lead to a phenomenon known as excited delirium. In order to determine whether severe physiologic stress in combination with the use of a CEW would cause a serious adverse physiological effect a controlled hemorrhage along with external warming was performed. The hemorrhage was conducted to induce tachycardia, hypotension and catecholomine release as a compensatory mechanism. These signs, along with hyperthermia, are associated with excited delirium.

Preliminary data was gathered in order to assess the effectiveness of the proposed methodology to simulate a state of excited delirium. Three male swine (44 kg +/- 0.8 kg) were included in the study and one additional "sham" (43.4 kg) to observe the effects of the stress only. Under a surgical plane of anesthesia (2%-3% isoflurane) the animals were instrumented and subjected to hemorrhage and hyperthermia. Hemorrhage was induced using the Wiggers model in which blood is removed from the pig until a predetermined mean arterial pressure (MAP) is reached. The average baseline pressure prior to hemorrhage was 70 mmHg. For the proposed effort, it was determined that a MAP of 45 mmHg was sufficient in causing a stress from the blood loss. The swine were covered in a warming blanket to bring their core temperature up to 108°F. The normal temperature for the swine is 101° - 103°F (2.4° - 4.4° higher than humans). This increase in core body temperature is consistent with the sign of hyperthermia often observed in the field and previously described. Exposures to a CEW were given 20 times (4 sets of 5 exposures) in 30 minutes. Cardiac and pulmonary parameters were continuously monitored and blood samples were collected before and after each set of exposures and at one hour intervals for four hours.

The MAP decreased from its baseline value to 39.8, 43.7 and 44.3 mmHg for each of the three animals subjected to exposures. Heart rate increased on average from 112 to 185 beats per minute after the hemorrhage for the three animals subjected to exposures while the sham increased from 100 to 168 beats per minute. As expected, the heart rate remained elevated for the entire study for all animals. The baseline pH (7.44), PCO_2 (41.4 mmHg) and lactate (0.79 mM/L) values recorded were within the normal
average values previously reported for swine. The pH decreased slightly after hemorrhage for all in the exposed group to 7.38 and all three in the exposed group became acidodic during the exposures (average 7.25). Blood lactate increased above normal after the hemorrhage to 3.78 and increased further after each set of exposures to 8.93 mM/L. Compared to a previous study in which the same device was applied on healthy, anesthetized swine, these animals were more acidodic and had a greater increase in blood lactate.

This model successfully created a physiologically stressful state similar to excited delirium. The warming blanket induced an increase in core body temperature and the hemorrhage induced tachycardia, hypotension and dehydration. Epinephrine and norepinephrine were not directly measured in this preliminary study however, a compensatory mechanism of hypovolemic shock is a rise in these levels.

Electrical Weapons, Tasers, Less-Lethal Weapons

 ** Presenting Author*