

## Metabolic Acidosis – Detail

<p><sup>1</sup>What is metabolic acidosis?</p>	<p>A decrease in blood pH (measure of acidity or alkalinity) and bicarbonate caused by the accumulation of endogenous or exogenous acids.<sup>2</sup> This condition can lead to serious injury and death.</p>
<p>What are the common causes of metabolic acidosis?</p>	<p>Diabetic ketoacidosis, severe physical exertion, ingestion of certain toxins, ingestion of certain medications, ingestions of certain illicit substances, severe infections.</p>
<p>How does metabolic acidosis relate to a TASER<sup>®</sup> Electronic Control Device (ECD) exposure?</p>	<p>Because a TASER ECD exposure can cause strong muscle contraction, this can result in the increased production of lactic acid which is a by-product of muscle metabolism.</p>
<p>What is an evidence-based conclusion?</p>	<p>While prolonged muscle activity does produce lactic acid, human studies of ECD exposures up to 15 seconds (or 3 cycles) have shown that there is no clinically significant increase in metabolic acidosis. Strong physical exertion (e.g., resisting law enforcement restraint) can lead to profound metabolic acidosis and measures to limit the period of resistance might be beneficial in already acidotic persons.</p>
<p><b>The evidence:</b></p>	
<p>Prospective Human Studies</p>	<p>(Ho 2006<sup>3</sup>) In this resting adult population, the TASER X26 CEW [conducted electrical weapon] did not affect the recordable cardiac electrical activity within a 24-hour period following a standard five-second (s) application. The authors were unable to detect any induced electrical dysrhythmias or significant direct cardiac cellular damage that may be related to sudden and unexpected death proximal to CEW exposure. Additionally, no evidence of dangerous hyperkalemia or induced acidosis was found. Further study in the area of the in-custody death phenomenon to better understand its causes is recommended.</p> <p>(Moscati 2007<sup>4</sup>) Intoxicated adults with prolonged CEW exposure demonstrate small transient increases in measures of acidosis and no change in markers of cardiac injury.</p>

	<p>The increased acidosis was not clinically significant and self corrected.</p> <p>(Ho 2007<sup>5</sup>) Markers of acidosis and cardiac injury were similar among acidotic subjects who underwent both sham and real prolonged CEW exposure. Prolonged CEW exposure in humans does not appear to have an effect with regard to worsening acidosis that is already present.</p> <p>(Dawes 2007<sup>6</sup>) This study demonstrates that the new XREP [eXtended Range Electronic Projectile] CEW has no important deleterious effects on respiratory parameters, blood chemistries, or venous blood gases. These results are consistent with previous results for the TASER X26 CEW.</p> <p>(Vilke 2007<sup>7</sup>) A 5 s exposure of a [TASER] X-26 to healthy law enforcement personnel does not result in clinically significant changes of physiologic stress.</p> <p>(Vilke 2007<sup>8</sup>) There were no clinically significant or lasting statistically significant changes in cardiovascular, electrolyte, lactate or pH levels in human subjects after a 5 s TASER ECD activation.</p> <p>(Bouton 2007<sup>9</sup>) Cardio-respiratory and blood parameters were followed before and for 60 min after a 5 s TASER [ECD] exposure on 21 men and women law enforcement officer volunteers.</p>
Indirectly Related Human Studies	<p>(Pudiak 1995<sup>10</sup>) This finding suggests that stress can augment the toxic effect of cocaine and that minimizing stress may be an important consideration in the clinical management of cocaine overdose.</p> <p>(Strote 2006<sup>11</sup>) The findings are consistent with prior studies, suggesting a high frequency of restraint-related and excited delirium-related fatalities.</p> <p>(Kornblum 1991<sup>12</sup>) The conclusion reached after evaluation of these cases is that the [ECD] in and of itself does not cause death, although it may have contributed to death in one case.</p>

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	<p>(Ho 2007<sup>13</sup>) Prolonged CEW application did not impair respiratory parameters in this population of volunteers. Further study is recommended to validate these findings in other populations.</p> <p>(Fish 1993<sup>14</sup>) Electric injuries, whether a complication of deliberate electric shock or due to accidental injury, should be treated to preserve cardiac and respiratory function and to prevent further tissue damage.</p> <p>(Chan 2007<sup>15</sup>) In our study on human volunteers, VE, TV, and RR increased immediately following a standard [TASER ECD], but returned to baseline within 10 minutes. There was no evidence of hypoxemia or hypo-ventilation [in] our study subjects.</p>
<p>Animal Studies</p>	<p>(Hughes 2008<sup>16</sup>) Trials suggest that swine (based on physiology) will not experience a fatal event when continuously exposed to the TASER X26 for three minutes when adequate ventilation is provided and that continuous exposure to TASER X26 for up to three minutes is fully recoverable in healthy animals. The TASER X26 dose does not seem to be cumulative. Researchers did not observe an accumulation of the TASER ECD effect to a “toxic” level. There was no increased mortality with longer continuous ECD duration stimulation – up to 30 minutes.</p> <p>(Jauchem 2006<sup>17</sup>) ...the repeated use of electro-muscular incapacitating devices in a short period of time is, at least, feasible, with the caveat that some medical monitoring of subjects may be required (to observe factors such as lactate and acidosis).</p> <p>(Jauchem 2007<sup>18</sup>) Three repeated TASER device exposures had only transient effects on blood factors, which all returned to pre-exposure levels, with the exception of hematocrit (which remained elevated after 3 h). Since the increase in this factor was less than that which may occur after short periods of exercise, it is unlikely that this would be an indicator of any serious harm.</p> <p>(Dennis 2007<sup>19</sup>) Immediately after the [ECD] discharge, two deaths occurred in small swine because of ventricular fibrillation. In this model of prolonged EID exposure, clinically significant acid-base and cardiovascular disturbances were clearly seen. The</p>

	<p>severe metabolic and respiratory acidosis seen here suggests the involvement of a primary cardiovascular mechanism.</p>
<p>Other Relevant Information)</p>	<p>(Kroll 2008<sup>20</sup>) <i>Science and Medicine of TASER® Electronic Control Devices.</i></p> <p>(Dawes 2007<sup>21</sup>) Excited Delirium, Police Physicians Section Track.</p> <p>(Ho 2007<sup>22</sup>) The State of Current Human Research and Electronic Control Devices.</p> <p>(Jauchem 2004<sup>23</sup>) Effectiveness &amp; Health Effects of Electro-Muscular Incapacitating Devices.</p> <p>(2003) The Alfred Hospital 2003. <i>ADVANCED TASER M-26 Safety Analysis; 22 September 2003.</i></p> <p>(2003) The Alfred Hospital 2003. <i>ADVANCED TASER X-26 Safety Analysis; 29 June 2003.</i></p> <p>(Bozeman 2001<sup>24</sup>) <i>Medical Threat Assessment: The [ADVANCED] TASER M26 Less Lethal Weapon</i></p> <p>(Karch 1999<sup>25</sup>) Drug abusers who die during arrest or in custody.</p> <p>(Tisdale 1996<sup>26</sup>) Electrophysiological and Electrocardiographic Pharmacodynamics of Cocaine.</p>

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<sup>2</sup> *Stedman's Concise Medical Dictionary for the Health Professions, 3<sup>rd</sup> Edition.*

<sup>3</sup> Ho JD, Miner JR, Lakireddy DR, Bultman LL, Heegaard WG. Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. *Acad Emerg Med.* Jun 2006;13(6):589-595.

<sup>4</sup> Moscati R, Ho J, Dawes D, et al. Physiologic Effects of Prolonged Conducted Electrical Weapon Discharge on Intoxicated Adults. *Acad Emerg Med* 2007;14(5):63-64.

<sup>5</sup> Ho J, Dawes D, Bultman L, et al. Physiologic Effects of Prolonged Conducted Electrical Weapon Discharge on Acidotic Adults. *Acad Emerg Med* 2007;14(5):63.

<sup>6</sup> Dawes DM, Ho J, Johnson M, Miner J, Lundin E. BREATHING PARAMETERS, VENOUS GASES, AND CHEMISTRIES WITH EXPOSURE TO A NEW WIRELESS PROJECTILE CONDUCTED ELECTRICAL WEAPON. Lompoc District Hospital, Lompoc, CA, USA. Hennepin County Medical Center, Minneapolis, MN, USA. TASER International, Scottsdale, AZ, USA: Fourth Mediterranean Emergency Medicine Congress (MEMC IV); 2007.

<sup>7</sup> Vilke GM, Sloane CM, Bouton KD, et al. Physiological Effects of a Conducted Electrical Weapon on Human Subjects. *Ann Emerg Med.* Aug 23 2007.

<sup>8</sup> Vilke G, Sloane C, Bouton K, et al. Cardiovascular and Metabolic Effects of the TASER on Human Subjects. 2007.

<sup>9</sup> Bouton K, Vilke G, Chan T, et al. Physiological Effects of a Five Second TASER Exposure. San Diego State University San Diego Heart Institute: Society for Academic Emergency Medicine; 2007.

<sup>10</sup> Pudiak CM, Bozarth MA. Cocaine fatalities increased by restraint stress. *Life Sci.* 1994;55(19):PL379-382.

<sup>11</sup> Strote J, Range Hutson H. TASER use in restraint-related deaths. *Prehosp Emerg Care.* Oct-Dec 2006;10(4):447-450.

<sup>12</sup> Kornblum RN, Reddy SK. Effects of the TASER in fatalities involving police confrontation. *J Forensic Sci.* Mar 1991;36(2):434-438.

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