# Physiological Effects of a Five Second TASER Exposure

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## Abstract

The TASER® X26 has gained popularity by law enforcement agencies as a less lethal weapon. However, there have been a number of sudden deaths of suspects following TASER exposure. The purpose of this study was to examine the effects of a single TASER exposure on markers of physiological stress. Cardiorespiratory and blood parameters were followed before and for 60 min after a 5 s TASER exposure on 21 men and women law enforcement officer volunteers. Data were analyzed using RM ANOVA. (* different from baseline value, $P < 0.05$)

| | *baseline* | *1 min* | *10 min* | *30 min* | *60 min* |
|---|---|---|---|---|---|
| VE (L·min$^{-1}$) | 15.9 ± 4.2 | 26.5 ± 7.8* | 17.9 ± 4.2 | 16.0 ± 5.7 | 15.3 ± 4.1 |
| TV (L·breath$^{-1}$) | 0.87 ± 0.26 | 1.26 ± 0.60* | 0.91 ± 0.27 | 0.90 ± 0.36 | 0.84 ± 0.27 |
| RR (breaths·min$^{-1}$) | 18.8 ± 4.1 | 22.9 ± 5.3* | 20.5 ± 4.6 | 18.7 ± 4.5 | 18.6 ± 3.7 |
| $P_{ET}CO_2$ (mm Hg) | 33.5 ± 2.9 | 34.5 ± 4.4 | 33.5 ± 3.0 | 32.8 ± 2.6 | 33.1 ± 2.0 |
| pH | 7.43 ± 0.03 | 7.41 ± 0.03* | 7.43 ± 0.03 | 7.43 ± 0.03 | 7.43 ± 0.03 |
| Bicarbonate (mEq·L$^{-1}$) | 24.1 ± 2.2 | 22.8 ± 2.0* | 23.1 ± 1.7* | 24.2 ± 1.7 | 24.0 ± 1.5 |
| Lactate (mmol·L$^{-1}$) | 1.38 ± 0.45 | 2.80 ± 0.81* | 2.45 ± 0.62* | 1.45 ± 0.56 | 1.39 ± 0.49 |

There was a statistically significant increase from baseline for VE, TV, and RR at 1-min postTASER exposure, which returned to baseline levels at 10 min. There were also statistically significant changes from baseline in blood pH, bicarbonate, and lactate at 1 and 10 min postTASER exposure that returned to baseline at 30 min. Based on these markers of stress, a 5 s TASER exposure does not appear to cause clinically significant physiological changes.

## Introduction

The use of the TASER as a less lethal law enforcement weapon has greatly increased with the new TASER® X26 model. However, there are a number of reports of sudden deaths of suspects following TASER exposure. Although the effects of the TASER have been poorly studied, it is generally regarded as safe (2, 7). Most of the data supporting the product's approval by the U.S. Consumer Product and Safety Commission were based on theoretical calculations and not on the basis of animal or human studies (10). Individuals who have died following TASER exposure tend to be in heightened states of physiological stress due to illicit drug use, especially phencyclidine and cocaine (7, 13), or in combination with heightened metabolic and physiological stress after a struggle with law enforcement officers. There are also several deaths reported in subjects after TASER exposure who were found not to be under the influence of drugs, although these cases generally involved subjects with "excited delirium" and other co-morbid factors that were more likely to be related as the cause of the subject's death (1, 9, 14).

To date there has been only one human study published on the effects of TASER exposure. In a study funded by TASER International, Ho et al. (5) were unable to detect, following a 5 s TASER exposure in a healthy population, any induced-electrical dysrhythmias or cardiac cellular damage that could be related to sudden death. However, they did not report blood pH, and metabolic acidosis could increase the risk of cardiac arrest.

Because of its wide-spread use, it is important to assess the level of physiological stress from TASER exposure that could be a contributing factor to the incidents of sudden death. The purpose of this study was to determine the physiological stress, including ventilatory and blood pH and lactate concentration, from a standard 5 s TASER exposure in a healthy population.

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## Methods

- 21 men and women law enforcement officers (36.8 ± 6.7 yr; 73.9 ± 7.8 kg)
- baseline measurements taken prior to 5 s TASER exposure and for 60 min afterwards
  - ventilatory measures (Oxycon Mobile, VIASYS Healthcare, Yorba Linda, CA): minute ventilation (VE), tidal volume (TV), respiratory rate (RR), end-tidal $PO_2$ ($P_{ET}CO_2$)
  - blood measures: pH, bicarbonate, lactate
- Data analyzed using repeated measures ANOVA; alpha set at 0.05

## Results

- VE, TV, and RR were elevated above baseline levels at 1-min postTASER, but returned to baseline within 10 min (Figure 1)
- $P_{ET}CO_2$ was unaffected by the TASER exposure
- blood pH was decreased at 1-min postTASER, but returned to baseline within 10 min (Figure 2)
- blood bicarbonate and lactate concentrations were decreased and increased, respectively, at 1- and 10-min postTASER, but returned to baseline within 30 min (Figure 2)

*Figure 1. Ventilatory responses to 5 s TASER exposure*

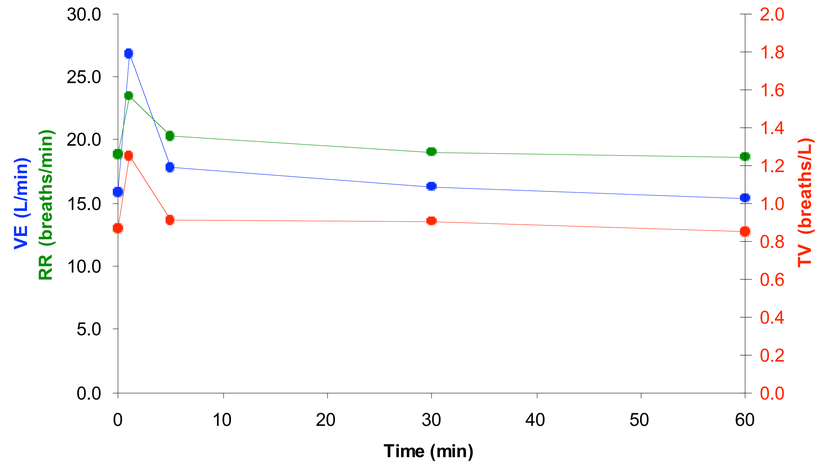
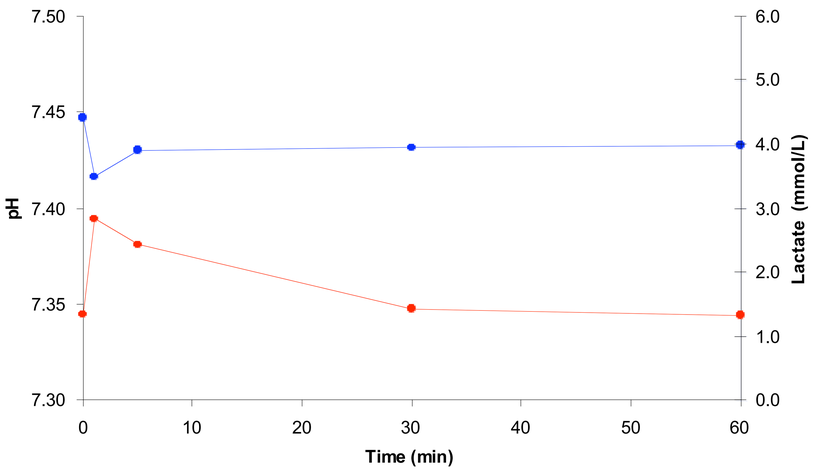



*Figure 2. Blood responses to 5 s TASER exposure.*




## Discussion

Although there were statistically significant changes in some of the ventilatory and blood variables that were measured, the main finding of this study was that a 5 s TASER exposure in our population does not cause clinically significant physiological stress. The changes in VE, RR, and TV were briefly, but mildly, elevated after TASER exposure though there was no evidence of metabolic-induced hyperventilation as $P_{ET}CO_2$ was unaffected. Changes in ventilatory and blood measures suggest that the physiological stress from a 5 s TASER exposure is no more than that from moderate-intensity exercise.

Sudden in-custody-deaths (ICD) have occurred in subjects placed in custody following TASER exposure. Though some have suggested a causal link between TASER exposure and sudden ICD (7, 13, 16), Strote and Hutson (15) in a review concluded that it is difficult to link TASER exposure to subject death. However, should TASER exposure cause acidosis, this might promote sudden death in subjects displaying symptoms of excited delirium.

Excited delirium has been likened to a state of metabolic acidosis (3) and is a phenomenon that is purported to put individuals at higher risk for sudden death in restraint-related conditions such as a TASER exposure. This condition is often induced by chronic, illicit drug and can also be the result of drug treatment for mental disorders (4). Subjects who display this type of behavior may be at greater risk to becoming acidotic (3) that could bring about sudden death (6).

In a related study, Ho et al. (7) did not detect any induced electrical dysrhythmias or evidence of cardiac cellular damage that may be related to sudden and unexpected death proximal following a single 5 s TASER exposure. In addition ventilatory indicators of stress were not indicative of advanced levels of stress that may put subjects at high risk for sudden death. Similarly, in two pilot studies, Levine and colleagues also failed to observe any ECG abnormalities or changes in troponin I in over 100 subjects following a single 5 s TASER exposure (10, 11).

Based on these limited observations, a 5 s TASER exposure does not cause clinically significant indications of physiological stress that could be causally linked to sudden death. However, our subjects were healthy and were not under the influence of any illicit drugs, thus these results may not be generalizable to populations who are were taking common drugs of abuse and/or who had developed lactic acidosis from high-intensity exercise.

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