

# COMPARISON OF ACIDOSIS MARKERS ASSOCIATED WITH LAW ENFORCEMENT APPLICATIONS OF FORCE

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## **Study Objective**

Subjects who confront Law Enforcement Authorities (LEA) are an increased risk for injury and sometimes death. Occasionally, unexpected sudden death (SD) occurs. The SDs that occur in these situations can be alarming and many theories of causation have been espoused. These theories have included drug intoxication/overdose, induced positional asphyxia, electrocution due to Electronic Control Devices (ECDs such as TASER® devices), mental illness or mental health drug non-compliance, various types of force or restraint used, and effects of ECDs. 123 Work in this area does not suggest that any of these theories completely explains what happens and there are instances of these types of deaths occurring in the absence of these possible causes. 4567

Another hypothesized cause of SD is a worsening acidosis leading to a cardiopulmonary arrest. It is not clear if this acidosis is due to volitional subject behaviors or to LEA tools/tactics. Our objective was to compare common volitional subject behaviors and commonly used LEA tools/tactics or restraints to determine which, if any, cause the highest levels of acidosis.

We present the first known comprehensive evaluation of this. This abstract demonstrates the physiologic interactions between subject behavior and available control tools and tactics.

#### Methods

This was a prospective evaluation of human volunteers in a LEA training class. Following informed consent, randomization to 1 of 5 study groups (Figures 1-5) occurred:

- 1. Maximal "heavy bag" exertion x 45 sec (simulating subject resistance)
- 2. 10 sec TASER X26 ECD application
- 3. Full face exposure to Oleoresin Capsicum (OC) spray
- 4. 150 meter sprint + scaling a 4 foot wall (simulating subject fleeing)
- 5. 40 yard flee (sprint) + 20 sec fight with a LEA K9

A 6th group of subjects performed a run up and down 2 flights of stairs ("as if late for a meeting") so that a common layperson activity was included in the analysis for comparison.

Volunteers had venous sampling before and after their events. Sampling continued at 2-minute intervals until 12-minutes post event. Values for pH and Lactate were determined and compared between study arms using k-sample equality of medians tests. Descriptive analysis was used where appropriate.

## Discussion and Summary

\*Sudden, unexpected deaths in LEA custody are of research interest because a universal mechanism has not yet been found.

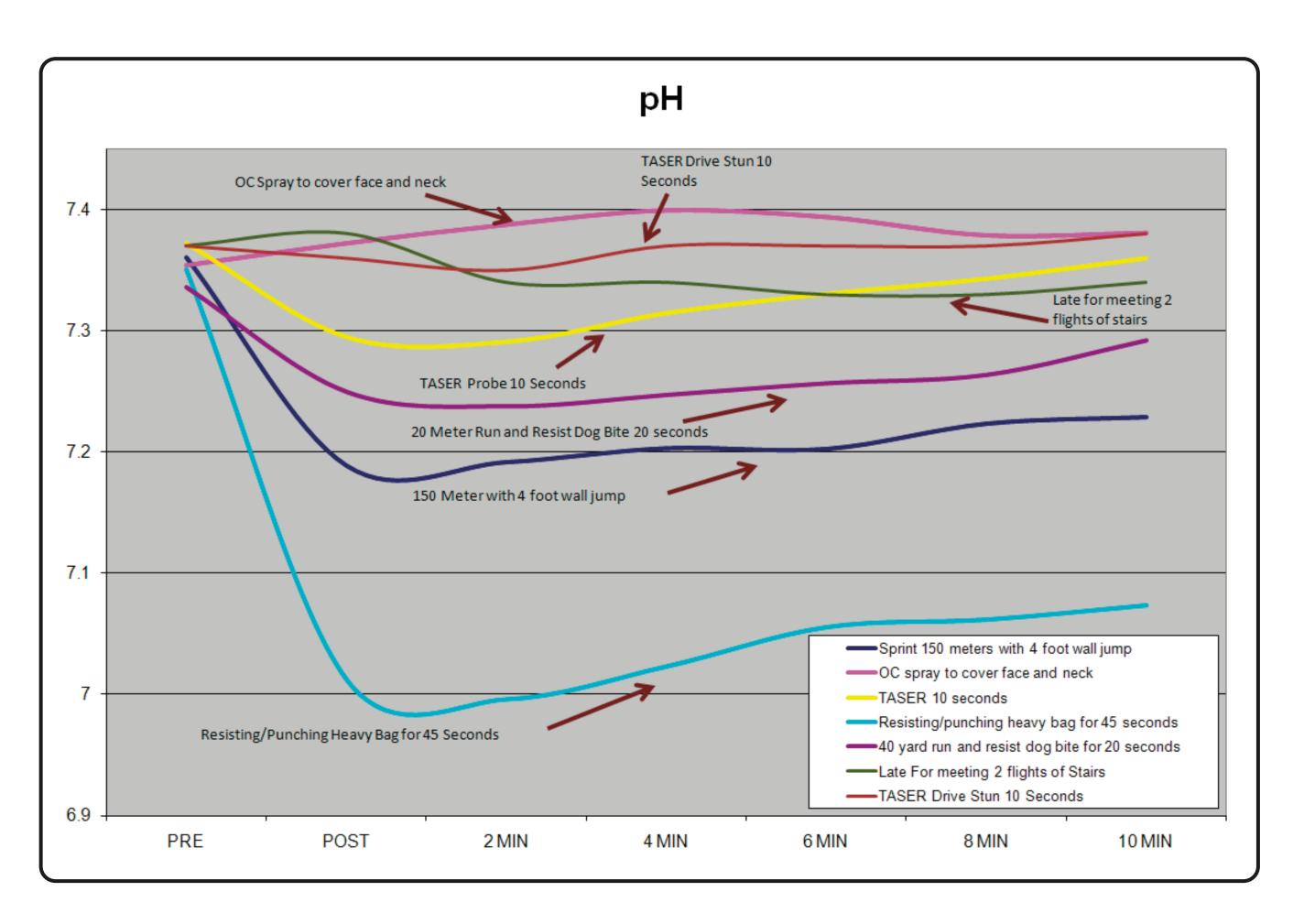
\*A proposed mechanism of death is profound acidosis leading to a cardiopulmonary arrest.

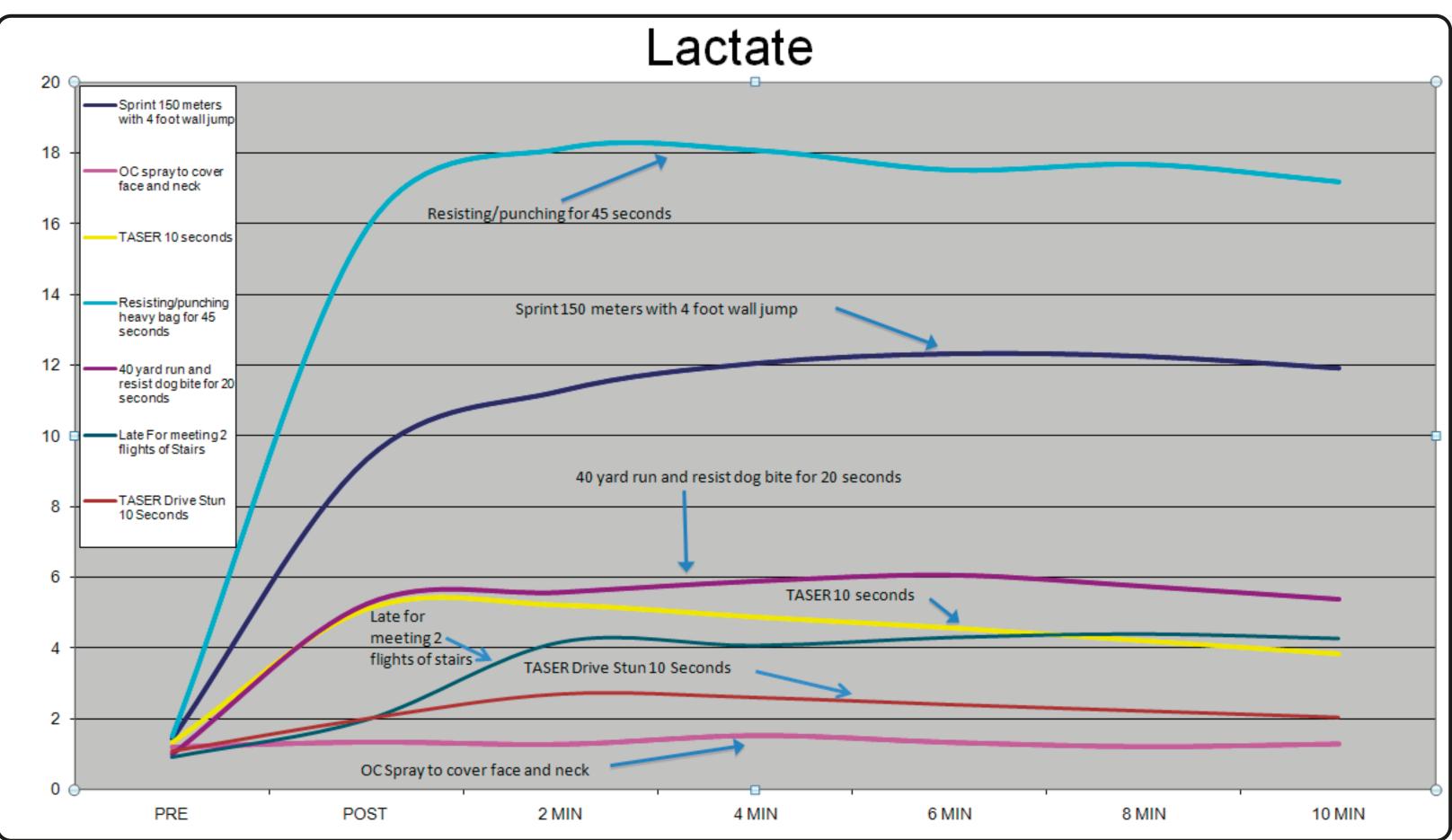
\*Associated factors include illicit stimulant abuse, agitated and delirious behavior, violent resistance and mental illness.

\*LEA may use different tools/tactics to apprehend and restrain resistive subjects including the ECD, Oleoresin Capsicum pepper spray, hand-to-hand grappling, LEA canine, and application of restraints. Subjects volitionally choose to comply or attempt to flee or resist. Physiologic acidosis associated with these tools/tactics restraints and behaviors have not been examined before.

\*Violent resistive grappling, fleeing and resisting a LEA canine were the most physiologically damaging activities from an acidosis standpoint in that order.

\*A common layperson activity of briskly negotiating 2 flights of stairs was physiologically similar to the application of an ECD for 10 seconds.













#### Results

\*n=62, median age 35 (range 19 to 67), 85.5% male, median BMI 27.8 (range 19.1 to 44.1). There was no difference between age, gender, or BMI between the groups.

\*Median baseline pH was 7.36 (range 7.28 to 7.44) with no difference between the groups (p=0.23).

\*Median post exposure pH for group 1 was 7.01 (range 6.94 to 7.18, IQR 6.99 to 7.05)

\*Median post exposure pH for group 2 was 7.29 (range 7.24 to 7.35, IQR 7.26 to 7.33)

\*Median post exposure pH for group 3 was 7.37 (range 7.33 to 7.40, IQR 7.38 to 7.39)

\*Median post exposure pH for group 4 was 7.16 (range 7.05 to 7.31, IQR 7.13 to 7.31)

\*Median post exposure pH for group 5 was 7.26 (range 7.30 to 7.40, IQR 7.22 to 7.31)

\*These significant differences (p<0.001) persisted over the subsequent 6 measured time points.

\*Median baseline lactate was 1.15 (range 0.61 to 3.55, IQR 0.75 to 2.35) with no difference between the groups (p=0.07).

\*Median post exposure lactate for group 1 was 14.71 (range 8.9 to 18.7, IQR 13.7 to 17.40)

\*Median post exposure lactate for group 2 was 5.49 (range 1.3 to 7.2, IQR 4.3 to 5.9)

\*Median post exposure lactate for group 3 was 1.39 (range 0.6 to 2.4, IQR 1.3 to 1.7)

\*Median post exposure lactate for group 4 was 10.98 (range 3.3 to 14.6, IQR 7.4 to 13.2

\*Median post exposure lactate for group 5 was 5.01 (range 1.5 to 9.6, IQR 3.5 to 7.0)

\*These significant differences (p<0.001) persisted over the subsequent 6 measured time points.

### Conclusions

\*The exertional groups of heavy bag and sprint had a lower pH and higher lactate after the exposure than the other groups.

\*The exposures of the TASER ECD and the OC spray had higher pH and lower lactate than the other groups.

\*Volitional behaviors of resistance and fleeing induced the most profound levels of acidosis.

\*Measured LEA tools/tactics did not induce acidosis to the same levels as volitional subject behavior.

\*The common activity of briskly going up and down stairs causes similar acidosis physiology to a 10 second ECD application.

\*This work represents the first known study to evaluate acidosis that may be associated with LEA applications of force.

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