MedCrave
Step into the World of Research
Forensic Research & Criminology International Journal

Research Article

Open Access
CrossMark

Assessing the symptoms associated with excited delirium syndrome and the use of conducted energy weapons

Abstract

Incidents where the police and corrections officers confront a person exhibiting the symptoms of the excited delirium syndrome (ExDS) has become an important concern, although rare in occurrence. To date there has been two prospective, epidemiologic studies which have examined the frequency of the symptoms of ExDS during a police use of force confrontation. Using a prospective research design, we analyzed a cohort of 635 arrestees who exhibited symptoms of ExDS as reported by 17 police agencies from six states in the U.S. over twelve months in 2013 during a use of force incident. We sought to determine if police officers could recognize the associated symptoms of ExDS, determine their prevalence during a use of force confrontation, and to assess if the symptoms were observable across multiple agencies. We also assessed the types of resistance displayed by the arrestees and the outcomes of the use of a conducted energy weapon (CEW) in response to the resistance. Officers reported observing thirteen symptoms associated with ExDS. Using descriptive statistics and regression analysis (p=0.05) showed that 58 percent of the arrestees presented 3 to 4 symptoms, 30 percent presented 5 to 6 symptoms, and 12 percent presented 7 or more symptoms. A CEW was applied in 38 percent (n=240) of the incidents and all arrestees were controlled and restrained in the prone position. None of the arrestees died and in 79 percent of the incidents, an arrestee did not sustain an injury. Officers from multiple agencies were able to recognize the varying symptoms associated with ExDS and their prevalence. The outcome of the incidents showed that applying a CEW with an arrestee exhibiting signs of ExDS is a safe and viable use of force device reducing the likelihood of an arrestee death and minimizing arrestee injuries. Based on the results policy, training, and the focus of future research is discussed.

Keywords: excited delirium syndrome, conducted energy weapons, arrest related deaths, police use of force

Volume 6 Issue 3 - 2018

Darrell L Ross,[1] Michael H Hazlett[2]
[1]Department of Sociology, Anthropology, and Criminal Justice, Valdosta State University, USA
[2]School of Criminal Justice, Western Illinois University, USA

Correspondence: Darrell L Ross, Professor and Department Head, Department of S, A, & CJ, 1500 N. Patterson St., 1014 Nevins Hall, Valdosta State University, Valdosta, GA, 31698-0060, USA, Tel (229) 333-5943, Fax (229) 333-5492, Email dross@valdosta.edu

Received: April 27, 2018 | **Published:** June 06, 2018

Introduction

Excited delirium syndrome (ExDS) has been defined as the sudden death of an individual involving an acute (minutes to hours) transient disturbance in consciousness and cognition, marked by disorientation, disorganized and inconsistent thought processes, inability to distinguish reality from hallucinations, disturbances in speech, disorientation to time and place, and misidentification of individuals.[1] In a majority of these deaths the individual exhibited violent behaviors, struggled with police, correction officers, or medical personnel during control and physical restraint of the person, within a matter of several minutes after the cessation of the struggle the person is observed to be in cardiopulmonary arrest and resuscitation is usually unsuccessful. Frequently an autopsy does not reveal anatomic evidence to show trauma or natural disease or toxicological findings sufficient to explain the death. Commonly, pathologists cite the symptoms of ExDS on the death certificate as contributing factors of the death.[2–4] Deaths associated with ExDS were first reported in a case report in 1849 when psychiatrist Dr. Luther Bell at the McClean Asylum for the Insane in Massachusetts described the condition of 40 mentally ill patients who died from a fatal new disease.[5] Common features observed in these patient's deaths included: fever, rapid pulse, increasing confusion, loss of appetite and sleep, mania, and violent behaviors. Patients condition deteriorated over several weeks before dying. The clinical condition was referred to as Bell's Mania or acute exhaustive mania and is considered the forerunner of the syndrome of ExDS.[1,2,4,6] Other case reports described similar symptoms of Bell's Mania and were referred to as acute delirious mania, lethal catatonia, acute psychotic furors exhaustive syndrome, and typhoma. As new antipsychotic medications emerged through the 1950s, the incidence of deaths associated with Bell's Mania declined. By the mid-1980s a number of deaths associated with cocaine use were reported by Fishbain and Wetli and they described symptoms associated with chronic stimulant abuse as excited delirium.[7] Common factors observed in these deaths included: acute drug intoxication, mental illness, agitation, hyperactivity, violence, bizarre and self-injurious behaviors, hallucinations, delusions, paranoia, and elevated body temperature.

For years there has been a controversy as to a standardized case definition of ExDS. Case report and post-mortem literature since the 1990s has shown that ExDS comprises several clinical features including: delirium with agitation, hyperthermia, violent agitation, acute psychotic behavior, bizarre behaviors, profuse sweating, incoherent speech, extraordinary strength and endurance, lack of response to painful stimuli, hyperactivity, respiratory arrest, and

death.[8-11] Many of these individuals were naked or partially clothed, attracted to water or shiny objects like glass, and a majority involve stimulant drug use. Moreover, individuals diagnosed with a mental illness represent another vulnerable population who may exhibit the symptoms of ExDS. Individuals with a psychotic illness have also exhibited the same symptoms of those under the influence a chemical substance and may be explained by the person abruptly stopping their prescribed medication, from escalation of underlying untreated disease, from the central nervous system adaptations to medications, and/or from also abusing illicit drugs.

Explaining the specific pathophysiology of ExDS can be complex and it remains uncertain why some individuals die while others do not. Generally, males, with an average age of 37 comprise a majority of the deaths associated with ExDS. Of the common features of ExDS, four have been identified as major symptoms of ExDS: delirium with agitation, hyperthermia, respiratory arrest, and death.[8,12] Stimulant drug use, particularly cocaine is associated with ExDS, although amphetamine, methamphetamine, phencyclidine (PCP), lysergic acid diethylamide (LSD), cathinone (bath salts), and marijuana, have also been identified.[13-14] Post mortem analysis of brain tissues suggest that a lack of adaptive changes in dopamine receptor binding may be related to aberrant molecular processing in the brain of individuals who abuse chemical stimulants.[6] Elevated dopamine levels and failed transporter function leads to agitation, violent behaviors, which can raise core body temperature resulting in tachycardia, tachypnea, and hyperthermia. Hyperthermia is a common component of ExDS and a harbinger of death with this syndrome. In a majority of reported deaths, cardiac enlargement has been found at autopsy.[1,15,16] In some cases, underlying natural disease can contribute to the sudden death.[1] The constellation of chemical substances, psychomotor agitation, creating an elevated heart rate and blood pressure, large pupils, and sweating is referred to as sympathomimetic toxidrome.[17] Collectively these factors can result in multi-organ failure and cardiovascular collapse leading to death. [18] For many years it was believed that a high percentage of persons experiencing an episode of ExDS would be fatal. However, it is recognized that with appropriate therapeutic treatment, mortality rate of ExDS is as high as 11percent.[10,15] It is also estimated that ExDS deaths account for about 10 percent of deaths from cocaine.[8]

An episode of ExDS will generate high levels of agitation and violence requiring police intervention and the use of varying force and restraint measures. When a sudden arrest-related death occurs in police or in correctional custody, numerous questions will emerge as to the cause of death. Because these types of deaths involve a multitude of factors classifications of death may be listed as undetermined, an accident, natural, or a homicide. Regardless of the classification of death, the intervening officers' use of force will be scrutinized particularly if a conducted energy weapon (Taser) was used and the person is controlled and restrained in the prone position with hands secured in handcuffs behind the back and the legs also restrained. It has been theorized that controlling and restraining a combative person in the prone position increases the likelihood of asphyxiation by compromising ventilation. Laboratory and prospective field research have shown compelling evidence that prone restraint position does not lead to asphyxia.[19–26]

Moreover, CEWs have been increasingly used by law enforcement and corrections officers to assist in subduing violent and combative persons, like those exhibiting symptoms of ExDS and are considered intermediate use of force weapons. In order to quickly control a violent individual, to minimize the person's exertional struggle against control, and to maintain the officer's and the persons' safety, the CEW is the most recommended and preferable approach over other non-deadly force measures.[27,28] A CEW generates a high voltage and delivers a low-amperage electrical current through two probes. It has also been theorized that an ExDS arrest-related death may be caused by a CEW. Zipes suggested in a case series report of eight "clinically healthy" persons, that seven of the eight had enlarged hearts which make them more vulnerable to sudden cardiac death, and that the CEW potentially may externally pace the heart into a fatal arrhythmia, such as ventricular fibrillation or ventricular tachycardia.[29] This report has been challenged by other researchers questioning the lack of criteria for describing what a "clinically healthy person" actually means and it lacked detailed explanation of the true cause of death.[30–33] Conversely, other studies cited in the literature have not implicated CEWs as a cause of death.[34–38]

A syndrome can be described as the association of several clinically recognizable features, signs, symptoms or characteristics that occur together rather than a specific disease.[39] The spectrum of symptoms and behaviors of ExDS overlap with many other disease presentations and there remains no universally recognized diagnostic criteria or consistent definition.[13,40] The American College of Emergency Physicians and the National Association of Medical Examiners and have recognized ExDS as a legitimate syndrome.[41–42] ExDS is considered a medical emergency and if not properly treated, it can be life threatening.[11,43] The American Medical Association and the American Psychiatric Association, however, have yet to accept ExDS as a syndrome as it is not a billable procedure. DiMaio and DiMaio note that even though ExDS is not a billable procedure it does not mean it is not a legitimate diagnosis.[44] Prior research on the characteristics of ExDS have primarily been performed from a retrospective perspective. Currently there have been only two prospective studies published which identified and described ten features of ExDS and their frequency during the restraint and intervention process by police which included: violent behavior, including: tolerance to pain, did not fatigue, rapid breathing, superhuman strength, constant or near constant activity, non-responsive to police, sweating profusely, naked or inappropriately clothed, attraction to glass, and tactile hyperthermia.[45,46]

The objective of this research was to replicate the two former prospective studies to examine the prevalence of symptoms associated with ExDS during a police use of force confrontation. We previously performed a prospective analysis of the outcomes violent prone restraint incidents in policing.[23] In this article we report on a cohort of arrestees from the former study who exhibited symptoms associated with ExDS to broaden the knowledge base on the subject. Additionally, we analyzed the application of the CEW and its outcome with this cohort. Although rare, incidents where the police and correctional personnel respond to subjects exhibiting ExDS has become an important concern. An arrest-related death presents a potential for criminal prosecution of officers and the potential for civil liability claims filed against the agency and responding officers for a wrongful death. The Fourth, Sixth, Ninth, and Tenth Circuit Appellate Courts have commented that an arrestee's diminished capacity is a factor to be considered as an officer decide to use a level of force. Officers are not trained or expected to make a clinical diagnosis in the field but providing them with additional research can enhance their awareness and focus their observations on the behavioral symptoms whereby

they may appropriately direct their initial response and use of force control measures. The findings will assist in enhancing the training of officers in the symptoms and behaviors associated with ExDS and assist officers in providing emergency personnel with valuable on scene observations of the behavioral symptoms with which to provide appropriate medical intervention. Further, should a death occur, officer observations can assist investigators and the medical examiner in their assessment as to the contributing factors of the death. The findings will also be instrumental in assisting in determining the appropriate case definition of ExDS in order to properly categorize this population and provide optimal treatment.

Methods

The study used a purposive sample of 17 law enforcement agencies from six states. Of these participating agencies, 12 were municipal police departments (64%) and 5 were County Sheriff departments (36%). The study was authorized by an Institutional Review Board and was considered exempt. The agency head was informed of the objectives of the research and he or she approved the research and/or legal counsel in some agencies also agreed to participate in the study. Confidentiality was guaranteed to each agency and each agency head was informed that they could drop out of the study at any time. Using a prospective design, a designated agency person collected use of force data during the calendar year of 2013.

Data collection

As a use of force incident occurred, a designated agency person transferred the incident information as reported by the involved officer (s) use of force report to the data collection instrument when either defensive resistance, active resistance, and/or active aggravated resistance was encountered. Defensive resistance was defined as arrestee attempting break free from an officer's grip or control, pulling or twisting away from the officer, curling an arm in toward the chest and stiffening the muscles and limbs, or running away from the officer. These actions are normally meant to defeat the officer's efforts of control and not intended to harm the officer. Second, active resistance was defined as the arrestee using personal weapons to physically assault the officer (i.e., grabbing, wrestling, punching, or kicking the officer). Third, aggravated active resistance involves actions which may seriously injury or kill the officer including felonious attacks using personal weapons or other weapons. The data collection instrument captured the following information: arrestee demographics, nature of the contact, the condition of the arrestee, types of arrestee resistance, types of force measures used by the officer, the number of officers responding, whether the arrestee was placed in the prone restraint position and duration, whether officers placed weight on the arrestee in the prone position, the types of injuries sustained by the arrestee, and the method and location of the transport of the arrestee. All collection instruments were sent to the researchers for analysis.

Data Analysis

We previously reported the outcomes of violent prone restraint of 1,085 use of force incidents with the participating agencies (2016). This research analyzed a cohort of 635 arrestees (58%) from the original study who displayed violent resistance and who were identified as exhibiting behaviors of being under the influence of alcohol, under the influence other chemical substances, displaying psychologically distress, or exhibited symptoms of either drugs and/or psychologically distressed. The data collection instrument captured the arrestee's condition during the encounter and provided for the following thirteen symptoms variables associated with ExDS to be reported by officers: violence, non-responsive to police, high tolerance to pain, incoherent speech, hyperactivity, exhibited extreme strength, extreme stamina (did not tire), exhibited bizarre behaviors, rapid breathing, attracted to glass, hot to the touch, profuse sweating, and naked or partially naked. We report on the prevalence of these symptoms, the types of resistance displayed by this cohort, and the outcomes of using a CEW. The research design used descriptive and quantitative methods to assess the data. Regression analysis was used to develop an outcome model to show the occurrence, relationship, and variance between the variables examined. Confidence interval values were analyzed at a 0.05 probability level.

Limitations

Limitations of this study included:

i. The data assessed is based on the perceptions of the officer as determined by the condition and behaviors exhibited by the arrestee during the encounter;

ii. The data is reflective of the accuracy of reporting by the involved officer (s);

iii. The accuracy of the data transferred from the officer's report to the data collection instrument; and

iv. The data may not reflect all violent restraint incidents which occurred at the reporting agency during the study period. None of the officers performed a blood or chemical analysis of the arrestee.

Results

Characteristics of the arrestees

The officers made 110,173 arrests and 1,085 incidents comprise the total data set. Officers either determined the arrestee's condition as sober or undetermined in 16 percent of incidents (n=175). Officers confronted 915 arrestees (84%) who exhibited behaviors and symptoms consistent with alcohol intoxication (n=280; 26%), other chemical substance (n=195; 18%), psychological disturbed (n=245; 22%), or exhibited symptoms of psychological distress and/or chemical substance (n=195; 18%). Arrestees condition determined as sober or undetermined were excluded from the analysis. Moreover, alcohol intoxication is generally not associated with ExDS. Arrestees exhibiting behaviors aligned with alcohol intoxication showed significantly fewer or inconsistent symptoms reported and were also omitted from the analysis. A total of 635 arrestees (58%) were assessed, 90 percent were male, and the average age was 34.

Prevalence of ExDS symptoms and combination of symptoms

As shown in Table 1, the overall prevalence of the observed symptoms associated with ExDS of 635 arrestees identified as exhibiting behaviors consistent with a chemical substance (excluding alcohol), psychologically distressed, and/or both. Similar to the Hall et al.,[45] and Baldwin et al.,[46] studies, the symptoms were aggregated into three categories (combinations of symptoms) including: three to four, five to six, and seven or more symptoms. Overall thirteen symptoms associated with ExDS were reported by the officers and because multiple symptoms can be reported with one arrestee in

one incident, they will total over 100 percent. Regression analysis showed that these symptoms are significant at $p < 0.05$ across the three categories, at 0.714. Violent behaviors as a symptom was not included in Table 1 as it was a symptom reported by the officers in about 85 percent of the incidents and was consistently reported in all types of conditions of the arrestee, including those deemed to be sober or undetermined. Since violence can be manifested regardless of the arrestee's condition, it was not considered a unique discriminator for ExDS and the assessment focuses on the twelve symptoms, excluding violence. This finding is consistent with the Hall et al.,[45] and Baldwin et al.,[46] studies. Table 1 also displays the prevalence of three categories of combinations of reported symptoms. Arrestees exhibiting three to four symptoms accounted for 58 percent of the incidents (n=368). The prevalence of each reported symptom in this category did not exceed 30 percent of occurrence. A majority of arrestees (n=190; 30%) exhibited 5 to 6 symptoms and no one symptom exceeded 65 percent in occurrence. In the third category arrestees exhibited seven or more symptoms which accounted for 12 percent of the incidents (n=77) and no symptom exceeded 75 percent. None of the arrestees exhibited all twelve symptoms but 8/77 arrestees did present with ten (0.10%).

Table 1 ExDS Symptoms, Prevalence of Occurrence & Combinations of Symptoms (N=635)

Symptoms & % Overall occurrence		Combinations of symptoms %		
		3 to 4 (58%)	5 to 6 (30%)	7 Plus (12%)
Non-Responsive to Police	68	30	65	70
High Pain Tolerance	61	27	64	75
Hyperactivity	55	15	53	74
Incoherent Speech	51	28	50	63
Extreme Strength	49	21	48	67
Extreme Stamina	46	13	51	70
Bizarre Behaviors	39	20	55	67
Rapid Breathing	21	8	15	25
Naked/Partially Nude	12	3	12	29
Hot to Touch	11	1	4	11
Profuse Sweating	10	8	18	38
Attraction to Glass	4	0	1	3
r^2= 0.714	p= 0.05			

Beyond violent behaviors, a core of seven symptoms were consistently reported regardless of the categories and included: non-responsive to police, high pain tolerance, extreme strength, incoherent speech, hyperactivity, extreme stamina, and bizarre behaviors. While these symptoms were prevalent in about 71 percent of this cohort, the predictability of their progression of order of occurrence was not determinable. Being naked or partially nude and breathing rapidly were moderately reported. Symptoms of hot to touch, attraction to glass, and profuse sweating were reported less frequently. As shown in Figure 1, the combinations of ExDS symptoms shows an inverse relationship of occurrence. As the frequency percentage of symptom categories increased, the percentage of arrestees exhibiting the symptoms decreased. A majority of arrestees (58%) exhibited three to four symptoms associated with ExDS. The symptoms of non-responsive to police, high tolerance to pain, hyperactivity, and incoherent speech occurred with the most frequency in this category. As the combinations of symptoms increased from five to six, the prevalence of their occurrence declined to 30 percent. As the symptoms increased to seven and higher their prevalence of occurrence declined to 12 percent. When the categories of 5 to 6 and 7 or more symptoms are combined, it was more likely for arrestees to exhibit additional symptoms including: naked and partially nude, rapid breathing, hot to touch, and profuse sweating. The symptoms of nudity or partial nudity, hot to touch, profuse sweating, and rapidly breathing were more likely to be exhibited by arrestees in the 7 or more symptoms category differentiating it from the other two categories. Attraction to glass was rarely reported.

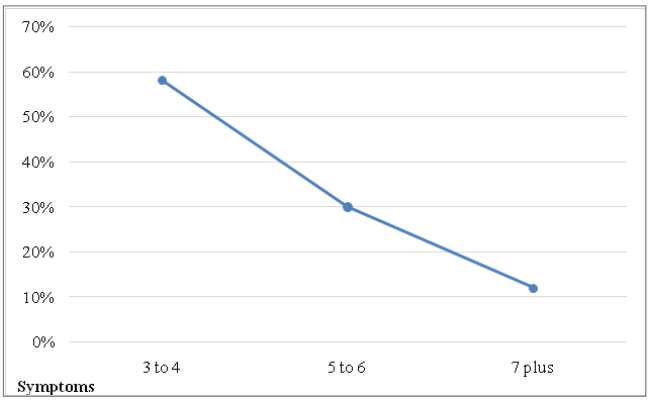

Figure 1 Relationship of the prevalence of symptom categories.

Use of force and CEW applications

Table 2 shows the type of arrestee resistance officers encountered by the categories of symptoms exhibited and the outcomes of the use of force by responding officers. Regression analysis shows that the arrestee resistance, use of the CEW, and injury potential are significant at $p < 0.05$ across the three symptoms categories, at 0.704. The model shows that as more ExDS symptoms were presented by arrestees, higher types of resistance occurred. Overall, arrestees exhibiting 3 to 4 symptoms of ExDS were more likely to present defensive resistance. Arrestees exhibiting 5 to 6 symptoms of ExDS presented

active resistance more frequently while arrestees presenting 7 or more symptoms were more likely to escalate their resistance from active resistance to aggravated active resistance. Various empty-hand control techniques (i.e., joint locks, control holds, strikes; pressure points, muscling techniques, excluding neck restraints) were commonly used after the use of the CEW and during the control and restraint process, and all arrestees were handcuffed. On average four officers responded to the incident. The application of a CEW was more frequently used on arrestees presenting 5 to 6 and 7 and more ExDS symptoms and when the arrestee escalated to active resistance and or aggravated active resistance (n=245; 39%). The CEW was applied in about 30 percent of the incidents while the arrestee continued to resist in the prone position, during the restraint process. On average, officers activated two trigger pulls prior to grounding the arrestee (78%) and applied one trigger pull as the arrestee continued to resist the officers' efforts of control in the prone position (22%). The probe mode was used more commonly than the Drive Stun mode (89% v. 11%). The primary target of the CEW was the back and the legs (87%) and 13 percent made contact in the chest/abdomen area.

Table 2 Arrestee Resistance, Use of Force, and CEW Usage by ExDS Symptoms Categories

Outcome variable	Categories of symptoms and % outcome		
	3 to 4	5 to 6	7 Plus
Defensive Resistance	75	5	0
Active Resistance	25	85	75
Aggravated Active Resistance	0	10	25
Empty-Hand Control Techniques	100	100	100
Handcuffed	100	100	100
CEW	0	32	45
Prone Resistance	5	25	35
Weight Applied	30	72	79
Hobbled	0	28	38
No Injury	80	79	77
Mild Injury	20	21	17
Significant Injury	0	4	6
Emergency Medical	15	79	100
Hospital by EMS	10	69	100
r^2= 0.704 p= 0.05			

The prevalence of 5 to 6 or 7 and more symptoms of ExDS resulted in arrestees more commonly resisting while in the prone restraint position (35%). It was more likely that one officer placed their weight (i.e., knee) on the back of the arrestee in order to control and restrain the arrestee (60%) and two officers placed weight (i.e., knee) on the back in about 34 percent of the incidents for a duration from 1 to 5 minutes. Also, because the arrestee continued to resist while in the prone position, arrestees were hobbled in 33 percent of the incidents. None of the arrestees died in this study. Overall, arrestees did not sustain an injury in about 79 percent of the incidents (n=500). Arrestees were more likely to sustain a mild injury in about 18 percent (n=115) of the incidents and they sustained a serious injury in about 3 percent (n=20). Mild injuries resulted in: a cut, abrasions and bruises, signature marks from the application of the CEW, hypertension of the wrist, arm, or shoulder, strained muscles, and nerve tissue damage in the wrist. Examples of serious injuries included: trauma to the head and torso, dislocation, a facture, or a laceration. As arrestees presented 5 or more ExDS symptoms, emergency medical personnel were commonly requested on average in 85 percent of the incidents (n=545) and they transported the arrestee to the hospital for either sustaining an injury or for an evaluation in 70 percent (n=445). All arrestees presenting 7 or more symptoms were transported to the hospital (n=77). A high percentage of arrestee injuries sustained resulted from the nature of their violent resistance, falling after the deployment of the CEW, and their continued resistance during and after the restraint process in the prone position. The remainder were transported to the jail by the arresting officers (n=190).

Discussion

The types of encounters reported by the officers in this research not only present a public health concern as officers continue to respond to situations involving the psychologically disturbed and/or those under the influence of a chemical substance, but they also present a danger and a safety risk to the responding officers. The behaviors and the type of resistance demonstrated by these persons is unpredictable and officers must remain alert to protecting themselves as well as the arrestee throughout the interaction. Because the police frequently contact a mentally impaired individual or an individual under the influence of a chemical substance, recognizing the symptoms associated with ExDS and responding to the person's exhibited behaviors is an important concern for the officers, as well as for responding emergency medical personnel. Our study represents the third prospective study which examines the prevalence of symptoms associated with ExDS during a violent and dynamic street confrontation requiring responding officers to use varying force measures. Data was analyzed from multiple agencies across six states and similar to the Hall et al.,[45] and Baldwin et al.,[46] studies we found that the officers were able to recognize and document the symptoms associated with ExDS regardless of the etiology of the arrestee's condition. We also found that officers were more likely to observe arrestees exhibiting three to four symptoms in 58 percent of the encounters (excluding violence) and a combination of symptoms up to six, accounted for 88 percent. While 12 percent of the arrestees exhibited seven or more symptoms of ExDS, this finding was only slightly higher than the former studies (9%). The findings showed a descending inverse relationship, as the symptom categories increased, the likelihood of their prevalence of occurrence decreased. We agree with other researchers that an officer encountering an arrestee exhibiting 7 or more symptoms of ExDS is a rare occurrence in policing overall. The findings show that the likelihood that an officer will encounter an arrestee exhibiting five or more symptoms of ExDS is less than one percent (110,173 arrests/267= 0.0024%).

While the identified symptoms and combination of symptoms of ExDS varied with the arrestee's condition, a core of seven symptoms were identified in a majority of arrestees. Of concern for responding officers is those arrestees exhibiting additional symptoms beyond the core number including: naked/partial nudity, hot to touch (hyperthermia), rapid breathing, and profuse sweating. Attraction to glass was rarely reported. These four additional symptoms were common in the seven or more symptoms category which not only expands the potential number of symptoms to twelve, they also represent the potential of elevating the risk of an arrest-related

death. The medical literature indicates that the symptom of "hot to the touch" (hyperthermia) is an important ExDS symptom and it significantly increases the risk of a sudden arrestee death.[6,8–10,15,38,47–50] Collectively these studies reveal that the body temperatures of those ExDS arrestees who died, ranged from 104° to 108° averaging about 105°. Encountering a violent and combative arrestee who is naked or partially clothed, who is profusely sweating, combined with the other associated symptoms and hyperthermia (hot to the touch) can provide indicators to responding officers that immediate control and restraint in needed in order for the arrestee to receive medical treatment. Intervening with an arrestee who exhibits the core seven symptoms combined with the additional four symptoms, including the presence of hyperthermia, would indicate the presence of a significant physiological disturbance, whereby increasing the risk of a potential arrest-related death.

This research only reported on a cohort of arrestees who exhibited symptoms associated with ExDS where officers used force to control them. We did not examine any records of those individuals who may exhibit ExDS symptoms who were not in police custody and died. The associated symptoms of ExDS was reported across 17 law enforcement agencies in six states and were consistently observed by the officers. The research findings of the exhibited symptoms comport with the past case reports and retrospective studies identifying arrest-related deaths. Combined with Hall et al.,[45] and Baldwin et al.,[46] prospective research findings, we believe the symptoms documented in this study supports a detailed definition of ExDS and the prevalence of the associated symptoms underscores the validity of ExDS as a bona fide clinical syndrome.[51,52] Arrestee resistance was associated with the symptom combinations categories and a corresponding relationship was observed with arrestees who exhibited 5 to 6 and 7 and more symptoms and the type of resistance presented. Simply stated, the more prevalent that ExDS symptoms were exhibited, the higher the level of arrestee resistance. Officers are more likely to confront active resistance from arrestees in both categories but were more likely to confront aggravated active resistance from arrestees exhibiting 7 or more symptoms. The levels of arrestee resistance resulted in officers deploying the CEW, using empty-hand control techniques, and hand handcuffs. When arrestees were placed in the prone restrained position, they continued to resist in about 35 percent of the incidents which required the use of the hobble in about 33 percent of the incidents.

We assessed the deployment of the CEW with this cohort. A CEW is an electrical weapon which operates on two, 3V, batteries and when activated it delivers 0.36 J (joules) of energy producing 19 pulses per second. The device can be deployed from a distance and releases two insulated lead wires with metal probes on the end. When both probes make contact with a person's skin, with at least 12 inches of spread between the probes, a completed electrical circuit will successfully deliver a discharge. The application will result in momentarily incapacitating the person. A second mode of deployment is known as drive stun and the CEW must be held directly against the person and is used as pain compliance. A standard discharge cycle lasts for five seconds by depressing the trigger. CEWs satisfy all relevant electrical standards.[53] Because the deployment of the CEW causes stress on the human body, several concerns have emerged that discharging the device may place those exhibiting symptoms of ExDS at an increased risk of sudden death. CEWs have become the most common non-deadly force device used by police officers and when feasible they have been recommended as the preferred device when an officer is faced with severely aggressive and an agitated person.[26–28,54] Tuttle reported that 950,000 CEWs have been sold and besides usage in the United States with 18,000 officers, it is used in 107 countries.[55] Tuttle further reported that there have been 3,680,000 field applications and 2,420,000 applications in training, that CEWs have reduced injuries to arrestees and officers, has saved 198,701 lives, and it has averted the use of deadly force in approximately 5.4 percent of arrest incidents. This data is also consistent with several published studies.[56,57] Deaths temporarily related to CEW applications have raised the concern that the device directly causes death as it adversely impacts a person's physiology. A significant outcome of this research is that none of the arrestees died regardless of the force measures used. The officers deployed the CEW on average for about 15 seconds (three trigger pulls), commonly placed the arrestee in the prone position, with one or two officers placing their weight on their back of the resisting arrestee for a period from 1 to 5 minutes, each arrestee was handcuffed, and the hobble was further applied in about 33 percent of the incidents. Further, officers demonstrated comprehension of the incident circumstances and in a majority of incidents called for emergency medical personnel who provided medical attention on scene and transported the arrestee to the hospital for further treatment or evaluation. Our findings provide greater weight of evidence and support the human scientific research which has been conducted showing that the application of the CEW does not elevate the risk of death. While there is no risk-free use of force device or technique, or restraint equipment, scientific research consistently shows that the CEW reduces the risk of injury or death with arrestees than other forms of force.[28,34,37-38] Additionally, arrestees exhibiting symptoms ExDS are generally impervious to pain and the CEW provides a viable and safe use of force response to overcome the arrestee's combative behaviors.

It has been theorized that CEW exposure in the chest area will induce cardiac arrest.[58] Echocardiographic studies, however, examining CEW exposure to the chest do not support this contention. Further, two epidemiological studies disproved the theory as subjects exposed to probes in the chest and did not sustain adverse effects from the CEW application.[59,60] Human subject studies which evaluated serial troponin levels as a marker for cardiac injury or ischemia did not find significant adverse levels after CEW exposure.[34,37,61,62] There have been no reports of ectopy, dysthymia, QT prolongation, interval changes or other EKG changes immediately following an exposure to a CEW.[38,63–64] Other researchers found that after a 5 second exposure to a CEW no changes in mean heart rates of blood pressure, no ventricular pacing or dysrhythmias.[65] Further researcher report that there have not been any published reports of seizures being induced by the CEW or research showing that a CEW exposure creates a significant elevation in lactate levels or pH shifts, or significant clinical increases in acidosis or catecholamines.[28,66–71] Our findings showed that 13 percent of the arrestees sustained probes in the chest/abdomen area and were not adversely affected. To date, there is no medical evidence linking causation of ventricular fibrillation with the use of CEW.[72]

Roberts and Vilke concluded that after examining the medical literature on whether the CEW induces life-threatening cardiac dysrhythmias appears to be very low.[73] The cardiac risk profile of exposure from a CEW is extremely low and is estimated at 1 in 2,8873,147.[72] The risk of death in a police CEW use of force incident is less than 0.25 percent and out of 310,000 annual field uses of the

CEW, about 1 in 3,500 is involved in an arrest-related death.[36,74] Field research of CEW applications during arrest show the effectiveness of using the CEW on combative arrestees' ranged from about 70 percent to about 89 percent.[75-77] Concerns have emerged that because an ExDS arrestee commonly exhibits hyperactivity, under the influence of a chemical substance, and may demonstrate rapid breathing, that being exposed to the CEW, with multiple applications, may compromise breathing. A CEW exposure does not appear to interfere with breathing in humans.[78] Researchers have shown that one or two exposures of the CEW on human subjects after vigorous exercise did not result in clinical significant changes in ventilatory or blood parameters of physiologic stress.[79–81] Our findings support these findings as ExDS arrestees were commonly exposed to multiple CEW activations over a period of 15 seconds and did not exhibit adverse effects even when placed in the prone position from 1 to 5 minutes. Further studies have shown that prolonged use of the CEW on exhausted humans did not produce negative clinical metabolic changes and there is no correlation between the number of exposures and the mortality rate of arrestees.[65,82] Studies in the field have consistently shown that use of the CEW has reduced arrestee injuries. Eastman et al.,[56] showed that of 426 CEW incidents, 99 percent of the arrestees had minor or no injuries and concluded that in 5.4 percent of the incidents, deadly force was averted.[56] Bozeman et al.,[34] found that in 893 use of force incidents in over 1 million calls for service, no significant injuries were reported in 504 applications of the CEW.[35] Bozeman et al.,[34] further examined 1,000 CEW exposures of arrestees and found that 99.75 percent did not sustain an injury or had minor injuries.[36] Strote et al.,[83] found that of 1,110 uses of CEW significant injuries were rare.[83] Taylor and Woods examined data from four police agencies over four years and found that officer and suspect injuries and injuries requiring medical attention after deploying the CEW were lower than for other forms of force.[84] Our findings showed that sustaining a significant injury after exposure to a CEW was rare, occurring in about 3 percent and arrestees did not receive an injury in 79 percent of the incidents.

Conclusion

This research has documented that law enforcement officers from multiple agencies and multiple states were able to assess and document the various symptoms associated with ExDS regardless of the arrestee's condition. These observations were made under violent and dynamic street encounters, requiring officers to respond by using various force measures including the CEW, where not one arrestee died and a majority did not sustain an injury. Results of the study demonstrate that when recognizing the associated symptoms of ExDS, using appropriate force measures, including the CEW, and providing access to emergency medical attention, can assist in reducing the potential risk of a sudden arrest-related death. The study findings support prior recommendations that using the CEW is not only the preferred use of force device when faced with violent and agitated arrestees but also shows that its application is safe and assists in reducing arrestee and officer injuries. The findings of the research provide greater empirical evidence over previous human subject studies as to the safety of using the CEW under varying arrest environments and with various arrestee conditions exhibiting symptoms of ExDS. Agency administrators who have developed policies and practices which direct officers in gauging their force measures in response to the behaviors and symptoms of the arrestee, within the confrontation circumstances, and using the CEW for higher levels of resistance, should be confident that the study outcomes supports such policy guidance. The research results also affirm for officers that the use of the CEW is a safe non-deadly force device when applied in confrontations of arrestees exhibiting symptoms of ExDS.

Moreover, this study has identified common symptoms of ExDS, their prevalence, and their combinations of occurrence. Combined with the previous research on the subject training on these symptoms should be provided to officers, dispatchers, administrators, emergency medical personnel, and investigators. By policy, training should be developed which brings these positions together, along with mental health personnel, to focuses on the tasks of each position to provide a coordinated response, when feasible, when officers are faced with an arrestee exhibiting ExDS symptoms. As observed by the officers' actions in this research, being able to recognize the symptoms of ExDS can impact a positive confrontation outcome. Officer observations can be relayed to responding emergency medical personnel and should a death result officers can more accurately advise medicolegal investigators in identifying if the arrestee was experiencing ExDS. Officers should also be instructed that when deciding to use force measures, control and restraint should be applied quickly to minimize the arrestee's exertional activity, to shorten the confrontation time span, and once the arrestee is safely restrained, emergency medical personnel should intervene. The outcome of this research supports the use of prompt control and restraint measures, emergency medical intervention, and transport to the hospital by medical personnel. Training on First Aid, CPR, crisis intervention, response to the mentally ill, drug interactions, and de-escalation techniques should also be provided to officers. A checklist of these symptoms should be provided to dispatchers in order to obtain as much information about the arrestee's behaviors and condition when dispatching officers to the location. Further, the checklist should be embedded into the department's response to resistance report, so that officers can fully document their observations, and fully document their verbal attempts of control and all use of force measures applied. Agency investigators tasked with investigating these incidents should receive training on the associated symptoms of ExDS and the agency's response protocols. It is recommended that officers and investigators refer to the ExDS investigation checklist recommended by Coyne et al.,[13] and Kroll et al.,[85] Continued research should focus on best use of force protocols and their outcomes in the field to determine how they assist emergency medical personnel in providing necessary medical intervention. Additional research which identifies the most effective therapeutic interventions by medical personnel should also be conducted. Combining the research findings between these two entities can guide the police and pre-hospital personnel in developing appropriate protocols when responding to arrestees exhibiting symptoms of ExDs which may reduce an arrest-related death. Finally, ongoing research should continue which further identifies the brain biomarkers that may be associated with an arrest-related death and further research which examines the associated cardiac stress risk factors which occur in violent arrestees exhibiting symptoms of ExDS.

Acknowledgments

None.

Conflict of interest

Author declares that there is no conflict of interest.

References

1. DiMaio TG, DiMaio VJM. *Excited delirium syndrome: Cause of death and prevention*. CRC Press, Taylor and Francis Publishers, Boca Rotan, FL; 2006.
2. Vilke GM, DeBard MJ, Chan TC, et al. Excited delirium syndrome (EXDS): Defining based on a review of the literature. *J Emerg Med.* 2011;46(5):1–9.
3. Jauchem JR. Deaths in custody: Are some due to electronic control devices (including TASER® devices) or excited delirium? *J Forensic and Leg Med.* 2010;17(1):1–7.
4. Wetli CV (2006). *Excited delirium.* In: Ross DL, Chan TC, editors. *Sudden deaths in custody*. Humana Press, Totowa, NJ; 99–112.
5. Bell LV (1849). On a form of disease resembling some advanced stages of mania and fever, but so contra-distinguished from any ordinarily observed or describe combination of symptoms, as to render it probable that it may be an overlooked and hitherto unrecorded malady. *Am J Insanity.* 1849;2:97–127.
6. Mash DC, Duque L, Pablo J, et al. Brain biomarkers for identifying excited delirium as a cause of sudden death. *Forensic Sci Intl*. 2009;190(1–3):13–19.
7. Fishbain DA, Wetli CV. Cocaine intoxication, delirium, and death in a body packer. *Ann Emerg Med*. 1981;10(10):531–532.
8. Wetli CV, Mash D, Karch SB. Cocaine-Associated Agitated Delirium and the Neuroleptic Malignant Syndrome. *Am J Emerg Med*. 1996;14(4):425–428.
9. Ross DL. Factors associated with excited delirium. *Mod Path*. 1998;11(11):1127–1137.
10. Karch SB. Possible strategies for the diagnosis of fatal excited delirium syndrome. *Acad Forensic Pathol.* 2012;2(3):273–283.
11. Vilke GM, Payne-James J, Karch SB. Excited delirium syndrome (ExDS): Redefining an old diagnosis. *J Forensic Leg Med.* 2012;19(1):7–11.
12. Karch SB. Excited delirium and neuroleptic syndrome, Chp. 1. *Pathology of drug abuse,* 3rd ed. CRC Press: 2001; 120–129.
13. Coyne CJ, Binh T, Vilke, GM. Excited delirium syndrome (ExDS). In: Ross DL, Vilke GM, editors. *Guidelines for investigating officer-involved shootings, arrest-related deaths, and deaths in custody*, Routledge, Chp. 9; 2011:187–20.
14. Thorton SL, Darracq MA, Ly BT. Amphetamines, cathinones (bath salts), and cocaine. In: Ross DL, Vilke GM,editors. *Guidelines for investigating officer-involved shootings, arrest-related deaths, and deaths in custody*, Routledge, Chp. 10; 2018: 201–216.
15. Stratton SJ, Rogers C, Brickett K, et al. Factors associated with sudden death of individuals requiring restraint for excited delirium. *Am J Emerg Med*. 2001;19(3):187–191.
16. Ross DL. Case analysis of restraint deaths in law enforcement and corrections. In: Ross DL, Chan TC, editors. *Sudden deaths in custody*. Humana Press, Totowa, NJ; 2006: 139–168.
17. Schep LJ, Slaughter RJ, Beasely DM. The clinical toxicology of methamphetamine. *Clinical Toxicology*. 2010;48(7):675–694.
18. Chan P, Chen JH, Lee MH, et al. Fatal and nonfatal methamphetamine intoxication in the intensive care unit. *J Toxicology*. 1994;32(2):147–155.
19. Chan TC, Neuman R, Clausen J, et al. Weight force during prone restraint and respiratory function. *Am J Forensic Med and Path*. 2004;25(3):185–189.
20. Ho JD, Dawes DM, Moore JC, et al.. Effect of position and weight force inferior vena cava diameter: Implications for arrest-related deaths, *Forensic Sci Int*. 2011;212(1–3):256–259.
21. Hall CA, McHale AMD, Kader AS, et al. Incidence and outcome of prone positioning following police use of force in a prospective, consecutive cohort of subject. *J Forensic Leg Med*. 2012;19(2):83–89.
22. Michalewicz BA, Chan TC, Vilke GM, et al. Ventilatory and metabolic demands during aggressive physical restraint in healthy adults. *J Forensic Sci*. 2007;52(1):171–175.
23. Ross DL, Hazlett MH. A prospective analysis of the outcomes of violent prone restraint incidents in policing. *Forensic Research & Criminology International J*. 2016;2(1):1–10.
24. Savaser DJ, Campbell C, Castillo EM, et al. The effect of prone maximal restraint position with without weight force on cardiac output and hemodynamic measures. *J Forensic Leg Med*. 2013;40(1):39–44.
25. Vilke GM, Michalewicz B, Kohlkorst F, et al. Does weight force during physical restraint cause respiratory compromise? *Acad Emeg Med.* 2005;12(51):16–22.
26. Kroll MW, Still GK, Neuman T. Acute forces required for fatal compression asphyxia: A biomechanical model and historical comparisons. *Med Sci Law*. 2017;57(2):61–68.
27. Vilke GM, Payne–James JJ. Excited delirium syndrome: aetiology, identification, and treatment. In: J Gall, Payne-James JJ, editors. *Current practice in forensic medicine*. 2, Wiley and Sons; 2016: 97–117.
28. Ho JD, Dawes DM, Nelson RS, et al. Acidosis and catecholamine evaluation following law enforcement use of force. *Acad Emerg Med.* 2010;17(7):60–68.
29. Zipes DP. Sudden cardiac arrest and death following application of shocks from a TASER electronic control device. *Circulation*. 2012;125(20):2417–22.
30. Heegard WG, Halperin HR, Luceri R. Letter by Heegard et al. regarding article, Sudden cardiac arrest and death following application of shocks from a TASER electronic control device. *Circulation*. 2013;127(1):259.
31. Ho JD, Dawes DM. Letter by Ho and Dawes. regarding article, Sudden cardiac arrest and death following application of shocks from a TASER electronic control device. *Circulation*. 2013;127(1):259.
32. Nantakumar K, Waxman M. Letter by Natakumar and Waxman regarding article, Sudden cardiac arrest and death associated with application of shocks from a TASER electronic control device. *Circulation*. 2013;127(23):840.
33. Vilke GM, Chan TD, Karch S. Letter by Vilke et al. regarding article, Sudden cardiac arrest and death following application of shocks from a TASER electronic control device. *Circulation*. 2013;127(1):259.
34. Bozeman WP, Haudia WE, Heck JJ, et al. Safety and injury profile of conducted electrical weapons used by law enforcement officers against suspects. *Ann EmergMed*. 2009; 20(10):1–10.
35. Bozeman WP, Stopyra JP, Klinger DA, et al. Injuries associated with police use of force. *J Trauma Acute Care Surg*. 2018;84(3):466–472.
36. Kroll MW, Lucceri R, Lakureddy D, et al. Do TASER electrical weapons actually electrocute? *Canadian J Cardiology.* 2016;32(10):1–5.
37. Kroll MW, Lakkireddy DR, Stone JR. TASER electronic control devices and cardiac arrests: Coincidental or causal? *Circulation.* 2014;129(1):93–100.
38. Jauchem J. Pathophysiologic changes due to TASER® devices versus excited delirium: potential relevance to deaths-in-custody. *J Forensic Leg Med*. 2011;18(4):145–153.
39. Mash DC. Excited delirium and sudden death: A syndrome disorder at the

extreme end of neuropsychiatric continuum. *Front Physiol*. 2016;7:435.

40. DeBard ML, Alder J, Bozeman W. *White paper report on excited delirium syndrome. ACEP excited delirium task force.* American College of Emergency Physicians; 2009: 1–18.
41. Stephens BG, Jentzen JM, Karch S, et al. National association of medical examiners position paper on the certification of cocaine-related deaths. *Am J For Med Pathol*. 2004;25(1):11–13.
42. Excited delirium task force. White paper report on Excited Delirium Syndrome. American College of Emergency Physicians (ACEP). 2009.
43. Gill JR. The syndrome of excited delirium. *Forensic Sci Med Pathol.* 2014;10(2):223–228.
44. DiMaio VJM, DiMaio TG. Excited delirium syndrome. In: Kroll MW, Ho JD, editors. *TASER® conducted energy weapons: physiology, pathology, and law*. New York: Springer Science; 2009: 347–63.
45. Hall CA, Kader AS, McHale AM, et al. Frequency of signs of excited delirium syndrome in subjects undergoing police use of force: Descriptive evaluation of prospective consecutive cohort. *J Forensic Leg Med.* 2012;20(1):1–6.
46. Baldwin S, Hall C, Bennell C, et al. Distinguishing features of Excited Delirium Syndrome in non-fatal use of force encounters. *J Forensic Leg Med.* 2016;41:21–27.
47. Wetli CV. Fatal cocaine intoxication: A review. *Am J Forensic Med Pathol*. 1987;8(1):1–2.
48. Ruttenber AJ, Lawler-Heavner J, Yin M, et al. Fatal excited delirium following cocaine use: Epidemiologic findings provide new evidence for mechanism of cocaine toxicity. *J of For Sci*. 1997;42(1):25–31.
49. Otahbachi M, Cevik C, Bagdure S. Excited delirium, restraints, and unexpected death: A review of pathogenesis. *Amer J Forensic Med and Pathol.* 2010;31(2):107–112.
50. Park KS, Korn CS, Henderson SO. Agitated delirium and sudden death: Two case reports. *Pre-hosp Emerg Care*. 2001;5(2):214–216.
51. Hughes EL. *Special panel of review of excited delirium*. Weapons and Protective Systems Technologies Center, National Institute of Justice; 2011:1–43.
52. Gonin P, Beysard, Yersin B, et al. Excited delirium: A systematic review. *Acad Emerg Med*. 2018;25(5):552–565.
53. Panescu D, Nerheim M, Kroll MW. Electrical safety of conducted electrical weapons relative to requirements of relevant electrical standards. *Con Proc IEEE EMBS*. 2013;35:5342–5347.
54. Nakajima Y, Vilke GM. Use of force in prehospital environment. In: Zeller SL, Nordstrom KD, Wilson MP, editors. *The diagnosis and management of agitation*. Chp. 12; 2016: 173–188.
55. Tuttle S. *Risk management: TASER conducted energy weapons field data; risk management.* AXON, Scottsdale, AZ; 2018.
56. Eastman AL, Metzger J, Pepe P, et al. Conducted energy devices: A prospective, population-based study of the medical safety of law enforcement use. *J Trauma.* 2008;64:1567–1572.
57. Fredik FV, Kaminski RJ, Conney MD, et al. The influence of agency policies on conducted energy device use and police use of lethal force. *Police Quarterly*. 2014;17(4):328–358.
58. Rich B, Brophy JM. Estimating the risk of cardiac mortality after exposure to conducted energy weapons. *The Can J Cardiol*. 2015;31(1–2):1439–46.
59. White MD, Reday J, Dawes DM, et al. An incident level profile of TASER device deployments in arrest-related deaths. *Police Quarterly.* 2012;16(1):85–112.
60. Sloane CM, Chan TC,Vilke GM. Thoracic spine compression fracture after TASER activation. *J Emerg Med*. 2008;34(3):283–5.
61. Vilke GM, Sloane CM, Bouton KD, et al. Physiological effects of a conducted electrical weapon on human subjects. *Ann Emerg Med*. 2007;50(5):569–75.
62. Ho JD, Dawes DM, Readon RF, et al. Echocardiographic evaluation of a TASER X-26 application in the ideal human cardiac axis. *Acad of Emerg Med*. 2008;15(9):838–844.
63. Dawes DM, Ho JD, Reardon RF, et al. Echocardiographic evaluation of TASER X26 probe development into the chests of human volunteers. *Am J Emerg Med*. 2010;28:49–55.
64. Stopyra JP, Winslow JE, Fitzgerald DM, et al. Intracardiac electrocardiographic assessment of precordial TASER shocks in human subjects: A pilot study. *J Forensic Leg Med*. 2017;52:70–74.
65. Ho JD, Dawes DM, Bultman LL, et al. Prolonged taser use on exhausted humans does not worsen markers of acidosis. *Am J Emerg Med.* 2009;27(4):413–418.
66. Ho JD, Dawes DM, Heegard WG, et al. Lactate and pH evaluation in exhausted humans with prolonged TASER X26 exposure or continued exertion. *Forensic Sci Intl.* 2009;19(1–3):80–86.
67. Bozeman WP, Teacher E, Winslow JE. Transcardiac conducted electrical weapon (TASER) probe deployments: Incidence and outcomes. *J Emerg Med*. 2012;43(6):970–975.
68. Kunz SN, Calkins HG, Adamec J, et al. Adrenergic and metabolic effects of electrical weapons: Review and meta-analysis of human data. *International J of Leg Med.* 2018;10:1–7.
69. Dawes DM, Ho J, Miner J. The neuroendocrine effects of the TASER X26: A brief report. *For Sci Intl*. 2009;183(1–3):14–19.
70. Ho JD, Miner JR, Laireddy DR. et al. Cardiovascular and physiologic effects of conducted energy weapon discharge in resisting adults. *Acad Emerg Med*. 2006;13(6):589–95.
71. Brewer JE, Kroll MW. Field statistics overview: Chapter 24. In: Kroll MW, HO JD, editors. *TASER Conducted Electrical Weapons: Physiology, Pathology, and Law.* Springer Science; 2009.
72. Panescu D, Kroll MW, Brave M. Cardiac fibrillation risks with TASER conducted electrical weapons. *Conf Proc IEEE EMBS.* 2015;323–329.
73. Roberts EE, Vilke GM. Restraint techniques, injuries, and death: Conducted energy weapons. *Encl For and Leg Med*. 2016;4:118–126.
74. Laub JH. *Study of deaths following elctro muscular disruption*. National Institute of Justice, Washington D.C.; 2011: 1–40.
75. Mesloh C, Wolf R, Henych M, et al. Less lethal weapons for law enforcement: A performance-based analysis. *Law Enf Exec Forum*. 2008;8(1):133–149.
76. White MD, Ready J. The impact of the TASER on suspect resistance: Identifying predictors of effectiveness. *Crime and Delinquency*. 2008;11:1–33.
77. White MD, Ready J. The TASER as a less lethal force alternative: Findings on use of effectiveness in a large metropolitan police agency. *Police Quarterly*. 2007;10(2):170–191.
78. Bozeman W. Additional information on TASER safety. *Ann Emerg Med*. 2009;54(5):758–759.
79. Vilke GM, Sloane CM, Suffecool A, et al. Physiologic effects of the TASER after exercise. *Soc Academic Emeg Med*. 2009;16(8):704–710.
80. Vilke GM, TC Chan, Slone C, et al. *The effect of TASER on cardiac respiratory and metabolic physiology in human subjects*. Department of Justice Report, Washington D.C.; 2011: 1–28.

Citation: Ross DL, Hazlett MH. Assessing the symptoms associated with excited delirium syndrome and the use of conducted energy weapons. *Forensic Res Criminol Int J.* 2018;6(3):187–196. DOI: 10.15406/frcij.2018.06.00206

81. Ho JD, Dawes DM, Bultman LL et al. Respiratory effect of prolonged electrical weapon applications on human volunteers. *Acad Emerg Med*. 2007;14(3):197–201.

82. Dawes DM, Ho JD, Reardon RF, et al. The physiological effects of multiple simultaneous electrical device discharges. *The Western J Emerg Med*. 2010;11(11):49–56.

83. Strote J, Walsh M, Angelidis M, et al. Conducted electrical weapon use by law enforcement: An evaluation of safety and injury. *J Trauma*. 2010;68(5):1239–1246.

84. Taylor B, Woods DJ. Injuries to officers and suspects in police use-of-force cases: A quasi-experimental evaluation. *Police Quarterly.* 2010;13(3):260–289.

85. Kroll MW, Wetli CV, Mash D, et al. Excited delirium checklist. In: Kroll MW, Ho JD, editors. *TASER conducted electrical weapons physiology, pathology, and law*. Springer-Verlag; 2014: 433–434.

Citation: Ross DL, Hazlett MH. Assessing the symptoms associated with excited delirium syndrome and the use of conducted energy weapons. *Forensic Res Criminol Int J.* 2018;6(3):187–196. DOI: 10.15406/frcij.2018.06.00206