



## Original communication

## Distinguishing features of Excited Delirium Syndrome in non-fatal use of force encounters



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## ABSTRACT

**Study objective:** The frequency with which the police encounter non-fatal cases of Excited Delirium Syndrome (ExDS) has not been well studied. To date only a single prospective, epidemiologic study has been completed to determine the prevalence of the features of ExDS in police use of force (UoF) encounters. We examined a cluster of previously published features associated with ExDS to establish if these features were consistently recognizable across policing populations, thus demonstrating reproducibility. We further sought to determine whether any feature or number of concomitant features were likely to have physiologic significance. These are important first steps in determining a case definition of ExDS in a law enforcement and medical setting.

**Methods:** A prospective evaluation of a consecutive cohort of subjects involved in UoF encounters with police was conducted. Data were collected through the UoF reporting database of a large Canadian law enforcement agency from January, 2012 to December, 2013. The ten core characteristics of ExDS that have been observed in past research were documented by officers and, consistent with previous research, the presence of six or more features was used to identify probable cases of ExDS and a state of medical emergency.

**Results:** UoF occurred in 4799 of 5.4 million police–public interactions (0.09%). Of the UoF encounters, 73 (1.5%) subjects displayed six or more features of ExDS. Upwards of 9.2% of these subjects could be expected to be at risk of sudden and unexpected arrest-related death (ARD). Features with the highest odds of being presented with a large number of concomitant features included “Does not Fatigue”, “Superhuman Strength” and “Tactile Hyperthermia” (287, 137 and 93 times higher, respectively). Moreover, “Tactile Hyperthermia” demonstrated the highest odds of being presented in individuals with a large number of features as opposed to those with fewer (33 times higher).

**Conclusion:** We demonstrate that there is the ability for law enforcement officers to consistently recognize and report features of ExDS that have been associated with ARD. The varying presence of features across the examined categories indicates that some features are more distinguishing than others, which may enable narrowing the scope of features that represent ExDS and understanding its pathophysiology. The current debate surrounding whether or not ExDS exists limits first responders and emergency physicians in their ability to increase awareness, improve training and interventions, and design appropriate policy and response protocols to reduce ARDs.

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## 1. Introduction

### 1.1. Background

In hospital settings, there are a wide variety of conditions that can result in delirium with agitation (e.g., schizophrenia).<sup>1</sup> Many hospital protocols are aimed at the detection and treatment of acute delirious states because of the high mortality associated with them.<sup>2</sup> There are patients in similar circumstances outside the walls of the hospital who also require medical help, but whose presentation provides significant challenge. When bystanders witness individuals who have severe agitation combined with incoherence and aggression, police are often called because the person is disruptive or it is presumed that the individual requires legal intervention. Similarly, police may be called to assist paramedic staff with the management of an unruly and violent patient. Sometimes these people die. If there is no difference in anticipated outcome between one violent person and another, then there is no reason for police officers and paramedics to be trained to manage them differently. However, physicians have begun to recognize that individuals who die suddenly and unexpectedly in the context of a police use of force (UoF) event have striking similarity in their symptomatology immediately prior to death.<sup>3</sup> That symptomatology is deserving of appropriate investigation, regardless of the highly marginalized nature of the individuals suffering it.

Sudden and unexpected arrest-related death (ARD) in the context of police UoF has been discussed for more than 30 years in the modern medical literature. Studies of these deaths began in the 1980s when Wetli and Fishbain documented noticeable likenesses in the presentation of individuals intoxicated with cocaine who died during police UoF incidents, such that they believed a new syndrome had been identified.<sup>4</sup> Wetli and Fishbain coined this syndrome excited delirium, which has since been defined as "... a state of extreme mental and physiological excitement, characterized by extreme agitation, hyperthermia, hostility, exceptional strength and endurance without apparent fatigue."<sup>5</sup> Retrospective study has continued to find that the majority of individuals who suffer ARD are males (95%) with a mean age of 36 years, who demonstrated profoundly unusual, yet similar behavior at the scene immediately prior to death.<sup>6–15</sup> While research has shown that many of these subjects were intoxicated with sympathomimetics at the time of their ARD, multiple authors have also documented a large number of cases where the onset is associated with underlying psychiatric disease.<sup>6–8,13,15,16</sup> Furthermore, pathophysiologic assessment of the brains of individuals who have died in a state of ExDS identified two biomarkers (dopamine transporter and heat shock protein), which provide a method to objectively test for ExDS at autopsy.<sup>7</sup>

Evidence that the cluster of features described by Wetli and Fishbain can be found consistently across populations by different law enforcement officers is an important first step in determining a case definition of ExDS in a law enforcement and medical setting. If the cohort of individuals in a state of ExDS cannot be reliably identified then accurate estimates of incidence, prevalence, morbidity, and mortality cannot be made. Anecdotally among police, paramedics, and emergency medicine physicians, not all individuals in a state of ExDS die. Currently, the literature has defined probable cases of ExDS based on the presence of perceived abnormal behaviour and at least six of the ten potential clinical criteria for ExDS.<sup>3,17,18</sup> This has been argued to indicate that an individual is in a highly abnormal state, one that could only be described as a medical emergency.<sup>18</sup> While individuals who have died of ExDS often display a high number of features,<sup>19</sup> it is currently unknown if a particular feature is more likely to co-occur

with a large number of other features and whether a feature or smaller cluster of features is illustrative of underlying pathophysiology, or predicts death. It is possible that the evaluation of consistent symptomatology in live persons, before ARD, could determine a tipping point at which death ensues. If the population of persons with features of ExDS can be consistently identified, focussed study into the underlying pathophysiology can be continued in live persons and research can be targeted toward the interruption of the processes that lead to death, before death occurs. Moreover, appropriate intervention and treatment strategies can only be implemented and assessed for their effectiveness if the population that needs them can be consistently identified prior to death.

To date, a single prospective epidemiologic study of the characteristics of individuals undergoing police UoF has been carried out that documents the frequency with which the published features of ExDS were encountered.<sup>19</sup> In that study, the only individual who died demonstrated all ten features of ExDS during the police UoF event prior to death. In order to determine whether the ability to detect and document those features remains consistent across police officers in different communities, and to further evaluate whether a feature or cluster of features is suggestive of significant pathophysiology, the following study was undertaken.

### 1.2. Importance

Documentation of the presence of a syndrome only after a person has died does little to protect the health and safety of persons involved in police UoF events or the officers involved in those events. While ExDS is recognized as a unique diagnostic entity by those in the medical field that come into most frequent contact with these subjects (e.g., emergency physicians, medical examiners),<sup>3,20</sup> it has not been formally recognized by the American Psychiatric Association,<sup>21</sup> or the World Health Organization.<sup>22,23</sup> As such, ExDS has remained a 'contested diagnosis'<sup>24</sup> in the medical field, viewed by some as a political diagnosis that attributes ARDs to natural disease, instead of examining police intervention.<sup>22,25</sup> However, if the cohort can be reliably identified across populations by different first responders, and a cluster of features substantiated, further study can be directed toward quantifying the mortality rate, understanding the pathophysiology, and targeting treatment to preserve life.

### 1.3. Goals of this investigation

The current research represents one of the few prospective studies to examine the prevalence of each feature associated with ExDS and compare the prevalence rates to those in Hall et al.<sup>18,19</sup> Investigation of another UoF cohort enables determination of the consistency with which ExDS is seen and will help establish which of the published list of features are more likely to be present in individuals undergoing police UoF. If there is consistency in the identified population, and there is biologic plausibility that the constellation of symptoms represents medical risk, then a solid foundation for a case definition of ExDS can be achieved. Furthermore, this study will examine the odds that individual ExDS features appear concomitantly with a large number of other features to determine if any individual feature is more important for predicting a medical emergency or understanding the underlying pathophysiology. Identification of the population at risk (by virtue of similar shared characteristics with subjects who have died) enables the evaluation of targeted response strategies in order to improve public safety and reduce the risk of sudden ARDs.

## 2. Methods

### 2.1. Study design and selection of participants

Data for the study was collected over a two-year consecutive time period from January 1, 2012 to December 31, 2013 through standardized reporting in a large Canadian law enforcement agency. In that agency it is policy for law enforcement officers to generate post-incident reports of police UoF in their Subject Behaviour/Officer Response (SB/OR) database. The SB/OR was revised prior to the study to enable prospective documentation of the following ten features of ExDS during the UoF encounter: pain tolerance, constant/near constant activity, not responsive to police presence, superhuman strength, rapid breathing, does not fatigue, naked/inappropriately clothed, sweating profusely, tactile hyperthermia, and glass attraction/destruction. Officers gained access to that list of features when they indicated in the agency reporting system that the subject was suffering from any perceived emotional disturbance; at that point an additional drop down menu opened in which the presence of each of the ten features could be checked off. For comparative and analytic purposes, and consistent with previous research,<sup>3,17–19</sup> the number of features displayed were aggregated into three categories (less than three, three to five, and six or more).

All data are self-reported by officers and are based on their perceptions at the time of the incident. Multiple reports are required if more than one officer applied force during an incident and reports can include multiple subjects and/or multiple UoF applications on the subject. Data was included for analysis in this study if any UoF above the application of physical control “soft” occurred (physical control soft includes joint locks, come-along techniques, simple handcuffing). Only actual applications of force, and not the use of interventions as deterrents (e.g., draw and display of a firearm), were included in the analysis. For a ‘major police incident’ such as a death or serious injury, other investigative and reporting processes are initiated; an SB/OR report for these incidents may not be completed until the investigative process is concluded. The investigations can be lengthy and as a result, such incidents during this time period did not appear in the sample.

The research was deemed exempt by the agency’s institutional review board and the anonymized data was subsequently obtained through a Research Application and Undertaking.<sup>26</sup> The research was conducted following approval from Carleton University’s Research Ethics Board.

### 2.2. Primary data analysis

Data was prepared for analyses using IBM SPSS Statistics for Windows, Version 22.0.<sup>27</sup> Most analyses were conducted at the subject level; multiple data checks and merges were performed to ensure each subject was only represented once. The use of drop-down menus and checkboxes in the SB/OR means that responses were constrained and hence, no outliers were observed. The variables used in the analyses were mandatory for completion of the SB/OR report, thus no missing data was observed. When merging report data from multiple officers for an individual subject, all UoF and/or features of ExDS documented by any officer involved in the interaction were aggregated to ensure all documentation was included.

## 3. Results

### 3.1. Characteristics of the data

During the study period, 5244 SB/OR reports were completed by 2893 officers. The reports contain 5962 UoF events involving

4799 subjects. The number of police–public interactions during the two-year time period was 5.4 million, indicating a 0.089%, 95% CI [0.086, 0.091] UoF per police–public interactions rate (i.e., force is applied in approximately 89 of every 100,000 police–public interactions). Subjects undergoing police UoF were predominantly male (90.8%), had a mean age of 31 (SD  $\pm$  9.8, range 12–87), and were violent (65.8%). There were two ( $n = 2/4801$ , 0.04%; 95% CI 0.01, 0.15) sudden and unexpected ARDs of violent and agitated subjects during this period, though they were not included in the sample due to external investigative processes that are invoked under these circumstance. The cause of death of one subject was identified as acute cocaine toxicity combined with ExDS and at this time the cause of death of the second subject has not been released.

### 3.2. Prevalence

Out of 4799 subjects on which the police applied force, 1480 (30.8%) were perceived to be emotionally disturbed and a drop down menu for the ExDS features became available for completion. The majority of subjects undergoing police UoF were not perceived to be emotionally disturbed or did not exhibit any features of ExDS ( $n = 3635/4799$ , 75.7%). Overall, 9.2% ( $n = 441/4799$ ) of subjects displayed three or more features of ExDS and 1.5% ( $n = 73/4799$ ) of subjects displayed six or more features. None of the subjects displayed all ten features of ExDS; although 4/4799 (0.1%) presented with nine.

### 3.3. Demographics

The majority of subjects displaying six or more features of ExDS were male (95.9%) with a mean age of 29.8 (SD  $\pm$  9.4). A one-way between subjects analysis of variance (ANOVA) was conducted to compare subject age of those who were not perceived to be emotionally disturbed, or did not exhibit more than two features of ExDS, with those who displayed three to five features of ExDS, as well as with those who presented with six or more features of ExDS. There was no significant difference in age at  $p < 0.05$  across the three categories,  $F(2, 4796) = 4.87$ ,  $p = 0.615$ .

### 3.4. ExDS features and violent behaviour in emotionally disturbed subjects

To examine whether violent behaviour and the features of ExDS were distinctively presented with larger clusters of features, prevalence rates were calculated for subjects perceived to be emotionally disturbed. “Violent Behaviour” was presented in 82.6% of all subjects perceived to be emotionally disturbed, with only slight increase across the categories of features. Overall, of the ExDS features “Pain Tolerance” (36.8%), “Not Responsive to Police Presence” (35.3%), and “Constant-Near Constant Activity” (29.3%) consistently appeared most frequently across the categories, while “Glass Attraction-Destruction” (5.6%) and “Hyperthermia” (0.5%) were presented the most infrequent. As illustrated in Fig. 1, in subjects displaying less than three features, no one feature exceeded 26%, and in subjects displaying three to five features, no one feature exceeded 70%. In those with six or more features, “Does not Fatigue”, “Pain Tolerance”, “Constant-Near Constant Activity”, “Rapid Breathing” and “Superhuman Strength” all presented in over 80% of the subjects.

To further determine whether violent behaviour and the feature of ExDS were distinctly related to the number of concomitant features, as well as to examine potential pathophysiologic significance, odds ratios across the categories of ExDS in emotionally disturbed persons were calculated (see Table 1). All previously published

features of ExDS demonstrated a significant increase in odds of co-occurring with other ExDS features. The odds ratios for the comparison of three to five versus six or more features provides the approximate multiplier of how much higher the odds are of the feature being displayed with a higher (six or more) versus lower (three to five) number of concomitant features. Features with the highest odds of being presented with a large number of concomitant features included “Does not Fatigue”, “Superhuman Strength” and “Tactile Hyperthermia”. Compared to those with less than three features of ExDS, “Tactile Hyperthermia” significantly increased the odds of being presented with a large number of concomitant features (i.e., six or more). This effect was not significant when comparing subjects with less than three features to those with three to five. While results were significant, “Not Responsive to Police Presence” and “Glass Attraction-Destruction” presented the lowest odds of being presented in a large cluster of features or differentiating from a lower number of features (i.e., three to five). Lastly, the presence of violent behaviour did not significantly increase between three to five features and six or more.

**4. Discussion**

*4.1. Prevalence*

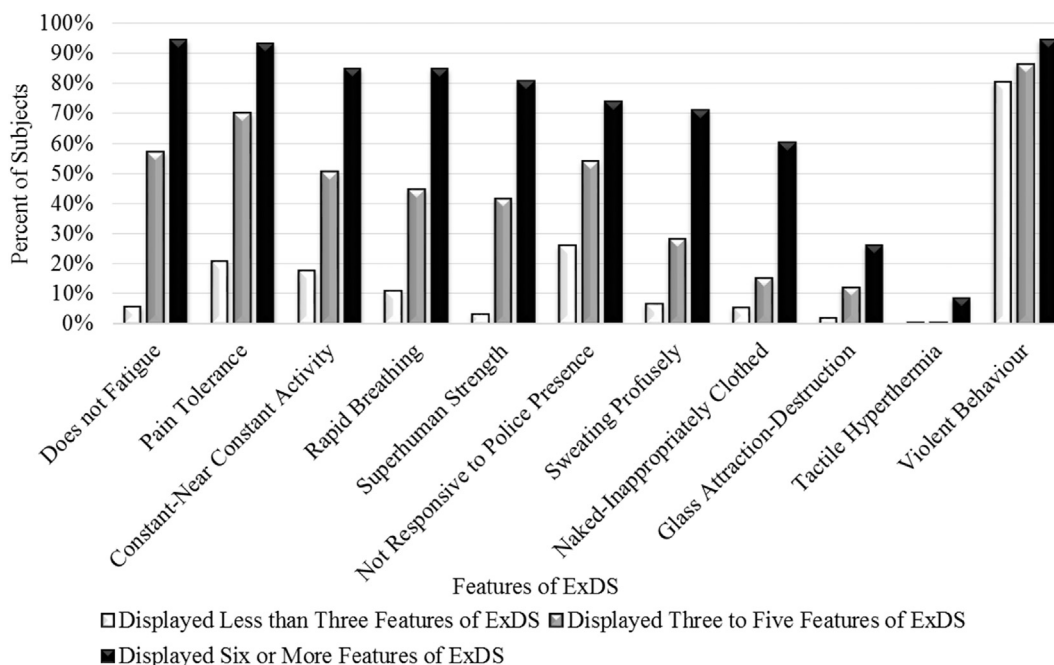
The overall rate of UoF in this cohort is slightly lower than some previous reports of UoF in Canada.<sup>18,19,28</sup> It is possible that the diverse geographical range policed by the law enforcement agency under study may have influenced the overall rate of UoF (i.e., other studies typically report UoF rates for large metropolitan areas only).<sup>18,19</sup> Our study is consistent with the findings of Hall et al.<sup>18,19</sup> in documenting that, contrary to popular belief, the vast majority (99.9%) of police–public interactions do not actually involve police UoF. Statistical evaluation of our data reveals that, with two deaths of agitated and violent subjects, at least 99.9% of subjects undergoing police UoF are anticipated to be free of sudden and unexpected ARD. This number is in direct keeping with the previous study by Hall and Votova.<sup>18</sup> This means that in our cohort of 73 subjects demonstrating a high number of ExDS features and two

deaths of agitated and violent subjects, upwards of 9.2% (based on the upper bound of the 95% CI) of these subjects could be expected to be at risk of sudden and unexpected ARD. Consistency in these findings, as well as the demographics of our cohort, suggest that a similar population is being examined across studies and represents a reproducible cohort of individuals undergoing police UoF.

Our study is the second large scale epidemiologic study done prospectively in a law enforcement environment in order to assess subjects who undergo UoF. We were able to demonstrate that there is the ability for law enforcement officers to consistently recognize and report features of ExDS that have been associated with ARD. The number and nature of these features is similar between studies involving differing police officers and populations.<sup>18,19</sup> In accordance with the previous epidemiologic study, we were able to demonstrate that, while individuals with features of ExDS are rarely encountered in policing overall, when force is used, subjects with multiple features of ExDS (three or more) are involved in up to 1 in 11 UoF encounters. Subjects with a large numbers of features (six or more) are seen in 1 in 66 UoF incidents. We have also demonstrated through this study that, fortunately, not all subjects with large numbers of features of ExDS die. However, if even a small number of these subjects die, the implications for police agencies are serious. A fatal outcome results not only in the loss of a life and the resulting mental/emotional trauma experienced by loved ones, but also incurs long-lasting financial and legal repercussions for the involved officers and their agencies (i.e., investigations, inquests, inquiries, and/or civil litigation may need to be conducted).<sup>29</sup> While critics of police UoF and the concept of ExDS in general opine that ExDS is a contrived condition used to excuse poor procedure or excessive UoF, the finding that not all individuals with multiple features of ExDS die is not new information for police officers, paramedics or emergency medicine physicians.

*4.2. Distinctness of violent behaviour & ExDS features*

Like the previous study,<sup>19</sup> we found that the majority of subjects in UoF encounters exhibited violence, particularly those perceived to be emotionally disturbed. Hall et al. asserted that the presence of



**Fig. 1.** Prevalence of features of ExDS and violent behaviour in UoF encounters with subjects perceived to be emotionally disturbed (n = 1480).

**Table 1**  
Odds of the concomitance of ExDS features and violent behaviour in UoF encounters with subjects perceived to be emotionally disturbed ( $n = 1480$ ).

Features of ExDS & violent behaviour	Subject perceived to be emotionally disturbed								
	Displayed features of ExDS								
	Less than three ( $n = 1039$ )	Three to five ( $n = 368$ )	Six or more ( $n = 73$ )	Less than three v. three to five		Less than three v. six or more		Three to five v. six or more	
	No. (%)	No. (%)	No. (%)	OR	95% CI	OR	95% CI	OR	95% CI
Tactile hyperthermia	1 (0.1)	1 (0.3)	6 (8.2)	2.8	0.2–45.3	93.0	11.0–783.3	32.9	3.9–277.4
Does not fatigue	59 (5.7)	210 (57.1)	69 (94.5)	22.1	15.8–30.8	286.5	101.1–812.0	13.0	4.6–36.3
Naked-inappropriately clothed	53 (5.1)	56 (15.2)	44 (60.3)	3.3	2.2–5.0	28.2	16.4–48.6	8.5	4.9–14.6
Rapid breathing	114 (11.0)	165 (44.8)	62 (84.9)	6.6	5.0–8.8	45.7	23.4–89.4	6.9	3.5–13.6
Sweating profusely	66 (6.4)	104 (28.3)	52 (71.2)	5.8	4.1–8.1	36.5	20.8–64.2	6.3	3.6–11.0
Superhuman strength	31 (3.0)	153 (41.6)	59 (80.8)	23.1	15.3–35.0	137.0	69.2–271.4	5.9	3.2–11.0
Pain tolerance	217 (20.9)	259 (70.4)	68 (93.2)	9.0	6.9–11.8	51.5	20.5–129.3	5.7	2.2–14.6
Constant-near constant activity	185 (17.8)	187 (50.8)	62 (84.9)	4.8	3.7–6.2	26.0	13.4–50.4	5.5	2.8–10.7
Glass attraction-destruction	19 (1.8)	45 (12.2)	19 (26.0)	7.5	4.3–13.0	18.9	9.5–37.7	2.5	1.4–4.6
Not responsive to police presence	270 (26.0)	199 (54.1)	54 (74.0)	3.4	2.6–4.3	8.1	4.7–13.9	2.4	1.4–4.2
Violent behaviour	836 (80.5)	318 (86.4)	69 (94.5)	1.5	1.1–2.2	4.2	1.5–11.6	2.7	0.9–7.8

violence is unlikely to discriminate between individuals who suffer from ExDS and those who do not.<sup>19</sup> Our findings support this, showing that within the UoF context, violent behavior does not significantly increase the odds of presenting a large number of concomitant ExDS features compared to a lower number.

The ExDS features “Does not Fatigue”, “Pain Tolerance”, “Constant-Near Constant Activity”, “Rapid Breathing” and “Superhuman Strength” were presented in over 80% of subject displaying six or more features. However, features with the highest odds of being presented with a large number of concomitant features included “Does not Fatigue”, “Superhuman Strength” and “Tactile Hyperthermia” (287, 137 and 93 times higher, respectively). Thus, the varying presence of features across the examined categories does indicate that some features are more distinguishing than others, which may enable narrowing the scope of features that represent ExDS. This will be particularly helpful if those features are associated with abnormal physiology in live persons in future study. For example, consistent with Hall et al.<sup>19</sup> “Tactile Hyperthermia” demonstrated the highest odds of being presented in individuals with a large number of features as opposed to those with fewer (33 times higher). Thus, we posit that this is indicative that a threshold of six or more concomitant features may appropriately identify individuals at elevated risk of ARDs because the presence of hyperthermia suggests severe physiologic disruption.<sup>3,17,18</sup> Indeed, Stratton et al. note that “... those who die from restrained ExDS are invariably hyperthermic”.<sup>13</sup> Review of historical cases of (fatal) ExDS confirmed that unusually high temperatures are often observed. Ross<sup>10</sup> reported the temperature of an early sample of ExDS subjects to be approximately 104 °F and Mash et al.<sup>7</sup> reported the mean body temperature of 59% of subjects with probable ExDS to be 105 °F. Similarly, in Ruttenber et al.’s study,<sup>11</sup> 38 of the 39 (97%) ExDS subjects examined were classified as having hyperthermia. It makes intuitive sense that detecting hyperthermia in the field would help identify subjects at risk of ARD.

In our study, “tactile hyperthermia” was reported more infrequently than was the case in other reports. Hall and Votova reported 109 (2.2%) individuals out of 4599 as being “hot to the touch.”<sup>18</sup> The lower rate of 0.2% in the current study may be a result of the clinical language used in the police agency’s ExDS checklist (“hot to the touch” vs. “tactile hyperthermia”). Hall et al.’s<sup>19</sup> use of lay terminology may be more appropriate for recognition and yield more consistent reporting by officers and paramedics in the field. Once “hot to the touch” has been established, and physical control has been achieved, determining an accurate measurement of the presence of hyperthermia may guide clinical care and also enable targeted examination of underlying biomarkers in live patients as

well as those who have died. While it is uncommon for coroners to examine biomarkers post-mortem, the completion of those assays will help determine the association between symptomatology and pathophysiology, further contributing to the case definition for ExDS as well as uncovering possible treatment strategies.<sup>7</sup> In this way, more observable characteristics, such as “hot to the touch” (tactile hyperthermia) may be a useful specific criterion for the presence of ExDS in future.<sup>18,19,30</sup>

#### 4.3. Implications

Lacking the necessary knowledge to identify probable cases of ExDS, officers remain at a disadvantage in terms of safety for themselves, the individual, and the public. Without the ability to discriminate between violent persons and those in a medical emergency, officers may either inflate the risk of morbidity and mortality for the individual or be reluctant to use force.<sup>31</sup> Thus, it is in the interest of public and police safety to provide support and training to ensure positive outcomes in police UoF encounters.<sup>31</sup> Hall et al.<sup>19</sup> argues that recognition of the multiple features of ExDS by police officers and prehospital personnel will help ensure that the transport of the individual to receive medical assessment and care is expedited. Current training on ExDS, while limited, appears to be focused on recognizing the features associated with ExDS and identifying it as a medical emergency; as a result, medical attention has been prioritized.<sup>29</sup> Our study provides support for these recommendations. However, the fact that ExDS is still not formally recognized as a syndrome by much of mainstream medicine (e.g., American Psychiatric Association<sup>21</sup> or the World Health Organization<sup>23</sup>) can lead to improper categorization of subjects, poorly targeted treatment strategies, and continued debate over optimal treatment. For example, benzodiazepines and antipsychotic medications have been the mainstay recommendations for treating ExDS, however, emerging data suggests that the dissociative agent Ketamine may be a more optimal choice due to faster onset and more complete behavior control.<sup>32–35</sup>

Continued research is required in order to determine the pathophysiology by which the presence of ExDS results in death.<sup>31</sup> As such, comparative analyses between fatal and non-fatal cases of ExDS may provide insight into the characteristics observed in individuals who die as a result of ExDS, and those who do not. This would assist in determining whether specific clusters of features uniquely predict sudden ARD. Though research by Strote et al.<sup>31</sup> found low specificity in the risk of sudden death in officer-identified cases of ExDS (relying on officers’ reference of the term “excited delirium”), our study provides evidence that such a study

should be targeted to individuals who display a large cluster of the ten features of ExDS which can be objectively recognized; designs for further study are facilitated by this knowledge.

Some argue that the features of ExDS previously found to be associated with ARD<sup>4,17</sup> do not differentiate individuals in that state from those with agitation due to stimulant use or psychosis. However, further work cannot determine which feature or cluster of features predicts ARD unless a consistent population (i.e., presenting a large number of features) can be identified and large scale epidemiologic study of medical outcome undertaken. Much of the work conducted to date has focussed either on the ARD population post-mortem, literature reviews of features of ExDS and now in trying to identify the cohort of interest in live populations. In our study, the rates with which features of ExDS were encountered aligns with other prospective research on ExDS.<sup>18,19</sup> Since those features in combination have been found to be remarkably common in cases of sudden and unexpected ARD, we believe the population of interest has now been defined.

Additional research is also required to determine effective officer control tactics (e.g., multiple handcuffing techniques) during incidents with individuals who may be suffering from ExDS. Training may be integrated into existing modules on mental health, crisis-intervention, de-escalation, First Aid, CPR, and the UoF, to ensure that relevant linkages between concepts are learned. As new research on ExDS emerges and best practices are identified, training should be updated accordingly. Collaboration among the various parties (e.g., paramedics, emergency physicians, hospital security, correctional officers, etc.) who repeatedly encounter probable cases of ExDS, may also help inform intervention options. Given the need for training, policy that supports training is also essential. For example, law enforcement policy may be developed that enforces mandatory ExDS training for officers and dispatchers.

#### 4.4. Limitations

This research was limited to police UoF encounters. There is no ability to determine how many people display features of ExDS or die in a state of ExDS without involvement of police or paramedics at the scene. Lack of standardization of coroner/medical examiner documentation in North America precludes even retrospective analysis of those events. Similarly, for unexplained deaths at a scene, without investigation of the features of ExDS at the time of death, there is no ability to determine whether shared features between deaths from stimulant abuse, unchecked psychoses, or other pathophysiology exists and could have been identified before death.

The standardized reporting system used to capture the data in the current study was developed primarily to assist police officers in articulating their actions surrounding a UoF incident. They are completed from an officer's perspective and are based on their interpretation of the events at the time of the encounter, thus they may contain some degree of bias. The reports are also retrospective in that they describe what an officer recalls from a past event regardless of how soon the report is completed. Retrospective accounts are limited in their own right due to memory errors, and stress may additionally impact those issues. However, the reports are typically completed in close proximity to the event (i.e., within 48 h), which decrease memory impairment issues, and no recording of officer's assessments of subjects at the time of the UoF event can realistically occur. The current results, which are based on a large sample of cases, correspond closely to the results reported by Hall and Votova,<sup>18</sup> suggesting there is consistency in standardized police reporting in spite of potential bias and the influence of stress on recall.

In our study, an important limitation was that the two deaths of agitated and violent subjects in the cohort were not included in the sample. This was due to external investigative processes that are invoked under these circumstances (agency policy does not require an SB/OR report be completed until the investigative process, which is often lengthy, is concluded). However, while one cause of death is still outstanding, the other was determined to be related to ExDS.

Another notable limitation was that due to the construct of the database itself, the features of ExDS were only collected if the subject was perceived by the responding officer to be emotionally disturbed. All subjects *not* perceived to be emotionally disturbed by officers received missing values for the features associated with ExDS. Although one could assume that most, if not all, probable cases of ExDS would be perceived as emotionally disturbed, capturing the information in this way biases our study against documenting all cases of ExDS, thereby underestimating its true prevalence. It is anticipated that the number of missing cases of extreme agitation is small. Hall et al.<sup>19</sup> collected ExDS identifiers for all subjects regardless of their perceived emotional state, and thus found slightly different (namely higher) prevalence rates. The use of drop-down menus and checkboxes in the SB/OR also means that responses were constrained and hence capture only what the database allows. This may also represent a source of bias.

Lastly, when merging report data for an individual subject, all recorded features of ExDS were recorded regardless of whether all involved officers included the same features. Due to the dynamic and prolonged nature of these incidents, study investigators did not attempt to judge which officer's report was "more correct," but rather included all variables if they appeared. Evidence that this procedure did not significantly bias the results is found in the fact that more than 90% of subjects are recorded as having less than three features of ExDS during the UoF encounters even when the highest possible number of features recorded was utilized.

#### Author contribution

Simon Baldwin and Dr. Christine Hall conceived the study. Simon Baldwin designed the study, obtained the data, managed the data (including quality control), and analyzed the data. Dr. Craig Bennell and Dr. Christine Hall provided statistical advice on study design and analysis of the data. Chris Lawrence provided advice on operational policing and the criminal justice system. Dr. Christine Hall provided advice on emergency medicine. Brittany Blaskovits and Simon Baldwin drafted the manuscript, and all authors contributed substantially to its revision. Simon Baldwin takes responsibility for the paper as a whole.

#### Disclaimer

The views expressed in the submitted article are the authors and not an official position of Carleton University, the Royal Canadian Mounted Police or the Vancouver Island Health Authority.

#### Conflict of interest

None declared.

#### Funding

None declared.

#### Ethical approval

The research was deemed exempt by the agency's institutional review board and the anonymized data was subsequently obtained

through a Research Application and Undertaking. The research was conducted following approval from Carleton University's Research Ethics Board.

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