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ARTICLE



# Adverse outcomes in non-fatal use of force encounters involving excited delirium syndrome

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## ABSTRACT

This study examined the risk of adverse outcomes during non-fatal encounters with subjects exhibiting features of Excited Delirium Syndrome (ExDS). Data for the study was collected over a five-year period through standardized reporting in a large Canadian law enforcement agency. Consistent with previous research, the presence of six or more of the ten features of ExDS was used to identify a probable case. Force was applied on 10,718 subjects, 197 (1.8%) of which were probable ExDS. Logistic regression were used to model the odds that use of force (UoF) interventions used on subjects in a state of probable ExDS resulted in adverse outcomes. Probable ExDS was one of the most important predictors of adverse outcomes in UoF encounters, even after controlling for associated risk factors. There were significantly higher odds that UoF was ineffective on subjects exhibiting more features of ExDS, resulting in an increased amount of force applied. In contrast, there were significantly lower odds of injury from UoF for individuals exhibiting probable ExDS. Officers, however, were at a higher risk of injury when dealing with those displaying a greater number of features. These results underscore the risks inherent to incidents involving cases of probable ExDS. A greater understanding of such risks may improve response strategies and promote public and police safety.

## ARTICLE HISTORY

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## KEYWORDS

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## Introduction

Sudden and unexpected arrest-related death (ARD) in the context of police use of force (UoF) encounters has been discussed for more than 30 years in the modern medical literature. Studies of these deaths began when Wetli and Fishbain (1985) 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. They 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’ (Morrison & Sadler, 2001, p. 46).

While not formally recognized as a diagnosis by the American Psychiatric Association (American Psychiatric Association, 2000) or the World Health Organization (Ranson, 2012;

World Health Organization, 2008), evidence to date defines probable cases of ExDS as those that present at least six of the following ten potential criteria: pain tolerance, constant/near constant activity, unresponsive to police presence, superhuman strength, rapid breathing, lack of fatigue, naked/inappropriately clothed, profuse sweating, tactile hyperthermia, and glass attraction/destruction (American College of Emergency Physicians Excited Delirium Task Force, 2009; Hall & Votova, 2013; Vilke et al., 2012). It has been argued that exhibiting six or more of these features indicates that an individual is in a highly abnormal state, one that could only be described as a medical emergency (Hall & Votova, 2013).

Due to the agitated, violent, and erratic state displayed by individuals suffering from ExDS, the police are almost invariably involved in encounters with them (Grant et al., 2009). However, many of the characteristics of ExDS (e.g. superhuman strength, pain tolerance, lack of fatigue) can make certain intervention methods less effective and possibly even injurious (Blaskovits et al., 2017). An investigation of the outcomes from non-fatal UoF encounters could thus provide a greater understanding of the risks involved in dealing with these individuals. This might lead to more appropriate response protocols (e.g. in terms of training, interventions, and/or policy development), mitigating injury and ARDs, as well as provide a greater understanding of the risks to first responders (primarily police officers). To achieve this, we took a novel statistical approach to analyze UoF data; one that accounted for the dynamic and violent nature of police interactions with individuals presenting ExDS.

### ***Use of force outcomes***

Mesloh et al. (2008) found that over half of subjects (56%) in UoF encounters were controlled with one UoF intervention and 85% were subdued by the end of the second application of force. Likewise, Smith and Petrocelli (2002) found that officer tactics were totally effective 74% of the time and at least minimally effective 88% of the time. North American research suggests that subject injury rates resultant from UoF encounters range from 17% to 64%, with officer injury rates between 10% and 20% (Alpert & Dunham, 2010; Hall & Butler, 2008; Smith et al., 2010). It appears that while injury commonly occurs in these types of encounters, these injuries are typically minor in nature (Hall & Butler, 2008; Smith et al., 2010; Smith & Petrocelli, 2002).

### ***Risk factors for adverse use of force outcomes***

Previous research indicates that violent subject behaviour is a common feature of ExDS (Baldwin et al., 2016; Hall & Votova, 2013). As a result, ExDS often involves a forceful struggle with police and the use of physical restraint (DiMaio & DiMaio, 2006; O'Halloran & Lewman, 1993; Stratton et al., 2001). However, given the nature of the catecholamine<sup>1</sup> surge and symptomology (e.g. pain tolerance, constant/near constant activity, superhuman strength) associated with ExDS, typical UoF interventions do not always work. For example, the use of physical control and/or pepper spray, which relies on manual force and/or pain compliance, can be rendered ineffective due to the behaviour of the subject (Vilke & Payne-James, 2016).

Ineffective UoF will likely result in more applications of force and a continued physical struggle, potentially leading to strenuous physical exertion (a risk factor for ARD; Ho et al., 2010; Rutenber et al., 1999; Vilke et al., 2012). In fact, Mesloh et al. (2008) reported that 78% of the subjects that required multiple UoF interventions continued to resist the officer (e.g. punch, wrestle, pull away). This type of physical resistance by subjects also has one of the largest associations with officer injury (Castillo et al., 2012; MacDonald et al., 2009). Paoline et al. (2012) found that officers were significantly more likely to be injured as the level of citizen resistance increased.

Moreover, individuals in a state of ExDS appear to be significantly more likely to be in possession of a weapon (Baldwin et al., 2018), posing obvious risks to subject and officer safety. The literature regarding the relationship between injury and weapon presence has found mixed results (Kaminski

et al., 2004; Kaminski & Sorensen, 1995; Paoline et al., 2012). However, this could be in part because when presented with a weapon, officers opt for an intervention option that provides greater time and distance from the subject (e.g. pepper spray, conducted energy weapon) and, consequently, experience lower injury rates when compared to the use of physical control (Baldwin et al., 2017).

Additionally, mental illness, abrupt cessation of psychiatric medication, and/or substance use (particularly chronic use of stimulants such as cocaine and methamphetamine) often precedes the onset of, and deaths associated with, ExDS (Coyne et al., 2017; Vilke et al., 2012; Vilke & Payne-James, 2016). Indeed, a review of the literature indicated that almost nine out of ten subjects in a state of ExDS were under the influence of some sort of substance, with stimulants being the most prevalent (Grant et al., 2009; Mash et al., 2009; O'Halloran & Lewman, 1993; Pollanen et al., 1998; Ross, 1998; Ruttenber et al., 1999; Stratton et al., 2001). While mental illness and alcohol intoxication are statistically unrelated to the UoF, drug impairment significantly increase the odds that force will be used (Kaminski et al., 2004). For example, Mesloh et al. (2008) reported that subjects under the influence of substances frequently have a much higher pain tolerance, which requires a greater amount of force to be used against them. Despite this, officers are less likely to be injured when subjects displayed signs of alcohol or drug use (Paoline et al., 2012).

### **The current study**

To date, only two prospective epidemiologic studies examining cases of ExDS involved in UoF encounters have been carried out, neither of which have examined UoF outcomes (Baldwin et al., 2016; Hall et al., 2013). Although it is assumed that an encounter with someone exhibiting probable ExDS would result in a prolonged struggle requiring a greater level of force, as well as increased risk of subject and officer injury, there is little empirical evidence to support this. Therefore, it remains unclear the extent to which officer encounters with probable cases of ExDS result in the use of multiple interventions, ineffective interventions, and injuries to subjects and officers. This study seeks to clarify the relationship by examining the unique effect of ExDS on adverse outcomes, controlling for the impact of several other risk factors identified in the literature.

## **Method**

### **Data source**

We collected data for the study over a five-year consecutive time period from 1 January 2012 to 31 December 2016 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 by the authors prior to data collection to enable prospective documentation of the ten features of ExDS cited in the literature (e.g. American College of Emergency Physicians Excited Delirium Task Force, 2009; Baldwin et al., 2016; Hall et al., 2013). Officers gained access to the list of features if they indicated in their report that the subject they encountered was suffering from a perceived emotional disturbance; at that point a drop-down menu opened and each of the ten features could be checked off as present or absent.

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 were included for analysis in this study if any UoF above the application of physical control 'soft' occurred (i.e. the use of joint locks, come-along techniques, and simple handcuffing). Furthermore, 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. This was because the threshold and manner of reporting deterrent methods, differed substantially across interventions and the completeness of these data could not be confirmed. 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 potentially lengthy investigative process is concluded. As a result, incidents undergoing investigation do not appear in the sample.

The research was deemed exempt by the agency's institutional review board and the anonymized data were subsequently obtained through a Research Application and Undertaking (Department of Justice, 1985). The research was conducted following approval from Carleton University's Research Ethics Board (REB #16-105,365).

### **Outcome measures**

Each UoF intervention during an encounter is captured as a unique event in the UoF reporting database. Recorded outcomes for each intervention include whether it was effective and resulted in subject and/or officer injury. When aggregating data for an individual subject, we calculated the total count of outcomes across reports. The dichotomous dependent variables were: (1) more than one UoF interventions were applied to the subject, (2) one or more interventions were ineffective, (3) one or more interventions injured the subject, and (4) one or more interventions injured the officer.

### **Predictor and control measures**

ExDS was the main predictor in the statistical models. Four control measures that have been associated with adverse outcomes in related literature were also included in the models: (1) perceived presence of drugs and/or alcohol, (2) a struggle going to the ground, (3) subject behaviour, and (4) perceived possession of a weapon (e.g. Baldwin et al., 2018; Coyne et al., 2017; Vilke et al., 2012). When aggregating report data for an encounter where multiple officers used force on the same subject, the highest value indicated across reports was selected (e.g. the report indicating the highest number of features of ExDS present). Likewise, any perception of comorbidities or risk factors across reports was selected (e.g. the perceived presence of drugs and/or alcohol, a struggle going to the ground, perceived possession of a weapon).

We then created variables for subjects perceived to be under the influence of drugs and/or alcohol (0 = no drugs or alcohol, 1 = alcohol only, 2 = drugs only, and 3 = drugs and alcohol), subject behaviour (0 = cooperative/resistant, 1 = assaultive, and 2 = threat of grievous bodily harm or death; GBHD), struggle that went to the ground (0 = no and 1 = yes) and subject perceived or believed to be in possession of a weapon (0 = no and 1 = yes). We developed ExDS categories by aggregating the number of features displayed into three categories (0 = less than three, 1 = three to five, and 2 = six or more). This is consistent with prior research (American College of Emergency Physicians Excited Delirium Task Force, 2009; Hall et al., 2013; Vilke et al., 2012). For comparative purposes, zero will be used as the reference category for all predictor and control variables in the regression models.

### **Statistical procedure**

Data were prepared for analyses using SAS 9.4 (SAS Institute, Cary NC, 2013). All analyses were conducted at the subject level; aggregation and duplicate checks were performed to ensure each subject was only represented once. The variables used in the analyses were mandatory for completion of the SB/OR report, thus no missing data were observed. The use of drop-down menus and checkboxes in the SB/OR reporting application means that all predictor variables were constrained and hence, no outliers were observed. Logistic regression was used to model the dichotomous outcome measures (i.e. more than one UoF interventions was applied to the subject, one or more interventions were ineffective, one or more interventions injured the subject, and one or more interventions injured the officer).

## Results

### *Characteristics of the data*

During the five-year study period, 11,725 SB/OR reports were completed by 4,868 officers. The reports contained 13,243 UoF interventions involving 10,718 subjects. The number of police-public interactions during that time was 13.2 million, indicating a .081%, 95% CI [.079, .082], UoF per police-public interactions rate (i.e. force is applied approximately one in every 1,235 police-public interactions). Subjects undergoing police UoF were predominantly male (91%), had a mean age of 32 ( $SD \pm 11.4$ ), and were reportedly violent (65.8%). There were four (out of 10,718; .037%; 95% CI [.015, .096]) sudden and unexpected ARDs of violent and agitated subjects during this period, though they were not included in the sample due to the external investigative processes that are invoked under these circumstances.

### *Prevalence*

Out of 10,718 subjects on which the police applied force, 3,322 (31%) were perceived by officers to be emotionally disturbed, and a drop-down menu for the ExDS features became available for completion. Approximately 10.1% ( $n = 1,087$ ) of subjects displayed three or more features of ExDS and 1.8% ( $n = 197$ ) of subjects displayed six or more features.<sup>2</sup> A very small number of subjects ( $n = 4$ ; .04%) presented with all ten features of ExDS. Including the four deaths of extremely agitated and violent subjects, in addition to the cohort of 197 subjects demonstrating a high number of ExDS features, this means that upwards of 5% (based on the upper bound of the 95% CI) of these subjects could be expected to be at risk of sudden and unexpected ARD.

### *Demographics and risk factors of subjects displaying six or more features of exDS*

The majority of subjects experiencing probable ExDS were males (94.9%) in their early 30's ( $M = 31$ ,  $SD \pm 10$ ). A one-way between subject 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 probable ExDS. No significant difference in age across the three categories was observed,  $F(2, 10,715) = 2.675$ ,  $p = .069$ . There was a significant difference in the number of officers who responded to the encounter across the three categories,  $F(2, 10,715) = 29.393$ ,  $p < .001$ . A Tukey post hoc test indicated that there were significantly more officers on scene when subjects were in a state of probable ExDS ( $M = 3.7$ ,  $SD \pm 2.8$ ), compared to those who displayed three to five features ( $M = 3$ ,  $SD \pm 2.4$ ,  $p < .001$ ), and less than three features ( $M = 2.6$ ,  $SD \pm 2.1$ ,  $p < .001$ ).

Furthermore, officers perceived subjects who displayed probable ExDS to be under the influence of drugs (41.6%) and drugs and alcohol (38.6%) at a much higher rate than those displaying less than three features (10.1% and 19.5%, respectively). Compared to encounters with subjects displaying less than three features, subjects exhibiting probable ExDS almost exclusively resulted in a struggle going to the ground (70.5% versus 91.9%) and involved a higher rate of violent behaviour (63.8% versus 83.2%). Officers perceived subjects to be in possession of a weapon 40.6–45.7% of the time; there were no differences observed in relation to perceived weapon possession across the three categories of displayed ExDS features. [Table 1](#) outlines the demographics and risk factors of subjects displaying probable ExDS.

### *Intervention outcomes*

The descriptive results indicated that almost half (48.7%) of UoF encounters with subjects exhibiting probable ExDS involved the use of more than one intervention options. Conversely, only 15.2% of subjects displaying less than three features involved multiple interventions. Similar increases in

**Table 1.** Demographics and risk factors with displayed features of ExDS.

	Displayed features of ExDS											
	Less than three ( <i>n</i> = 9631)				Three to five ( <i>n</i> = 890)				Six or more ( <i>n</i> = 197)			
	<i>n</i>	%	<i>M</i>	<i>SD</i>	<i>n</i>	%	<i>M</i>	<i>SD</i>	<i>n</i>	%	<i>M</i>	<i>SD</i>
Male	8772	91.1%			798	89.7%			187	94.9%		
Age			31.7	11.4			32.6	11.1			31.4	10.0
Subject perceived to be under the influence of drugs and/or alcohol												
No drugs or alcohol	2582	26.8%			201	22.6%			30	15.2%		
Alcohol only	4198	43.6%			147	16.5%			9	4.6%		
Drugs only	975	10.1%			234	26.3%			82	41.6%		
Drugs and alcohol	1876	19.5%			308	34.6%			76	38.6%		
Number of police officers on scene			2.6	2.1			3.0	2.4			3.7	2.8
Struggle that went to the ground	6791	70.5%			727	81.7%			181	91.9%		
Subject behaviour												
Cooperative/resistant	3487	36.2%			150	16.9%			33	16.8%		
Assaultive	5046	52.4%			534	60.0%			119	60.4%		
Threat of grievous bodily harm or death	1098	11.4%			206	23.1%			45	22.8%		
Subject was perceived or believed to be in possession of a weapon	3908	40.6%			407	45.7%			85	43.1%		

Note. Consistent with prior literature, subjects displaying six or more features are referred to as 'probable cases of ExDS'.

UoF ineffectiveness and officer injury were associated with probable cases of ExDS. More specifically, subjects presenting with probable ExDS demonstrated much higher rates of one or more interventions being ineffective (46.7%) and resulting in officer injury (28.4%), compared to subjects displaying less than three features (12.9% and 14.4%, respectively). Lastly, probable cases of ExDS demonstrated slightly higher rates that one or more interventions would result in subject injury relative to those who displayed fewer features (i.e. less than three; 69% versus 61.3%). Table 2 demonstrates the rates for each category of displayed features of ExDS and risk factors. Additionally, a detailed breakdown of outcomes in relation to the unique and total number displayed features of ExDS can be accessed at <https://osf.io/vwh2m/>.

## Predictors of adverse outcomes in non-fatal uof encounters

### Amount of force

Probable ExDS increased the *unadjusted* odds of more than one UoF intervention being applied to the subject by five times, compared to those with less than three features (OR = 5.3, 95% CI [4.0, 7.0],  $p < .001$ ).<sup>3</sup> Here, we discuss the *adjusted* ORs, which are also presented in Table 3. The data included in Table 3 indicate that even after controlling for other risk factors (i.e. perceived drug and alcohol use, violent behaviour, a ground struggle, and perceived weapons) that have been associated with adverse outcomes (e.g. Baldwin et al., 2018; Coyne et al., 2017; Vilke et al., 2012), the odds that more force was applied to probable cases of ExDS increased by a factor of almost four (OR = 3.65). Other risk factors that increased the odds that more force was applied to the subject included them being perceived to be under the influence of drugs and alcohol (1.27 times or 27%<sup>4</sup>), assaultive behaviour (2.9 times), threat of GBHD (3.2 times), a ground struggle (nearly 4 times) and the perceived presence of a weapon (59%).

**Table 2.** Intervention outcomes with displayed features of ExDS and risk factors.

	More than one use of force event applied to the subject % of <i>n</i>	One or more of the interventions ineffective on the subject % of <i>n</i>	One or more of the interventions injured the subject % of <i>n</i>	One or more interventions resulted in injury to the officer % of <i>n</i>
<b>Displayed features of ExDS</b>				
Less than three	15.2%	12.9%	61.3%	14.4%
Three to five	33.8%	32.8%	68.9%	22.7%
Six or more	48.7%	46.7%	69.0%	28.4%
<b>Subject perceived to be under the influence of drugs and/or alcohol</b>				
No drugs or alcohol	14.5%	13.3%	51.9%	12.2%
Alcohol only	15.4%	11.3%	67.4%	14.5%
Drugs only	21.1%	22.7%	59.0%	18.2%
Drugs and alcohol	22.4%	20.1%	65.9%	19.0%
<b>Subject behaviour</b>				
Cooperative/resistant	8.4%	8.9%	51.8%	10.1%
Assaultive	21.1%	17.1%	68.3%	18.7%
Threat of grievous bodily harm or death	26.3%	23.8%	63.7%	15.6%
<b>Struggle that went to the ground</b>				
No	6.6%	12.0%	66.5%	5.4%
Yes	21.6%	16.4%	60.3%	19.2%
<b>Subject perceived or believed to be in possession of a weapon</b>				
No	15.5%	14.9%	68.5%	17.2%
Yes	20.0%	15.5%	52.9%	12.6%

### Use of force ineffectiveness

Probable ExDS increased the *unadjusted* odds that one or more interventions were ineffective on the subject by almost 6 times, compared to if one exhibited less than three features (OR = 5.9, 95% CI [4.5, 7.9],  $p < .001$ ). The *adjusted* ORs included in Table 3 indicate that the unique effect of probable ExDS increased the odds that an intervention was ineffective by a factor of almost four (OR = 3.94), after controlling for other risk factors in the model. This was the largest unique effect of all predictors. Other risk factors that increased the odds that an intervention(s) was ineffective included perceiving the subject to be under the influence of drugs (44%) or drugs in combination with alcohol (23%), assaultive behaviour (2 times), or threat of GBHD (2.7 times). A ground struggle marginally increased the odds that intervention would be ineffective (28%), while the perceived presence of weapons showed no impact on intervention efficacy. Interestingly, the presence of alcohol alone decreased the odds of intervention inefficacy by 22% (compared to those not perceived to be under the influence of substances).

### Subject injury

Compared to those with less than three features of ExDS, probable cases of ExDS increased the *unadjusted* odds that one or more interventions resulted in subject injury by 40% (OR = 1.4, 95% CI [1.0, 1.9],  $p = .028$ ). However, the *adjusted* ORs included in Table 3 suggest that when controlling for other risk factors in the model, the unique effect of probable ExDS actually decreased the odds of injury by 28%. Other risk factors that decreased the odds that an intervention(s) would result in injury to the subject included the officer perceiving the subject to be under the influence of alcohol (34%), drugs (21%), drugs in combination with alcohol (32%), assaultive behaviour (39%), and threatening GBHD (45%). A ground struggle increased the odds of subject injury by 48%, while the perceived presence of



**Table 3.** Adjusted odds ratios for UoF outcomes associated with displayed features of ExDS and risk factors.

Variables in the model	Use of force outcomes											
	Amount <sup>a</sup>			Ineffectiveness <sup>b</sup>			Subject injury <sup>c</sup>			Officer injury <sup>d</sup>		
	OR	95%CI	p	OR	95%CI	p	OR	95%CI	p	OR	95%CI	p
Displayed features of ExDS												
Less than three	1.00			1.00			1.00			1.00		
Three to five	2.11	1.80-2.48	<0.001	2.41	2.05-2.83	<0.001	0.73	0.63-0.85	<0.001	1.36	1.14-1.62	<0.001
Six or more	3.65	2.70-4.94	<0.001	3.94	2.93-5.30	<0.001	0.72	0.52-0.98	<0.037	1.57	1.14-2.18	<0.006
Subject perceived to be under the influence of drugs and/or alcohol												
No drugs or alcohol	1.00			1.00			1.00			1.00		
Alcohol only	1.08	0.93-1.25	0.290	0.78	0.67-0.91	0.001	0.66	0.59-0.73	<0.001	0.99	0.85-1.16	0.937
Drugs only	1.12	0.93-1.34	0.234	1.44	1.21-1.72	<0.001	0.79	0.68-0.90	0.001	1.32	1.09-1.59	0.004
Drugs and alcohol	1.27	1.09-1.48	0.002	1.23	1.05-1.44	0.009	0.68	0.60-0.77	<0.001	1.27	1.09-1.50	0.003
Subject behaviour												
Cooperative/resistant	1.00			1.00			1.00			1.00		
Assaultive	2.90	2.52-3.33	<0.001	1.98	1.72-2.27	<0.001	0.61	0.55-0.66	<0.001	1.81	1.59-2.07	<0.001
Threat of grievous bodily harm or death	3.15	2.64-3.77	<0.001	2.73	2.28-3.26	<0.001	0.55	0.48-0.62	<0.001	1.69	1.40-2.05	<0.001
Struggle that went to the ground												
No	1.00			1.00			1.00			1.00		
Yes	3.79	3.24-4.44	<0.001	1.28	1.12-1.45	<0.001	1.48	1.35-1.62	<0.001	3.88	3.28-4.59	<0.001
Subject Perceived or believed to be in possession of a weapon												
No	1.00			1.00			1.00			1.00		
Yes	1.59	1.42-1.79	<0.001	0.94	0.83-1.06	0.290	1.79	1.69-1.95	<0.001	0.76	0.67-0.86	<0.001

Note. Estimates adjusted for all other variables in the model. OR = odds ratio; CI = confidence interval.

<sup>a</sup>Model  $\chi^2(9) = 986.99, p < 0.001$ ; Cox & Snell  $R^2 = 0.09$ , Nagelkerke  $R^2 = 0.15$ ; Hosmer & Lemeshow  $\chi^2(7) = 16.79, p = 0.020$ .

<sup>b</sup>Model  $\chi^2(9) = 549.33, p < 0.001$ ; Cox & Snell  $R^2 = 0.05$ , Nagelkerke  $R^2 = 0.09$ ; Hosmer & Lemeshow  $\chi^2(8) = 16.09, p = 0.041$ .

<sup>c</sup>Model  $\chi^2(9) = 612.33, p < 0.001$ ; Cox & Snell  $R^2 = 0.06$ , Nagelkerke  $R^2 = 0.08$ ; Hosmer & Lemeshow  $\chi^2(8) = 54.09, p < 0.001$ .

<sup>d</sup>Model  $\chi^2(9) = 557.37, p < 0.001$ ; Cox & Snell  $R^2 = 0.05$ , Nagelkerke  $R^2 = 0.09$ ; Hosmer & Lemeshow  $\chi^2(8) = 26.49, p < 0.001$ .

weapons increased the odds by 79%, which was the largest unique increase in subject injury of all predictors.

### Officer injury

Compared to those with less than three features of ExDS, probable ExDS increased the *unadjusted* odds that one or more interventions resulted in officer injury by almost two and half times (OR = 2.4, 95% CI [1.7, 3.2],  $p < .001$ ). The *adjusted* odds ratios included in Table 3 indicate that when controlling for other risk factors in the model, the unique effect of probable ExDS continued to increase the odds of officer injury by 57%. Other risk factors that increased the odds of officer injury included encounters with subjects perceived to be under the influence of drugs alone and drugs in combination with alcohol (32% and 27%, respectively), and subjects that were assaultive or presented a threat of GBHD (81% and 69%, respectively). A ground struggle drastically increased the odds of officer injury by almost four times, while the perceived presence of weapons decreased the odds of officer injury by 24%.

### Discussion

There is a lack of research examining adverse outcomes in non-fatal UoF encounters involving ExDS. Unfortunately, this limits our ability to understand the risks involved for those experiencing such physiological conditions, the officers confronted by them, and the resultant threat to public safety. The current study is one of the largest epidemiologic studies conducted to date, aimed at assessing those who experience police UoF. This study is also the first to examine adverse outcomes in these types of encounters. The results demonstrate the unique effect that ExDS has on officers' use of multiple UoF interventions, ineffective intervention, and injuries to subjects and officers, while controlling for the effects of several other risk factors identified in the literature.

Exhibiting probable ExDS was one of the most important predictors of adverse outcomes in UoF encounters, even after controlling for associated risk factors (i.e. perceived substance use, violent behaviour, a ground struggle, and perceived weapons). Moreover, as the number of displayed features of ExDS increased, so did the magnitude of these adverse effects. More specifically, the results suggested that officer intervention was frequently ineffective on these subjects, likely due to the characteristic catecholamine surge and symptomology (e.g. pain tolerance, superhuman strength) associated with ExDS. Indeed, this would render typical UoF interventions that rely on pain compliance or manual force (e.g. physical control, pepper spray) unsuccessful (Vilke & Payne-James, 2016). Other features, such as constant/near constant activity and profuse sweating, particularly if naked or partially clothed, may make the subject more difficult to control. Thus, it appears that officers are at a notable disadvantage when encountering subjects in a state of extreme mental and physiological excitement.

The consequence of ineffective UoF on probable ExDS was a substantial increase in the amount of force required to gain control of the subject. This is indicative of a prolonged struggle, which is a serious risk factor for subjects in the ExDS state. Research suggests that strenuous physical exertion increases the risk of ARD for subjects experiencing ExDS (DiMaio & DiMaio, 2006). A prolonged or strenuous struggle can result in acidosis, rhabdomyolysis, and/or surges in catecholamines, which can act as contributing or causal mechanisms in sudden deaths (Ho et al., 2010; Ruttenger et al., 1999; Vilke et al., 2012). Based on these findings, there is a need to examine which specific intervention options show the most potential for safely, efficiently, and effectively controlling subjects displaying features of ExDS.

Interestingly, the UoF had a significantly lower odds of injury on subjects experiencing probable ExDS, despite the increased amount of force applied in these encounters. Again, this may be due to the catecholamine surge which manifests as pain tolerance, a feature displayed in 93% of probable cases of ExDS (Baldwin et al., 2016). This imperviousness to pain could mask subject's injuries

during the police interaction. Moreover, subjects who exhibit many of the features of ExDS are routinely treated as a medical emergency by police and transferred into medical care as soon as possible (rather than being processed criminally). Thus, in contrast to subjects who are arrested and detained in cells, officers are much less likely to be aware of their medical outcomes once the symptomology of this acute state has subsided.

In comparison to subject injury, UoF encounters with probable cases of ExDS present an increased risk of officer injury. This appeared to be attributable primarily to the violent nature and co-occurring factors (i.e. substance use) common in subjects displaying various concomitant features of the syndrome (Baldwin et al., 2018). Consistent with the literature (Castillo et al., 2012; Kaminski et al., 2004; Kaminski & Sorensen, 1995; MacDonald et al., 2009; Mesloh et al., 2008; Paoline et al., 2012), drugs alone and in combination with alcohol, violent behaviour, a ground struggle, and weapons, also emerged as important predictors of several adverse outcomes.

The results underscore the risk associated with UoF encounters involving a subject in the throes of high mental and physical excitement. Thus, training for first responders that provides the education and skills needed to manage individuals in said state is necessary (e.g. containment, multi-officer response strategies). Training that is integrated into existing modules on mental health, crisis-intervention, de-escalation, First Aid, cardiopulmonary resuscitation (CPR), and the UoF may ensure relevant linkages between concepts are learned. As new research on ExDS emerges and best practices are identified, training can be updated accordingly. Collaboration among the various parties (e.g. paramedics, emergency physicians, hospital security, correctional officers) most likely to encounter probable cases of ExDS, may also help inform intervention options.

### **Limitations**

Although various measures were implemented to ensure study quality, the research was limited in several ways. First, given that the study only included police UoF encounters, individuals who displayed features of ExDS, or died in a state of ExDS, without the involvement of police or paramedics were not accounted for. A lack of standardized 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, there is no ability to determine whether they shared features of stimulant abuse, unchecked psychoses, or other pathophysiology. However, considering the often violent and externalizing symptomology of ExDS (e.g. glass attraction/destruction, nakedness/inappropriate clothing), police are typically called. Further, given that similar rates have been observed across the literature (Hall et al., 2013), most probable cases were likely captured.

Another limitation of the research relates to data collection. The standardized reporting system used was developed primarily to assist police officers in articulating their actions in regard to a UoF incident. Reports are completed from an officer's perspective and are based on their subjective interpretation of the events at the time of the encounter, which may contain biases. Police officers receive annual training on conducting continuous risk assessments, which are based on their experiences and perceptions, as well as situational factors and the subject's behaviour. However, they are not trained to diagnose subjects and would not typically confirm alcohol or drug intoxication under these circumstances (as they are non-driving related offences). Future research that validates the accuracy of these perceptions against toxicology results and medical assessments, including compliance with psychiatric medication, is encouraged. In the absence of such clinical studies, first responders' perceptions of subjects displaying features of ExDS continue to provide valuable and previously unreported insights into the operational realities of dealing with these medically high-risk encounters.

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. These retrospective accounts are limited due to memory errors and stress, which have been found to impede recall (e.g. Yuille et al., 1994).

However, these reports are typically completed in close proximity to the event (i.e. within 48 hours), which may decrease memory impairment issues (e.g. Geiselman, 2010). While post-incident reporting is an obvious limitation, it would be impossible to complete a report during the event. Furthermore, the results of the present study, which are based on a large sample of cases, correspond closely to the results reported by Hall and Votova (2013), suggesting consistency in standardized police reporting in spite of potential biases and the influence of stress on recall. Future study investigating officer perceptions from retrospective recall against more objective sources, such as body worn camera (BWC) footage, may provide new insights (Ariel et al., 2015).

Another notable limitation relates to the nature 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 skews our study against documenting all potential cases of ExDS, potentially underestimating its true prevalence. It is anticipated that the number of missing cases of extreme agitation is small. Hall et al. (2013) 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.

Importantly, 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 officers' report was 'most correct,' but rather included all variables if they appeared. However, more than 90% of subjects were recorded as having less than three features of ExDS during the UoF encounter, even when the highest possible number of features recorded was utilized; this provides some evidence that this procedure likely did not seriously impact the results.

A final limitation is that the variables we examined in this study do not represent an exhaustive list of factors that can potentially predict adverse outcomes in UoF encounters, and some of these unexamined variables could predict such outcomes to a greater degree than ExDS (and influence the unique effect of probable ExDS on the outcomes). Indeed, while the presence of ExDS appears to predict the outcomes of encounters, this is highly contingent on the predictive model that we have specified, which omits several variables known to influence outcomes in UoF encounters (e.g. see Hickman et al., 2020). Our results should be treated with appropriate caution in light of this limitation, and future research should endeavour to examine a broader range of potential predictor variables, in addition to those examined here.

## Conclusion

Although future research is needed to confirm that this is the case, it appears that ExDS is an important predictor of adverse outcomes in UoF encounters. This finding underscores the risk that these encounters may present to officers and is important for understanding how the manifestation of ExDS and associated risk factors affect UoF effectiveness and injury. More practically, the findings are relevant for UoF policy and training, and can inform officer response to potential cases of ExDS. Of particular concern in these cases is the increased risk to subjects suffering from ExDS when they are over exerted during a prolonged struggle; this sort of stress can act as contributing or causal mechanisms in sudden deaths (Baldwin et al., 2018). Moreover, it appears that there is an increased risk to officers when engaging with subjects displaying a high number of features associated with ExDS. The results of this study emphasize the need for intervention strategies that promote containment, multiple member responses, and effective intervention options to quickly and efficiently control these subjects.<sup>5</sup> Such strategies may facilitate

a reduction in the extent of struggle involved and allow for more expedient monitoring of vitals, as well as immediate medical intervention, thus reducing risk of harm to the subject, officers, and any potential bystanders.

## Notes

1. Catecholamines are a group of hormones released in response to stress (e.g. Molinoff & Axelrod, 1971). They appear to be involved in sudden deaths, including fatal cases of ExDS (e.g. Baldwin et al., 2018; Otahbachi et al., 2010).
2. Consistent with prior literature (e.g. American College of Emergency Physicians Excited Delirium Task Force, 2009; Hall et al., 2013; Vilke et al., 2012), subjects displaying six or more features are referred to as 'probable cases of ExDS' for the remainder of the paper. For a detailed description of how many cases involve specific features of ExDS across the examined categories (i.e. <3 features, 3–5 features, >6 features), and an examination of which ExDS features are more distinguishing than others, see Baldwin et al. (2016).
3. *Unadjusted* (crude) odds ratios (ORs) display the full effect of probable ExDS on the outcomes. *Adjusted* ORs illustrate the unique effect of probable ExDS on the outcomes, while controlling for other risk factors which are known to be associated with ExDS and/or adverse outcomes in related literature (i.e. perceived drug and alcohol use, violent behaviour, a ground struggle, and perceived weapons).
4. In terms of interpretation, an OR of 1.27 means that the odds of an outcome are 27% more likely to occur in one group. Conversely, an OR of 0.73 means that the odds of an outcome are 27% less likely to occur in one group.
5. The data in this study do not indicate which specific intervention options are best suited for incidents involving ExDS. While higher levels of force could be used in the first instance to avoid struggles in incidents involving ExDS, we believe this recommendation is inappropriate without the necessary supporting data. Instead, we feel that promoting intervention strategies (e.g. multi-officer response strategies) to control these subjects quickly and efficiently, while reducing the risk of a prolonged struggle, is the most prudent approach. We hope to conduct further analysis in the future to address the question of which intervention options are best suited for incidents involving ExDS.

## Disclaimer

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

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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