



Original communication

Restraint related deaths and excited delirium syndrome in Ontario (2004–2011)



Alain Michaud, MD

675 Rang 1 Sud Roberval, Québec, G8H 2M9, Canada

ARTICLE INFO

Article history:

Received 30 December 2015

Received in revised form

20 March 2016

Accepted 1 April 2016

Available online 9 April 2016

Keywords:

Excited delirium syndrome

Physical exertion

Prone position

Restraints

Sudden death

Unexpected death

ABSTRACT

Restraint related death in individuals in excited delirium syndrome (ExDS) is a rare event that has been the subject of controversies for more than 3 decades. The purpose of this retrospective study was to retrieve data on all restraint related deaths (RRD) that occurred in Ontario during an 8-year period and compare them with an earlier study on RRD in ExDS covering the period 1988–1995 in Ontario. The Office of the Chief Coroner of Ontario website was consulted under verdicts and recommendations. The Canadian Legal Information Institute website was used to consult verdict explanations and coroner's summary of evidence. During the period 2004–2011, RRD occurred in 14 individuals in ExDS, a 33% reduction. Psychiatric illness as a cause of ExDS decreased from 57% to 14%. Cocaine was the cause of ExDS in 11 (79%) individuals. The number of RRD following a violent encounter in cocaine-induced ExDS (8) was identical in the 2 periods. RRD occurred in 6 individuals without ExDS following a violent encounter. Final restraint position preceding cardiorespiratory arrest was available in 36% of individuals with ExDS and 83% of individuals without ExDS. In both groups, cardiorespiratory arrests could be classified as immediate or delayed. All 4 individuals without ExDS who had immediate cardiorespiratory arrests were restrained in the prone position. Delayed cardiorespiratory arrest occurred in the non-prone position in both groups. Although many hypotheses may be put forward to explain changes in the epidemiology of RRD in ExDS in Ontario, multiple warnings and recommendations from coroners' inquests cannot be ignored. There is probably not a unique pathophysiological pathway leading to cardiorespiratory arrest in RRD. The death rate in RRD in ExDS is so low that drawing any conclusions based on statistical studies or on isolated case report could be hazardous.

© 2016 Elsevier Ltd and Faculty of Forensic and Legal Medicine. All rights reserved.

1. Introduction

Since the publication of Reay et al.,¹ the cause of sudden and unexpected death of individuals restrained for excited delirium syndrome has been a subject of controversy.^{2,3} While respiratory compromise in the prone position has been proposed, suggesting that restraints could play a significant role in these deaths,^{4,5,6} others believed that these deaths were the result of fatal autonomic dysfunction caused by abnormalities in dopamine signaling.^{7,8} Now recognized as a condition requiring rapid medical diagnosis and treatment, it has been suggested that the mortality in ExDS could be lowered if police officers had a pocket card describing the signs and symptoms of ExDS.⁹

Recently, Hall et al.¹⁰ published a study based on multiple data collected in 4 Canadian cities from August 2006 until March 2013.

One of these data was the documentation of “the final resting position of the subject, once physical control had been achieved and while awaiting disposition at the end of the police-public interaction”. As the only death occurred in the non-prone position in an individual presenting “all 10 features of excited delirium”, the authors explained that their results echoed “the earlier findings of Pollanen and other authors that sudden in custody death has more to do with the features of the individual”.

The goal of this study was to re-examine deaths in custody related to restraints in Ontario since the period 1988–1995 used by Pollanen et al.¹¹

2. Methods

Because verdicts and recommendations of coroners' inquests in Ontario are information available to the public, no ethics committee approval was necessary. Through the website of the Office of the Chief Coroner of Ontario (OCCO),¹² verdicts and recommendations

E-mail address: g.a.michaud@hotmail.com.

were consulted. Going backward from the date of the last inquest held in 2014, the names of the deceased were retrieved if the following key words “restraints”, “accident.custody”, “undetermined.custody.police”, “restraint asphyxia”, “accident.police”, “positional asphyxia”, “accident.jail”, “accident.detention center” were found in “Summary”. Then, through the Canadian Legal Institute Information (CanLII) website,¹³ the first name and the last name of the deceased followed by “coroner inquest” was used to have access to verdict explanations and the coroner’s summary of evidence. If verdict explanations and summary of evidence were not found, the OCCO was contacted. The year considered to be the study starting point was the year when the first individual died following the use of restraints. Then, all individuals who died following the use of restraints during an 8 year-span were considered for the study.

3. Results

Between 2004 and 2011, 20 coroner inquests were held following the use of restraints in Ontario. All individuals were men. The mean age was 35 years (SD 8.6). All deaths occurred in custody. Signs and symptoms of ExDS resulting from drug-induced psychosis or psychiatric illness were present in 14 (70%) individuals. Six (6) individuals were not in ExDS (Fig. 1, Fig. 2, Fig. 3).

In 11 (79%) individuals with ExDS, a violent physical encounter occurred with police officers. Loss of consciousness followed by cardiorespiratory arrest was immediately noticed in 5 individuals once handcuffs were in place. The other 6 individuals were still conscious after the application of handcuffs and unexpected cardiorespiratory arrest occurred following a bout of continuous fighting and struggling against restraints. In 3 (21%) individuals with cocaine-induced ExDS, minimal use of force was reported. One was a “body packer” who died from an acute cocaine overdose. In the other 2 individuals, “acute cocaine intoxication” or “cocaine poisoning” was mentioned in the summary but cocaine blood levels were not available. In individuals with ExDS, cardiovascular disease was mentioned in 4 individuals (29%). Conducted electrical weapon (CEW) was used in 5 individuals. Stun mode was briefly effective in

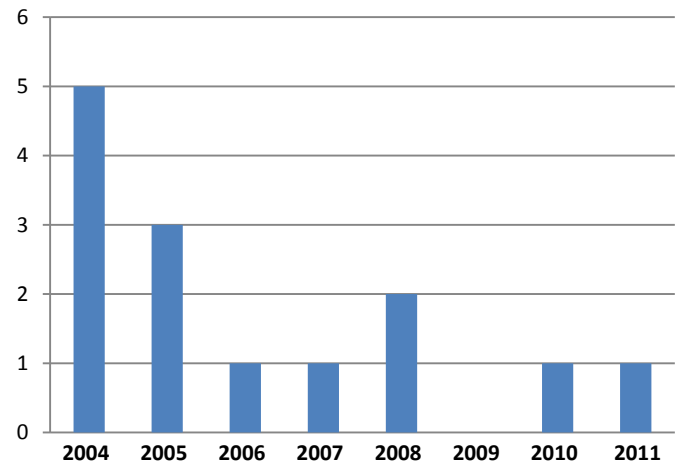


Fig. 2. Restraint related deaths associated with ExDS in Ontario (2004–2011).

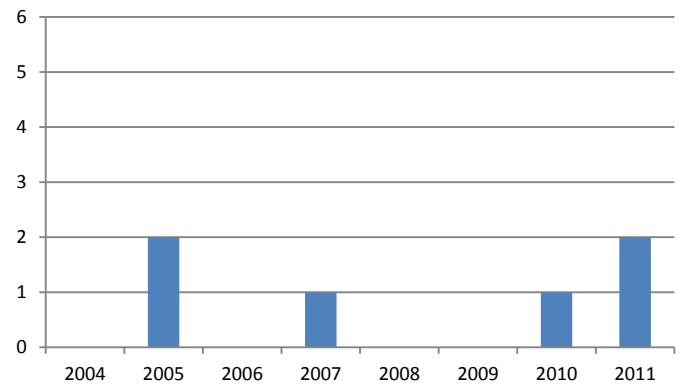
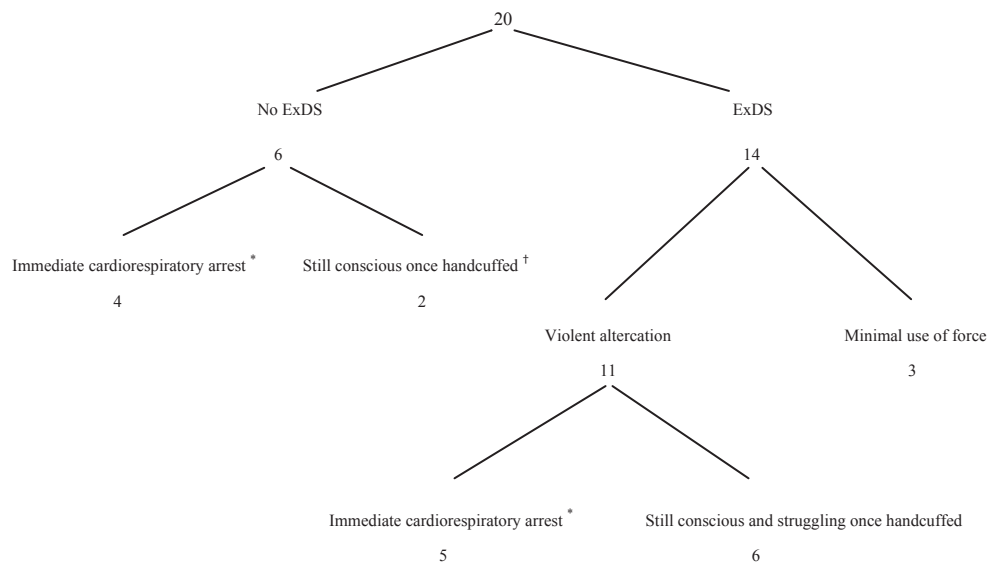


Fig. 3. Restraint related deaths in individuals without ExDS in Ontario (2004–2011).



* Unconsciousness observed immediately following the application of handcuffs.

† Still conscious but immediate breathing difficulties leading very rapidly to cardiorespiratory arrest.

Fig. 1. Sudden and unexpected deaths following restraints in Ontario (2004–2011).

3 out of 4 individuals with cocaine-induced ExDS, allowing the use of handcuffs. In an aggressive schizophrenic, sudden collapse and cardiorespiratory arrest occurred almost immediately when darts hit the anterior chest area from a distance of 4 feet. Final position and type of restraint used when the individuals lost consciousness was mentioned in 5 (36%) individuals with ExDS.

In the 6 individuals without ExDS, all deaths occurred following a violent altercation with police officers. In 4 individuals, loss of consciousness and cardiorespiratory arrest was noticed immediately once wrists were secured by handcuffs. Those individuals were all restrained in the prone position and in at least 3 cases, pressure was applied on the chest with a knee or the police officer(s) body (ies). In the case of an 18 years old healthy individual, chest compression by 2 police officers was preceded by a 2–3 min foot race. In the 2 individuals still conscious once handcuffed, “breathing difficulties” were observed in 1 individual and verbalized by the other. In both individuals, cardiorespiratory arrest occurred very rapidly thereafter. According to police officers, prone position was not used in 1 of those 2 individuals. The position used to restrain and handcuff the other individual who had submitted himself to a prolonged foot race was not mentioned. Final position and type of restraints were mentioned in 5 (83%) individuals without ExDS. Cardiovascular disease was mentioned in 2 (33%) individuals. Fig. 4 and Table 1 compare different data from this study with the period 1988–1995.

4. Discussion

Restraint related deaths (RRD) in ExDS are rare in Canada. In 2004, the death rate was estimated to be around 0.25 death/million/year.¹⁴ In the absence of a national registry on RRD, the OCCO and CanLII websites remain a valuable source of information as Ontario accounts for nearly 40% of the total Canadian population. By including all RRD for the period 2004–2011 and by taking advantage of the Pollanen et al. study,¹¹ this study shows that the epidemiology of RRD in ExDS has changed in Ontario and that RRD are not exclusive to individuals in ExDS.

4.1. Evolution of restraint related deaths associated to excited delirium syndrome in Ontario

Compared to the period 1988–1995, RRD in ExDS decreased from 21 to 14, a 33% reduction, and psychiatric disorders, as the cause of ExDS, decreased from 57% (12) to 14% (2). After 2005, only 1 death per year occurred on average (0.08 death/million/year). This decrease is not related to an increase rate of institutionalization as reintegration of individuals with mental illness is still the trend.

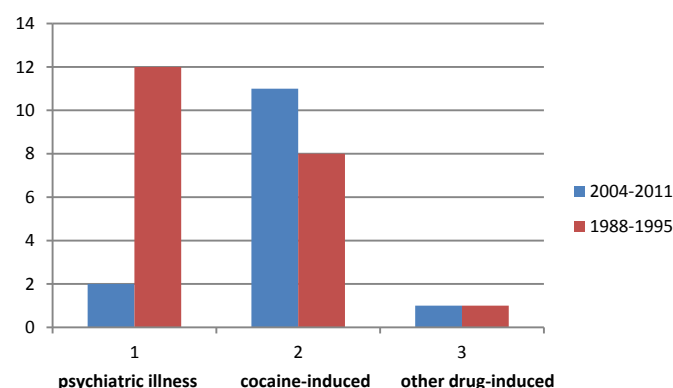


Fig. 4. Cause of excited delirium syndrome in restraint related deaths in Ontario.

Table 1

Restraint related death in excited delirium syndrome in Ontario.

	2004–2011	1988–1995
Number	14	21
Mean age (SD)	35.7 (8)	33 (10)
In custody	14 (100%)	18 (86%)
Psychiatric illness	2 (14%)	12 (57%)
Drug induced	12 ^a (86%)	9 (43%)
Cocaine (lethal range)	3/11 (27%) ^b	0/6
Violent encounter	11/14 (79%)	21 (100%)
Neck pressure	0	3 (14%)
Prone position	3 ^c	18 (86%)
Supine	1 ^d	0
Hog-tied II	1	2
Seizure preceding death	3 (21%) ^e	0
Cardiovascular disease	4 (29%)	4 (21%)

^a Cocaine in 11 cases, methamphetamine in 1 case.

^b No blood levels available (See Limitations).

^c No information available for 9/14 individuals; includes fatal collapse following CEW.

^d Very combative with police officers—was put in police wagon with handcuffs and ankle restraints only—was struggling side to side in police wagon—still combative at hospital arrival—unexpected death occurred when restrained supine at hospital arrival—no detail on restraint technique. II Hog-tied and left as such in prone position.

^e 2 cocaine-induced ExDS and 1 methamphetamine-induced ExDS.

Better social and health care of individuals with psychiatric disorders may have reduced the total number of police interventions during the period 2004–2011. Warnings from the OCCO concerning the association between restraints and fatal ExDS came in February 1995. Since 1995, the Pollanen et al. study¹¹ has been published and there have been repetitive recommendations from different coroners' inquiries held in Ontario. In November 2007, a jury recommended that a “policy be implemented that forbids first responders who are attending to a medical emergency from putting a patient in the prone position particularly with patients exhibiting the set of symptoms commonly referred to as excited delirium”. Since, there has not been a single death reported in a physically restrained psychiatric individual in Ontario. In 2006, paramedics patient standards on prone position in agitated psychiatric patients were changed from “not recommended” to “not be used”.¹⁵ In Toronto, Mobile Crisis Intervention Teams consisting of a specially trained police officer and a mental-health nurse have been created during the period 2004–2011. During the period 2004–2011, no death was associated with neck pressure and hog-tied was mentioned only once. Summaries reveal that police officers were aware of the association between restraints in the prone position and fatal ExDS but thought that “the risks of prone restraint” applied “only within the context of excited delirium.” That information suggested that restraints in the prone position were probably discarded as an option during interventions in individuals with ExDS and may possibly explain why, in the last 3 years of this study, there were more RRD in individuals without ExDS than in individuals with ExDS. There is indirect evidence that restraint techniques and training may have also evolved elsewhere in Canada. The only death reported in the Hall et al. study¹⁰ occurred between August 2006 and August 2009.¹⁶ In the Hall et al. study,¹⁰ hog-tying was not allowed and “significantly more individuals with any comorbidity detected at the scene were placed in a not-prone position”. However, within 6 weeks during the same period, 2 individuals died in custody while restrained in the prone position in Western Canada. Both deaths resulted in special inquiries.^{17,18}

4.2. Cocaine-induced fatal ExDS

Cocaine can cause multiple adverse effects other than acute psychosis. Based on findings in cocaine-induced fatal ExDS, some

have argued that fatal ExDS resulted from central nervous alterations leading to fatal autonomic dysfunction similar to the neuroleptic malignant syndrome^{7,19} or from an uncontrolled and severe metabolic acidosis. In this study, minimal use of force was reported in 3 (21%) individuals with cocaine-induced ExDS and the number of RRD in cocaine-induced ExDS following violent physical encounters (8) did not change between the 2 periods. At least 1 individual, possibly 3, died apparently from cocaine overdose. The total number of cocaine users was probably higher during period 2004–2011. Estimated prevalence of cocaine consumption in Canada was around 0.9% for period 1988–1995²⁰ and 1.9% in 2004,²¹ 1.6% in 2008²² and 0.9% in 2011²² and Ontario population increased by more than 2 million. The total number of police interventions in these circumstances and whether individuals with recreational blood levels of cocaine were less inclined to develop cocaine-induced ExDS is unknown. The majority of RRD in individuals with cocaine-induced ExDS following a violent encounter, 63% (5/8), occurred in the first 2 years of this study (2004–2005). Following a violent encounter in the last 4 years (2008–2011), there were more RRD in individuals without ExDS (3) than in individuals with cocaine-induced ExDS (2). The hypothesis that fatal ExDS results from central nervous system alterations leading to fatal autonomic dysfunction originates from reports and studies from Florida in individuals with cocaine-induced ExDS.^{7,19,23} Those authors also showed that police custody was the most important factor determining sudden death (odds ratio 22.3) and that summer season (odds ratio 2.5) increased the risk of fatal cocaine-induced ExDS.²³ Physical exertion associated with ExDS and the fact that cocaine can increase intracellular calcium^{24,25} should raise the possibility that the multiorgan failure syndrome (MOF) associated to cocaine may have more in common with hypermetabolic syndromes such as exertional heat illness, exertional rhabdomyolysis or malignant hyperthermia which are characterized by an uncontrolled increase in intracellular calcium.²⁶ The dramatic temperature drop and clinical improvement following use of dantrolene also suggests that the MOF described in cocaine users may have a relation with mitochondrial dysfunction.²⁷ The notion that severe metabolic acidosis could be a significant factor in RRD in cocaine-induced ExDS was introduced in 1999 by Hick et al.²⁸ They outlined the importance of police officers collaboration and, with the application of certain principles gained from past experiences, they described the successful reanimation of 5 individuals in cocaine-induced ExDS who never went into cardiac arrest in spite of pH as low as 6.76.²⁸

4.3. The prone position controversy in fatal ExDS

The prone position controversy in fatal ExDS is the core of a larger debate on whether law enforcement restraint techniques are the direct cause of cardiorespiratory arrest in RRD. In RRD, handcuffs can be used as a marker to distinguish the “control phase” from the “restrained phase”. This study shows that handcuffs can also be used as a marker to classify RRD as sudden (immediate) or unexpected (delayed). In this study, all sudden deaths (4) in individuals without ExDS occurred in the prone position with chest compression in at least 3 cases. In 2 of those 4 individuals, post-mortem did not reveal any potential factors that could be used to explain those deaths. This finding should question methods, results interpretations and any conclusions drawn from studies in healthy subjects designed to simulate the same circumstances. No clear distinction between the “control phase” and the “restrained phase” was made in the 5 case series articles where 70/71 cardiorespiratory arrests were reported in the prone position.^{4,5,6,11,29} In the Pollanen et al. study,¹¹ handcuffs were not mentioned in the 3 individuals “with pressure applied to the neck” and in 4 individuals

“with chest compression” in the prone position suggesting that at least 7 RRD occurred during the “control stage” during period 1988–1995. Isolated case reports of RRD in the non-prone position have been reported during the “restrained phase”.^{30,31} Recovery rates after exercise with chest compression in the prone position³² or “hobble restraints”³³ have been used as arguments that the prone position is not a predisposing factor in RRD in ExDS. Paterson et al.³⁴ have criticized both studies and have questioned their “ecological validity”. Moreover, in the phase 2 of Schmidt and Snowden's study,³³ subjects, once “placed in maximal restraint”, were immediately rolled “onto a side”. Their technique differed from early hog-tying and was developed by a local San Diego police department in 1992.³³ O'Halloran et al. explained that San Diego police department had “banned the practice of transporting subjects hogtied and proned” following death of 5 men restrained in prone position.⁵ Among the 6 individuals in ExDS who kept on struggling once handcuffed in this study, at least 2 individuals were tightly restrained in the prone position, 1 on a gurney, the other hogtied. At least 1 individual “went vital signs absent” very rapidly after being forcefully “strapped onto the restraint gurney in a supine (face-up) position”. Whether restraints resulted in abdomen compression in that case is unknown.

In this study, breathing difficulties and shortness of breath during the “restrained phase” were reported as the only complaint from the 2 individuals without ExDS. Shortness of breath is a subjective sensation reported in acute coronary insufficiency and acute diastolic dysfunction as well as in anxious individuals. Being restrained in the prone position may be uncomfortable even in healthy volunteers.³⁵ Psychotic individuals in ExDS are unable to communicate verbally. Struggling against restraints may be the only warning sign that they feel “short of breath”, that they are not comfortable or that a major event is occurring. An expected reaction of a psychotic and paranoid individual tightly restrained should be increased struggling and forcing desperately to change position. Hick et al. explained that “continued combativeness despite restraints, especially in the setting of sympathomimetic agents such as cocaine, seems to be a marker for a patient at high risk of sudden death”.²⁸ Struggling continuously against restraints or forcing desperately against tight restraints are 2 forms of static exercise that may have different hemodynamic consequences. Forcing desperately against tight restraints is an exercise similar to weight lifting. By severely increasing intrathoracic pressure, weight lifting can induce a Valsalva maneuver resulting in syncope.³⁶ By increasing significantly diastolic blood pressure, static exercise such as continuous struggling will increase myocardial oxygen demands.^{37,38} Unexpected cardiac events are likely to occur in hypermetabolic individuals in a clinical situation of sudden decrease in cardiac output or acute increase in myocardial oxygen demands. In medicine, potential deleterious consequences of prone position are recognized in critical care,³⁹ in anesthesiology,⁴⁰ in sudden unexpected death in epilepsy.⁴¹ Compared to the supine position, the prone position decreased the cardiac output by 14% in healthy subjects.⁴² Prone position impedes adequate observation and monitoring of individuals in ExDS who are at risk of unexpected cardiorespiratory arrest. There is probably not a unique pathophysiology leading to cardiorespiratory arrest in RRD. The finding that RRD occurred in the non-prone position in at least 1 individual without ExDS indicates that there is a risk associated with restraints but this should not be interpreted as if the prone position cannot increase that risk in ExDS.

4.4. Use and abuse of the expression excited delirium syndrome

Identifying individuals in ExDS is a subjective exercise based on non specific clinical features and it has a low specificity in

predicting fatal ExDS.⁴³ In public coroner inquests in Ontario, an expert is invited to explain issues related to ExDS to a jury. In regard to the schizophrenic individual, known in the past for “aggressive and unpredictable behaviour”, who collapsed immediately following the deployment of CEW in the chest, the use of ExDS should be questioned. The vast majority of the clinical features of ExDS were absent. The individual appeared quiet and was seated at police officers arrival. They were able to have a conversation with him. Situation deteriorated 5 min later when police officers explained that he was going to be arrested. This individual was discovered at autopsy to have SCN5A polymorphism of class III, a normal variant not likely to cause cardiac arrhythmia. An objective finding in this inquiry was the result of a blood sample, taken in the emergency department. As it showed a severe metabolic acidosis with pH of 6.85 and an anion gap of 27, this was considered as an evidence in favor of fatal ExDS. In this case, response time in the field (time between cardiac arrest and CPR start) was very high (roughly between 10 and 15 min) and toxicology was negative for cocaine. The jury was not aware that the mean initial pH and anion gap value in individuals sustaining an out-of-hospital cardiac arrest is 6.90 and 20 respectively.⁴⁴ Clinically, this individual had more in common with the 17 years old teenager who became upset when he learned that he had lost his job.⁴⁵

Individuals with cocaine-induced ExDS appear to be at higher risk of cardiorespiratory arrest during physical interventions. However, the violence and the length of the struggle during law enforcement encounters implies that the majority of those individuals had similar cardiovascular and physiological reserve than individuals without ExDS who died from RRD. In that regard, the possibility that heat shock protein 70 could be a non specific marker⁴⁶ would require more studies.

There are probably more cases of “near misses” in individuals restrained in the prone position than the 2 recently reported.^{47,48} The limiting factor during severe exercise is cardiovascular, not respiratory.⁴⁹ The ACEPW mentions that “the majority of lethal ExDS die shortly after a violent struggle”, “suddenly, typically following physical control measures”.⁵⁰ If the goal of the pocket card is to identify individuals in ExDS and to transfer them alive to appropriate medical care,⁹ understanding the potential impact of restraints on cardiovascular physiological adaptations to exercise is important considering the acute level of exhaustion occurring during violent encounters.^{51,52}

5. Limitations

This study has many limitations. It is retrospective. In Ontario, coroner inquest summary is a “document solely to assist interested parties to understand jury’s verdict”. In some summaries, the amount of information was extensive. In others on cocaine-induced fatal ExDS, information was sometimes minimal. Information concerning restraint positions used in some cocaine-induced fatal ExDS was lacking. It is possible that some individuals with cocaine-induced ExDS may have been classified erroneously in the sudden cardiorespiratory arrests category. Moreover, as no cocaine blood levels were available, it is impossible to know objectively if expressions such as “cocaine intoxication” and “cocaine poisoning” corresponded to individuals with cocaine blood levels such as in the 6 individuals in Pollanen et al. study.¹¹ The expressions “cocaine level well within a fatal range”, “potential lethal cocaine intoxication” and the presence of a body packer strongly suggest that 3 individuals may have had cocaine blood levels well over those found in the Pollanen et al. study.¹¹ Some of the information relies on testimony of events that occurred months or years earlier and witnesses’ testimonies may have been influenced by earlier meetings with their legal advisors. However, summary information

concerning the period studied was reliable for the number of deaths, the year of death, the cause of ExDS associated to RRD, the fact that RRD occurred in individuals with and without ExDS and that in both groups, cardiorespiratory arrests occurred rapidly or following a variable delay.

6. Summary

Epidemiology of RRD in ExDS has changed significantly in Ontario since the period 1988–1995 and impact of warnings and recommendations from coroners’ inquest on police officers’ training cannot be ignored. The fact that 30% of RRD occurred in individuals without ExDS suggests that ExDS may be an incidental finding in certain cases of RRD. Although some RRD in cocaine-induced ExDS appear inevitable, the violence and the length of the struggle suggest that the majority of those individuals had good cardiovascular reserve before law enforcement officers’ interventions. The death rate of individuals restrained for ExDS is so low that drawing any conclusions based on statistical studies or on isolated case report could be hazardous.

Conflict of interest

The author does not have any conflict of interest.

Funding

There is no funding related to this study.

Ethical approval

As explained in [Methods](#), verdicts and recommendations of coroners’ inquests in Ontario are information available to the public through the website of the Office of the Chief Coroner of Ontario (OCCO)¹². Therefore, no ethics committee approval was necessary.

Moreover, verdict explanations and coroner’s summary of evidence are also available to the public through the Canadian Legal Institute Information (CanLII) website¹³.

All the data used in the present study are from those 2 websites which are available to the public.

References

- Reay DT, Howard JD, Fligner CL, Ward RJ. Effects of positional restraint on oxygen saturation and heart rate following exercise. *Am J Forensic Med Pathol* 1988;**9**(1):16–8.
- Farnham FR, Kennedy HG. Acute excited states and sudden death. *BMJ* 1997;**315**(7116):1107–8.
- Pounder D. Death after restraint can be avoided. *BMJ* 1998;**316**(7138):1171.
- Reay DT, Fligner CL, Stilwel AD, Arnold J. Positional asphyxia during law enforcement transport. *Am J Forensic Med Pathol* 1992;**13**(2):90–7.
- O’Halloran RL, Lewman LV. Restraint asphyxiation in excited delirium. *Am J Forensic Med Pathol* 1993;**14**(4):289–95.
- Stratton SJ, Rogers C, Brickett K, Gruzinski G. Factors associated with sudden death of individuals requiring restraints for excited delirium. *Am J Emerg Med* 2001;**19**:187–91.
- Wetli CV, Mash D, Karch SB. Cocaine-associated agitated delirium and the neuroleptic malignant syndrome. *Am J Emerg Med* 1996;**14**:425–8.
- Mash DC, Duque L, Pablo J, Qin Y, Adi N, Hearn WL, et al. Brain biomarkers for identifying excited delirium as a cause of sudden death. *Forensic Sci Int* 2009 Sep;**190**(1–3):e13–9.
- Vilke GM, Payne-James J, Karch SB. Excited delirium syndrome (ExDS): redefining an old diagnosis. *J Forensic Leg Med* 2012;**19**:7–11.
- Hall C, Votova K, Heyd C, Walker M, MacDonald S, Eramian D, et al. Restraint in police use of force events: examining sudden in custody death for prone and not-prone positions. *J Forensic Leg Med* 2015;**31**:29–35.
- Pollanen MS, Chiasson DA, Cairns JT, Young JG. Unexpected death related to restraint for excited delirium: a retrospective study of deaths in police custody and in the community. *CMAJ* 1998;**158**:1603–7.
- Ministry of Community Safety and Correctional Services. Office of the Chief Coroner of Ontario. Verdicts and Recommendations. [accessed 10.04.15]. Available at: http://www.mcscs.jus.gov.on.ca/english/DeathInvestigations/Inquests/VerdictsRecommendations/OCC_verdicts.html.
- The Canadian Legal Information Institute (CanLII). Accessed April 10, 2015. Available at: <https://www.canlii.org/en/>.

14. Laur D. *Excited delirium and its correlation to sudden death and unexpected death proximal to restraint. A review of the current and relevant medical literature.* Canadian police research centre; 2004 [accessed 15.11.15]. Available at: <https://www.publicsafety.gc.ca/lbrt/archives/cnmcs-plcng/cn79034141-eng.pdf>.
15. Emergency Health Services Branch. *Ontario ministry of health and long term care. BLS basic life support. Patient care standards.* 2007 [accessed 25.11.15]. Available at: http://www.health.gov.on.ca/english/public/program/ehs/edu/pdf/bls_patient.pdf.
16. Hall CA, Kader AS, McHale AMD, Stewart L, Fick GH, Vilke GM, et al. Frequency of signs of excited delirium syndrome in subjects undergoing police use of force: descriptive evaluation of a prospective, consecutive cohort. *J Forensic Leg Med* 2013;**20**:102–7.
17. [Internet] *Witness says RCMP put knee in Dziekanski's back.* The Canadian Press; 2009 Feb 10 [accessed 30.09.11]. Available from: http://www.ctv.ca/CTVNews/CanadaAM/20090210/BC_braidwood_tuesday_090210/.
18. Public Safety Canada. *Commission for public complaints against the RCMP. Chair's public interest investigation re in-custody death of Robert Thurstom Knipstrom.* RCMP Act. Subsections 45.37(1) and 45.43(1). November 25, 2009 [accessed 16.03.16]. Available at: <http://www.publicsafety.gc.ca/lbrt/archives/cnmcs-plcng/cn32651-eng.pdf>.
19. Ruttenber AJ, McAnally HB, Wetli CV. Cocaine-associated rhabdomyolysis and excited delirium: different stages of the same syndrome. *Am J Forensic Med Pathol* 1999;**20**:120–7.
20. Health Canada. *Cocaine use. Recommendations in treatment and rehabilitation.* 2000 [accessed 25.11.15]. Available at: <http://publications.gc.ca/site/archive-archived.html?url=http://publications.gc.ca/collections/Collection/H49-155-2001E.pdf>.
21. Health Canada. *Canadian alcohol and drug use monitoring survey.* 2014 [accessed 25.11.15]. Available at: http://www.hc-sc.gc.ca/hc-ps/drugs-drogués/stat/_2011/summary-sommaire-eng.php#a4.
22. Canadian Center on Substance Abuse. *Canadian drug summary: cocaine.* 2015 [accessed 25.11.15]. Available at: <http://www.ccsa.ca/Resource%20Library/CCSA-Cocaine-Drug-Summary-2015-en.pdf>.
23. Ruttenber AJ, Lawler-Heavner J, Yin M, Wetli CV, Hearn WL, Mash DC. Fatal excited delirium following cocaine use: epidemiologic findings provide new evidence for mechanisms of cocaine toxicity. *J Forensic Sci* 1997;**42**:25–31.
24. Giammarco RA. The athlete, cocaine, and lactic acidosis: a hypothesis. *Am J Med Sci* 1987;**294**(6):412–4.
25. Sardão VA, Pereira SL, Oliveira PJ. Drug-induced mitochondrial dysfunction in cardiac and skeletal muscle injury. *Expert Opin Drug Saf* 2008;**7**(2):129–46.
26. Capacchione JF, Muldoon SM. The relationship between exertional heat illness, rhabdomyolysis, and malignant hyperthermia. *Anesth Analg* 2009;**109**:1065–9.
27. Allam S, Noble JS. Cocaine-excited delirium and severe acidosis. *Anaesthesia* 2001;**56**:385–6.
28. Hick JL, Rogers C, Green K. Sudden death in individuals in hobble restraints during restraint-associated cardiac arrest: a case series. *Acad Emerg Med* 1999;239–43.
29. O'Halloran RL, Frank JG. Asphyxial death during prone restraint revisited: a report of 21 cases. *Am J Med Pathol* 2000;**21**(1):39–52.
30. Park KS, Korn CS, Henderson SO. Agitated delirium and sudden death: two case reports. *Prehosp Emerg Care* 2001;**5**(2):214–6.
31. Channa Perera SD, Pollanen MS. Sudden death due to sickle cell crisis during law enforcement restraint. *J Forensic Leg Med* 2007;**14**:297–300.
32. Cary NRB, Roberts CA, Cummin ARC, Adam SL. The effects of simulated restraint in the prone position on cardio-respiratory function following exercise in humans. *J Physiology* 2000;**525**(supp):30–1.
33. Schmidt P, Snowden T. The effect of positional restraint on heart rate and oxygen saturation. *J Emerg Med* 1999;**17**(5):777–82.
34. Paterson B, Bradley P, Stark C, Saddler D, Leadbetter D, Allen D. Deaths associated with restraints in health and social care in the UK. The results of a preliminary survey. *J Psychiatr Ment Health Nurs* 2003;**10**(1):3–15.
35. Ho JD, Dawes DM, Moore JC, Caroon LV, Miner JR. Effect of position and weight force on inferior vena cava diameter-Implications for arrest-related death. *Forensic Sci Int* 2011;**212**:256–9.
36. Compton D, Hill PM, Sinclair JD. Weight-lifters' blackout. *Lancet* 1973;**2**(7840):1234–7.
37. Lind AR, McNicol GW. Muscular factors which determine the cardiovascular responses to sustained and rhythmic exercise. *Can Med Assoc J* 1967;**96**(12):706–15.
38. Smith JJ, Kampine JP. Physiology of exercise and the effect of aging. In: Smith JJ, Kampine JP, editors. *Circulatory physiology-the essentials*. 2nd ed. Baltimore: Williams & Wilkins; 1984. p. 218–45.
39. Malbrain ML, Cheatham ML, Kirkpatrick A, Sugrue M, Parr M, De Waele J, et al. Results from the international conference of experts on intra-abdominal hypertension and abdominal compartment syndrome. I. Definitions. *Intensive Care Med* 2006;**32**:1722–33.
40. Edgcombe H, Carter K, Yarrow S. Anaesthesia in the prone position. *Br J Anaesth* 2008;**100**:165–83.
41. Liebenthal JA, Wu S, Rose S, Ebersole JS, Tao JX. Association of prone position with sudden unexpected death in epilepsy. *Neurology* 2015;**84**:703–9.
42. Savaser DJ, Campbell C, Castillo EM, Vilke GM, Sloane C, Neuman T, et al. The effect of the prone maximal restraint position with and without weight force on cardiac output and other hemodynamic measures. *J Forensic Leg Med* 2013;**20**:991–5.
43. Strote J, Walsh M, Auerbach D, Burns T, Maher P. Medical conditions and restraint in patients experiencing excited delirium. *Am J Emerg Med* 2014;**2014**(32):1093–6.
44. Makino J, Uchino S, Morimatsu H, Bellomo R. A quantitative analysis of the acidosis of cardiac arrest: a prospective observational study. *Crit Care* 2005;**9**(4):R357–62.
45. Michaud A, Dupuis JY. Echocardiographic evaluation of TASER X26 in healthy volunteers. *Am J Emerg Med* 2010;**28**(4):521–3.
46. Johnson MM, David JA, Michelhaugh SK, Schmidt CJ, Bannon MJ. Increased heat shock protein 70 gene expression in the brains of cocaine-related fatalities may be reflective of postdrug survival and intervention rather than excited delirium. *J Forensic Sci* 2012;**57**(6):1519–23.
47. Nissen T, Rørwick P, Haugslett L, Wynn R. Physical restraint and near death of a psychiatric patient. *J Forensic Sci* 2013;**58**(1):259–62.
48. Maher PJ, Walsh M, Burns T, Strote J. Prehospital resuscitation of a man with excited delirium and cardiorespiratory arrest. *CJEM* 2014;**16**(1):80–3.
49. Guyton AC, Hall JE. *Textbook of medical physiology*. 11th ed. Philadelphia: Elsevier Saunders; 2006.
50. ACEP Excited Delirium Task Force. *American college of emergency physicians white paper report on excited delirium syndrome. Report to the council and board of directors on excited delirium at the direction of amended resolution 21(08).* September 10, 2009 [accessed 17.01.14]. Available at: <http://www.fmhac.net/Assets/Documents/2012/Presentations/KrelsteinExcitedDelirium.pdf>.
51. Ho JD, Dawes DM, Cole JB, Hottinger JC, Overton KG, Miner JR. Lactate and pH evaluation in exhausted humans with prolonged TASER X26 exposure or continued exertion. *Forensic Sci Int* 2009;**190**(1–3):80–6.
52. Ho JD, Dawes DM, Nelson RS, Lundin EJ, Ryan FJ, Overton KG, et al. Acidosis and catecholamine evaluation following evaluation following simulated law enforcement "use of force" encounters. *Acad Emerg Med* 2010;**17**(7):e60–8.