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National Study On Neck Restraint In Policing

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Foreword

Law enforcement officers in Canada are encountering an increasing number of subjects that are not responsive to standard arrest and restraint tactics. Typically, the individuals who are not responsive to traditional restraint techniques are under the influence of central nervous system stimulants or hallucinogens, suffering acute psychosis, or both; all of which present a challenging restraint and control problem for the responding officers. The frequency of officers encountering these subjects in an altered state of cognition, whose actions are typified by episodes of unpredictable, frenzied and violent behaviour is anticipated to continue to increase as cocaine and methamphetamine use grows on a national scale.

The inclusion of the latest less lethal technologies, such as the conducted energy device (Taser®), has not eliminated the requirement for officers to utilize physical control tactics to take these subjects into custody. The vascular neck restraint is one of the physical control techniques that officers frequently utilize to restrain these types of individuals. Many police agencies in Canada have included the neck restraint in their use of force paradigm for many years, some agencies have recently adopted or readopted the vascular neck restraint (VNR) and others yet are investigating whether the neck restraint is an appropriate technique to add to the training regimen.

There has been little consensus among police professionals and medical investigators regarding the risk of neck restraints applied by police personnel when restraining subjects of police interest. Many medical opinions, coroners' findings and legal reviews do not reflect the body of knowledge at the time. There are multiple techniques available in the spectrum of neck holds, with little information available regarding potential risks of various techniques. Each technique is different from the other and carries with it a different risk profile.

In order to investigate the medical, legal and expert trainer evidence surrounding use of neck restraints, the Canadian Police Research Centre (CPRC) facilitated the following review, which is entitled the National Study on Neck Restraints in Policing.

The intent of this review is to provide a multi disciplinary report evaluating police use of neck restraint, with specific attention to vascular neck restraint. The report began with extensive expert medical review of the body of medical evidence and case law surrounding application of neck restraint. The neck restraint was evaluated with focus directed to the various types of neck restraints, the risk of injury from application of the restraint, medical implications and any collateral issues pertaining to case law and training. Recommendations for future evaluations were also generated.

Ultimately, the final report on neck restraints in policing provides a framework around which administrators can make informed decisions regarding the following:

- Whether or not to teach / authorize the vascular neck restraint,
- Development of course training standards and lesson plans,
- Application threshold within the use of force continuum,
- Training and recertification recommendations,
- Policy development,
- Risk management

The Canadian Police Research Centre and the report's authors are proud to have contributed to furthering the knowledge, understanding and research of police practices in Canada and abroad.

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Summary of Report Recommendations:

1. Nomenclature

For ongoing implementation and evaluation of vascular neck restraint, it is highly recommended that consistent and definable nomenclature for vascular neck restraint is used. The term vascular neck restraint, or its abbreviation, VNR, should be used. Agencies implementing the copyrighted LVNR® should adhere to that specific terminology[1]. Police applications of restraint technology such as the vascular neck restraint are deserving of a professional and consistent nomenclature to separate use of this restraint technique from the variable, inconsistent and often incorrect attempts at restraint of a person's neck by untrained and non-police persons. There is a distinct and definable difference in application technique, physiology of effect and anticipated outcome between a vascular neck restraint and other types of holds involving the neck. Appropriate and consistent nomenclature assists in clarifying those differences.

The term "carotid sleeper hold" should be abandoned.

2. Injury Potential / Medical Considerations

This report finds that, while no restraint methodology is completely risk free, there is not medical reason to routinely expect grievous bodily harm or death following the correct application of the vascular neck restraint in the general population by professional police officers with standardized training and technique.

The medical ramifications of application of various and sundry neck holds by untrained individuals and non police personnel cannot be evaluated or anticipated in detail except to say that a lack of a standard approach changes the risk profile of the technique for the worse.

Professional application of the standardized vascular neck restraint should not be governed by the medical implications of lay person attempts at "neck holds" as the medical implications are likely to be vastly different.

Most police officers have no formal medical training and must anticipate that subjects fall under the normal physiologic and medical characteristics of the general population unless overwhelming evidence or clues presented to the officer suggest otherwise. Good policy guidelines will enable officers to apply appropriate techniques with appropriate discretion, thereby minimizing risk.

In the general population the medical implications of the application of vascular neck restraint are detailed in the sections that follow. Full discussion of the physiology of each body system as it responds to VNR application can be found in the body of this report under relevant section headings.

[1] The LVNR® is a registered trademark of the National Law Enforcement Training Center (NLETC), Kansas City, Missouri.

Specific risk groups for adverse outcomes following application of VNR by appropriately trained individuals:

While the authors of this report agree that application of a properly trained and applied vascular neck restraint confers very little physiologic risk to the general population, certain medical conditions may increase the risk of many activities, including being restrained. However, most abnormalities in physiology are not physically apparent to the police officer or others on approach of the violent individual requiring restraint. Relevant and appropriate health information is seldom available to the officers at the scene.

Officers have no medical training and should anticipate that subjects fall under the characteristics of the general population unless overwhelming evidence or clues presented to the officer suggest otherwise. The following risk groups are identified in this report because of their potential (although not proven) increased risk specific to the application of a VNR and because of their potential identifiability through visual inspection alone for officers with no reliable medical information and no medical training. The details of their potential increased risk are discussed in the body of the report, but the identifiable risk groups are:

1. The obvious elderly.

2. Obvious pediatric subjects.

3. Obvious or known Down's syndrome (Trisomy 21)

4. The obviously, visibly pregnant woman.

3. Legal Review

During the extensive legal and civil review of incidents involving the vascular neck restraint undertaken for this research project, it has become evident that there is little consensus on the status of the VNR specific to policing. Another difficulty in interpreting these legal findings is that in many of the cases reviewed, those sitting in judgment made no distinction between 'choke holds or respiratory restraints' and 'carotid holds or vascular restraints'. In many of the cases reviewed, it is clear the triers of fact did not appear to understand the disparate medical risks involved between the two different types of techniques. Confusing one technique with the other may explain, in part, why some courts have reacted so strongly to the use of a vascular neck restraint. For example, some courts have held that the use of the 'neck restraint' constitutes deadly force however; the medical review of the vascular neck restraint does not support this view.

However, where police use of a neck restraint has led to legal action, the courts have generally tended to focus on four issues:

i. Given the circumstances the officer was faced with, was the use of the neck restraint reasonable. In addressing this question the following are taken into consideration:

    - The risk of harm to the officers or others,
    - The level and type of resistance offered by the subject,

- The goal of the officer in applying the neck restraint,
- The perceptions of the officers involved in the incident

ii. Did the officers follow departmental policy?
iii. Were the officers properly trained in the use of the technique and was the application consistent with that training?
iv. Did the officer act in good faith, conscious of their responsibility for public safety.

In reviewing the cases involving law enforcement use of vascular neck restraints which resulted in recommendations, most focus on training and policy considerations. The recommendations arising from Canadian legal cases are summarized as follows:

i. Training on the use of the vascular neck restraint should be provided on a regular basis.
ii. In training, officers should be informed of the VNR's potential for adverse medical outcomes.
iii. The VNR should be limited by policy to situations where officers or others are in danger of physical harm.
iv. Police agencies should document all circumstances in which the VNR is used. This reporting data should be reviewed periodically to measure adherence to policy and to identify training issues.
v. Ongoing research should be conducted on the use of neck restraints and changes implemented where appropriate. (Although this recommendation was gleaned from the legal review, the medical experts tasked with reviewing the existing scientific research for this project unanimously indicated that no further medical research is required for making best-practices training standards and policy. With respect to the issue of restraint modality with subjects experiencing excited delirium syndrome, the international RESTRAINT study which is just in its infancy is seeking to address this concern.)

4. Training Considerations

The vascular neck restraint is a technique which is employed in dynamic, violent and rapidly changing events. In order to become competent in the use of this type of psychomotor skill[2], officers require initial training that as closely as possible reflects the conditions on which the technique will be applied in the operational environment. In this respect, training should begin with static, closed-motor instruction to master the proper application of the VNR, graduate through open-motor training and ultimately provide the opportunity for dynamic motor (stimulus response) or scenario-based training.

Officers should demonstrate the consistent ability to maintain the proper positioning of the VNR against a training partner who struggles against the restraint. This will decrease the probability of the VNR inadvertently becoming a respiratory restraint which increases the risk of harm to the subject.

Officers should demonstrate that they are able to continuously monitor the correct positioning of the VNR and once any improper positioning is identified either immediately obtain the correct positioning or discontinue the VNR.

[2] Muscle movement produced by action of the mind or will.

Officers should demonstrate that they understand and are able to apply the concept of disengaging from the neck restraint and either tactically repositioning or transitioning to other force options if the VNR has not achieved the desired result within 30 seconds.

As with all law enforcement use of force options, the goal of applying any restraint is to obtain subject compliance. With this in mind, officers should understand that the objective of the VNR is not to obtain unconsciousness but to obtain subject compliance. Officers should be taught to monitor the subject during the VNR application for signs of subject compliance and, should such compliance be forthcoming prior to unconsciousness, maximal compression should cease. In the case of voluntary compliance, the officers should maintain control of the subject and transition to handcuffing control using the agency-specific subject control and handcuffing techniques. In those circumstances where the subject continues aggressive behaviour against the VNR contrary to the professional verbal direction of the officer, maximal compression will likely result in involuntary compliance (unconsciousness) within 7-15 seconds.

Officers should be taught the signs and symptoms of unconsciousness so that such behaviour can be immediately identified. Once unconsciousness is identified, the officer applying the VNR should:

- Discontinue compression but maintain control of the subject,
- Place the subject in the appropriate position for prone handcuffing and once handcuffed,
- Move the subject into an appropriate side-lying recovery position and,
- Continuously monitor the subject for vital signs (primarily respirations) and,
- Ensure the subject regains consciousness within 30 seconds and provide verbal reassurance and,
- Where vital signs are absent or the subject does not regain consciousness within 30 seconds, alert emergency medical personnel and begin appropriate lifesaving measures.
- Following the application of a VNR, subjects who complain of pain or discomfort which is more than transitory should be allowed to seek medical attention at the first reasonable opportunity.

During training, officers should be afforded the opportunity to assume a triple role as the restrainer, the restrained and an observer officer.

VNR training should include classroom sessions which discuss and which the learner should be tested for comprehension of:

- The difference between respiratory and vascular restraints,
- The medical risks inherent to respiratory and vascular restraints,
- The identification of higher-risk subjects pertaining to VNR application,
- The identification of subjects who may be experiencing excited delirium syndrome and the associated medical emergency of this condition,
- Signs and symptoms associated with both voluntary (conscious) compliance and involuntary (unconscious) compliance,
- A review of pertinent Canadian legal action (criminal, civil and fatality inquiries) respecting the law enforcement use of neck restraints.
- A discussion of the use of the VNR which is consistent with the sections of the Criminal Code of Canada authorizing the use of force by peace officers.

- A discussion of agency-specific restrictions and/or prohibitions concerning the application of the VNR
- Agency-specific reporting and documentation procedures

Finally, as with all psychomotor skills, those that are not used consistently will deteriorate over time and those motor skills which are more complex will deteriorate more quickly. The legal review revealed several cases where the officers were not re-trained in the VNR technique on a regular basis (typically since the initial academy training) and this was associated with a deterioration of the officer's skill in applying the technique. Agencies incorporating the VNR are advised to consider the importance of frequent and mandated recertification training to maintain officer competency.

5. Use of Force Context

As mentioned previously, the VNR is not consistently placed within a use of force context in the Canadian law enforcement environment. The medical experts who contributed to this study opined that a properly applied VNR by a trained law enforcement officer is unlikely to result in serious injury or death.

The Criminal Code of Canada and related case law best describes deadly force as 'any force that is likely or intended to cause death or grievous bodily harm'. The medical research reviewed for this study does not support the placement of the VNR within the deadly force category. Plainly stated, the VNR, when properly applied, is neither likely nor intended to cause serious medical outcomes.

However, that statement does not imply that VNR application can be considered risk free. All modalities of law enforcement restraint carry with them an inherent risk of significant, unintended medical consequences. This concept does not render restraint modalities inappropriate for use particularly when the context of the situation indicates that restraint is appropriate. With respect to the VNR, it is the consensus of the medical panel that a reasonable, properly trained officer could apply a VNR without apprehension that it would result in serious bodily harm or death. VNR is simply a high level of 'Empty Hand' or 'Physical Control' and should be so referenced within the existing spectrum on the National Use of Force Framework (and similar frameworks/models).

6. Future Research

One of the most critical aspects in the incorporation of any use of force methodology into police practice is a clear understanding of the injury potential from using that force.

Further physiology-based research into how and why properly applied vascular neck restraints generate subject compliance is unlikely to answer questions regarding risk profile in the population who is exposed to VNR. Rather, properly conducted epidemiologic research into risk profiles will lead to appropriate answers in defining the relative risk of the restraint process in the population in question. Only restraint methodologies used in practice can be evaluated; VNR will likely be one of those restraint methodologies in many police services. In order to define the risk profile, the hold will have to be evaluated for its performance in the relevant population across a wide variety of subject characteristics and types of encounters.

In order to determine the correct and exact risk profile of VNR, research may not simply be an accounting exercise with evaluation by non trained analysts. Simple calculation of frequencies of events is unlikely to yield proper conclusions, particularly if the data collection period is short or the number of cases evaluated is small.

In order for epidemiologic research to lead to accurate conclusions, data must be systematically collected and evaluated correctly using the principles of epidemiologic evaluation with consideration for the confounding and interacting elements in the restraint process on the whole. The current environment of overreaction to isolated anecdotal events cannot help but create a reactionary state in which potentially valuable and low risk technologies are abandoned in favor of the next best touted alternate with an unproven profile. Risk management and appropriate data evaluation is not synonymous with abandonment of policies and procedures as a result of single adverse outcomes. While police personnel and the general public are significantly affected emotionally by the death of a person in custody, this type of modification in practice in response to isolated events is dangerous for all concerned.

Evaluation of policies and outcomes must consider the context of the situation on the whole and the known body of evidence at the time of the event. Research is a dynamic process and more data will become available over time. However, policy making and procedure implementation occurs at the current moment meaning evaluators of outcomes must be responsible to the state of known research at the time. Commentators and evaluators of police procedures such as judicial investigators and coroners' offices must be responsible to the research as it evolves and keep current as new evidence emerges and old theories are rejected.

The authors recommend the following future action be taken:

1. A National medical/law enforcement study be conducted that focuses on the relationship between persons restrained by police and the correlation to harm (injury and death). Currently there is no study or database which can assist officers or administrators in measuring the potential for harm between the various types of force options available.

2. A joint medical/law enforcement study on the issue of excited delirium and restraint methodology be conducted. This study would permit administrators to make best-practices policy and training decisions based upon the most current research in order to maximize the survivability potential for subjects experiencing excited delirium who must be restrained by police.

3. A standing National Medical Advisory Board be created and resourced. This Board would act as an independent, objective oversight group that would be an available resource to all law enforcement agencies in Canada. The board would be accessible to provide timely information to agencies with respect to:

    i. Immediate involvement in in-custody death investigations. To liaise with the pathologist or coroner of jurisdiction and ensure all necessary measures are taken and current science is applied to arrive at sound medical conclusions.

ii. Review of medical reports or records in use of force investigations where the complainant alleges significant injury.
iii. Assist agency researchers, trainers and administrators with medical reviews of new technologies, use of force systems or agency practices and policies.

Supported by the Canadian Association of Chiefs of Police (CACP), the National Medical Advisory Board could be attached to and accessed through the Canadian Police Research Centre.

End of Executive Summary

Declarations of Conflict of Interest

- Chris Butler: seconded by CPRC for the writing of the report; instructor in PPCT shoulder pin restraint; instructor (ACCT) in NLETC LVNR®.

- Dr Christine Hall. Financial remuneration by the CPRC for the coordination of and writing of this report. Compensation at rates less than income generated in clinical practice.

- Dr Bob Sheldon. No conflict. Compensation waived by Dr Sheldon.

- Dr Michael Hill. Financial remuneration by the CPRC for time spent reviewing documentation and preparing report. Compensation at rates less than income generated in clinical practice.

- Dr John Butt. Financial remuneration by the CPRC for travel and time spent reviewing documentation and preparing reports. Compensation at rates less than income generated in clinical practice.

Research Methodology

1. Evidence-Based Approach

Advances in the interest in sudden death proximal to police restraint combined with the need to further evaluate restraint methodologies prompted this literature review, expert consensus and report.

An evidence-based approach with scientific methodology was undertaken in order to accurately and completely review the available data surrounding vascular neck restraint and its implementation by law enforcement agency personnel. Utilizing comprehensive literature review combined with medical and police expert consultation enabled evaluation of the vascular neck restraint in its intended form for police application with scientific evaluation of anticipated negative outcomes.

Medical experts participating in this review believed that consideration of all details of adverse outcomes was essential in the interpretation of adverse events and in consideration of the general safety and utility of vascular neck restraint by trained police personnel. Reviewers also recognized the need to understand and include the notion of adverse events in the context in which the restraint is intended to be used by trained police personnel - a dynamic and rapidly changing violent situation. It is understood that the application of a vascular neck restraint is not a simple, stagnant procedure involving a willing subject. Reviewers considered the potential negative aspects of proper vascular neck restraint use as well as negative aspects of improper use. To that end, both the literature review and medical expert consensus was undertaken with a bias toward detecting adverse outcomes when vascular neck restraint was applied by trained and untrained police and non-police personnel.

Adverse outcomes of police restraint have been the subject of publication bias as nearly all adverse events following the application of police restraint are published either in medical, police or legal venues without similar publication of positive outcomes and appropriate applications that had the desired effect. With respect to reviewing vascular neck restraint, it was anticipated that real and consistent medical concerns with the application of vascular neck restraint (or other types of neck hold) would lead to an over representation of case reports, case series or expert consensus reports in the medical literature. With respect to this review, such publication bias was considered a desired event since the specific intent of this report was to uncover potential adverse effects of vascular neck restraint. Even with the anticipation of this bias, there was a paucity of medical literature available for review.

A systematic review or meta-analysis of available literature was not possible since there were simply no cohort studies of any description involving the use of neck restraint by any group in practical application. No body of data exists to be pooled, compared or analyzed using traditional systematic review methodology. Thus, the single cohort study surrounding outcome of neck compression was reviewed in detail and the available anecdote or single case reports were reviewed for their characteristics and for similarities or consistencies in theme, outcome or adverse events.

2. Discussion of Causation:

Events occur because of multiple converging reasons. However, in discussions of causation, it is important to consider that there are multiple interpretations of the term. Causation is not the same as association in statistical or scientific terms. The two terms are not interchangeable, yet the practice of inferring that an association is the same as causation occurs commonly when adverse events following police interaction are reported in the public venue (media), fostering confusion in the interpretation of medical/coroners' reviews.

In terms of physiology, the concept of causation can be broken down into two events. *Necessary causes*, or those processes which must be present for the physiologic event to occur and *contributing causes*, whose presence makes the necessary cause more likely. For example, a myocardial infarction (heart attack) is caused when adequate blood stops flowing down a coronary artery. The necessary cause of the myocardial infarction is the cessation of blood flow. Contributing causes in that instance would be things more likely to generate the decrease in blood flow such as high cholesterol, atherosclerosis, cigarette smoking and a family history of heart disease.

In some cases it is the sum of the contributing causes that ultimately allows the physiologic event to occur. In the example of the myocardial infarction, a patient might not have a completely blocked coronary artery, but during extreme physical exertion the artery is not able to supply enough blood to the hard working heart and a myocardial infarction occurs when the demand outweighs the supply (the necessary cause: inadequate blood flow). In other words, the right cascade of events happened to make the necessary environment present.

However, in autopsy, pathologists may or may not be able to elucidate all contributing causes or identify a necessary cause if that necessary cause leaves no trace. For example, some derangements in a person's blood (such as pH changes) cannot be evaluated after death as the state of death further alters the person's blood chemistry. Details of the case may be missing that enable the pathologist to understand the complex situation leading up to the event. There may not be specific traceable pathology to be revealed after death leaving the cause of death as unknown.

Even more troublesome, is that legal evidence rendered by coroners and medical examiners at legal proceedings and inquests are concerned with another term, that of "proximate cause". Proximate cause reflects the coroner or medical examiner's reference to events immediately preceding the individual's death. In other words, was the last thing that happened to the individual tied in any way to the death? If a person ate a fast food sandwich immediately prior to having a heart attack, ingestion of the sandwich would be assessed as part of the proximate cause of the heart attack. Intellectually, it is unlikely that the sandwich itself caused the heart attack, but ingestion of fast food functions as a marker for the cascade of events (poor diet, high cholesterol, etc) leading to coronary artery disease in the victim. However, in cases of sudden death in custody, the notion of proximate cause often leads to confusion and the incorrect inference that the last event was directly responsible for a death rather than functioning as part of a complex, multifaceted set of events leading to death.

For the purposes of this review the notion of causation was more strictly evaluated. The application of vascular neck restraint (factor of interest) and subject death (outcome of interest) were assessed for their cause and effect relationship according to Hill's criteria

for epidemiologic causation. Hill's criteria for causality state that in order for a factor to be determined causal in an outcome, there should be a temporal relationship between the factor and the outcome, there should be a dose-response curve, there should be biologic plausibility for the causal relationship, there should be consistency across studies, there should be no outcome of interest if the factor tested for its association is removed and the statistical strength of association between the factor of interest and the outcome should be consistent.

For a temporal relationship to exist, it means that the outcome happens at some point after the event of interest. A dose response curve indicates that more outcomes are likely if more events happen, or in the case of medications, more outcomes happen in proportion to the dose of the drug (for example, side effects are decreased when the dose of the drug is more carefully adjusted to the patient's weight; or more therapeutic effect is seen when a dose is appropriately increased). Biologic plausibility refers to the notion that it makes biologic sense that one thing causes another to happen. For example, it does not make biologic sense that placing an individual in a cold environment would cause the body temperature to rise continuously.

The remaining concepts in Hill's theory of causality are self explanatory in that different research studies should find the same thing if a true causal relationship exists, and the strength of that association in statistical terms should be consistent if a true cause and effect relationship exists.

It is easy to appreciate that Hill's criteria for causation adapt the notion that a factor must have a consistent and reproducible effect on the outcome rather than simply being present at the time of the event. It would be scientifically naïve to attribute a causal responsibility to a factor which, when removed or not present, does not alter the outcome.

Exhaustive data does not always exist for all treatments, interventions or procedures. Often assessment of the biologic plausibility of an event's effects on an outcome is the first step in evaluating whether a casual relationship can or does exist. At other times it may seem as though a biologic plausibility exists but when the factor or event is removed or was never in place, the outcome still happens, casting significant doubt on whether the event in question has any causal effect on the outcome. Such is the case in restraint methodology.

3. Literature Search:

Literature search and inquiry into police training manuals, publications and case law and other judicial proceedings was over-inclusive and included inquiry/evaluation of all references to any sort of neck holds, neck restraints, choke holds, head locks in order to overrepresent adverse events, concerns, coroners' findings, pathology findings and legal judgments or consideration. The authors followed an intention to treat model, meaning that if the intent of the individual was to apply any sort of neck hold (including vascular neck restraint) in an attempt to control an individual's actions, that data was evaluated regardless of the outcome of that hold.

Only one prospective cohort study from the 1940's was available that analyzed the outcome of neck restraint prospectively rather than retrospectively after fatal outcome or adverse event. With the knowledge that significant publication bias existed and the knowledge that virtually no further studies have been published evaluating one sort of

neck hold against another or looking at outcomes (positive and negative) over a period of time, attention was then paid other types of articles surrounding neck holds. Specific situational characteristics of the application of the hold, the type of hold applied and the characteristics of the individual applying and receiving the hold were investigated to see if consistent relationships/features could be determined from those articles and from available case law.

Key words for the literature search included: ***neck restraint, neck hold, vascular restaint, vascular hold, choke hold, head lock, carotid restraint, carotid hold, shime waza, death, adverse outcome, in custody death, police, restraint***. Bibliographies of articles retrieved from this search were hand searched for other specific and relevant articles, which were subsequently pulled and reviewed.

In order to gain a wider understanding of all events pertaining to manipulation of the neck, literature searching was also extended to include other types of adverse event reporting during manipulation of structures of the neck such as that surrounding chiropractic manipulation, carotid sinus massage in medical circumstances, and reports of strangulation or asphyxiation in the out of hospital environment or within context of restraint by police and non police personnel. Key words for these searches were entered in combination and included: ***carotid sinus massage, chiropractic, manipulation, neurologic, adverse outcome, stroke, carotid dissection, vertebral artery dissection, death, strangulation, asphyxiation.***

Judicial files for Canada and the USA were queried for a similar set of key words and included findings and investigations for police and non police utilizations of any and all types of neck restraint or neck holds. Publicly available databases containing case reports from legal findings were searched including Americans for Effective Law Enforcement (AELE), the Canadian Legal Information Institute (CANLII), FindLaw (www.findlaw.com), Cornell University (www.law.cornell.edu), The National Institute of Justice (NIJ), the British Home Office and the University of Calgary Law Library. In addition, 'Legal Aspects of Policing' (Ceyssens) and 'Summary of U.S. Supreme Court Decisions' (Looseleaf Law Publications) were accessed for relevant case articles. Reports from fatality inquiries were obtained through requests for information pertaining to the specific cases of interest made directly to the responsible public body.

Training books, manuals, procedures and policies surrounding neck restraint from Canadian and American police agencies were reviewed in detail for specifics of the technique, training procedures and documentation and to ensure consistency of a definition for vascular neck restraint and its specific physical application.

4. Expert Medical Opinion/Consultation:

Medical experts consulted had specialties relevant to the investigation of this technique. During the course of reviewing articles surrounding the application of neck restraint, it became obvious that the three specialties most relevant to this review included Cardiology/Electrophysiology, Neurology/Stroke and Pathology. Canadian medical experts with credible and advanced pedigrees in these specialties were specifically sought.

It is important to note that not all physicians are credible experts in all fields of medicine and that detailed knowledge regarding many facets of human physiology may only be

found at the specialist and sub-specialist level. Medical experts chosen to participate in this review were chosen because of their expertise at the specialist level as well as their relevant subspecialty training and research interests. Each of the experts involved was the first to be approached, and the group of experts assembled represents elite level expertise.

Medical experts were assigned review of articles relevant to the scope of their practice and to the concept of neck restraint overall. Each expert reviewed all articles assigned to them and was free to request and review any other articles as desired. Medical experts were encouraged to perform their own literature searches as desired to ensure that all articles of relevance had been retrieved. (For the complete list of medical articles and other research reviewed for this study, refer to appendix B – Bibliography).

In order for medical experts to understand the police application of vascular neck restraint, samples of multiple training manuals and police policies were supplied for their review. Combined review of medical and police literature allowed the medical experts to frame their opinions in terms of both medical data and actual street implementation practices improving the generalization of their recommendations to the police environment.

Expert opinion and consensus were completed with specific attention to the risks/anticipated issues under the understanding that a vascular neck restraint would be properly, correctly and consistently applied according to the definition provided in this report.

RESEARCH QUESTIONS set forth for this review:

For research questions, vascular neck restraint is specifically defined elsewhere in this report. Properly applied is defined as the application of the hold as specifically trained by appropriate instructor personnel. For research questions concerning other “neck holds”, the concept includes any and all variations of neck hold, correctly and incorrectly applied in police and non police situations.

1. In persons undergoing restraint utilizing vascular neck restraint what is the physiology by which a properly applied vascular neck restraint causes loss of consciousness?

2. In persons undergoing restraint utilizing vascular neck restraint are there clinical or situational markers to guide officers to know when vascular neck restraint has been effective and can be discontinued?

3. In persons undergoing restraint utilizing vascular neck restraint is there medical evidence to suggest that application of a vascular neck restraint is expected to cause grievous bodily harm or death?

4. In persons undergoing restraint utilizing vascular neck restraint are there specific situations in which grievous bodily harm or death may be anticipated?

5. In case law specific to the utilization of vascular neck restraint or any other type of neck hold, can themes or recurrent occurrences be determined that reflect individual or situational characteristics anticipated to lead to adverse outcomes?

6. In persons undergoing restraint utilizing vascular neck restraint or other neck holds, do databases or other recording systems exist that document characteristics of the vascular neck restraint including numbers of utilizations and number of adverse events?

National Study on Neck Restraints in Policing

Introduction

Within Canada (and North America generally) there continues to be an increasing number of events in which police officers encounter subjects who are not responsive to standard law enforcement compliance control techniques. Typically, these subjects are under the influence of central nervous system stimulants or hallucinogens which presents a challenging restraint and control problem for responding police officers.

Even considering the advancement of less lethal technologies such as the conducted energy device (TASER®) and other devices such as impact projectiles it is clear that in many occasions officers are required to know and utilize effective empty hand physical techniques to garner subject control since access to other tools or devices is either not possible or not appropriate. A vascular neck restraint is an empty hand control technique which does not rely upon the subjects' ability to feel and respond to pain stimulus to be effective.

Many Canadian police agencies have a vascular neck restraint control technique within the use of force framework. However, vascular neck restraints, like many other forms of police restraint have been subject to intense public and media scrutiny. Controversy surrounding the use of neck holds in general has resulted in dramatic variance amongst police agencies with respect to policy, course training standards and lesson plans pertaining to the neck restraint. Indeed, some police agencies are "banned" from using a vascular neck restraint technique, while other agencies teach and employ the technique at the active aggression or assaultive category. At least one Canadian police agency places the neck restraint at the deadly force category. However, it is also common for the members of police agencies to utilize the technique at a lower threshold due to the effectiveness of the restraint technique.

A review of the legal history of the neck restraint in policing as well as previous medical literature shows that there is little agreement upon professionals as to the risk of the neck restraint technique, the type of neck restraint that is 'safest' and the threshold at which an officer can legally apply the technique.

As a result of these inconsistencies, the Canadian Police Research Centre (CPRC) was tasked with facilitating a review of the current research pertaining to neck restraints in the policing environment and thus the National Study on Neck Restraints in Policing was borne.

The National Study on Neck Restraints in Policing report provides a medical review of the existing literature and research in the field of the police use of vascular neck restraints. This review includes discerning between the various types of neck restraints, the risk of injury from application of the restraint, medical implications and any collateral issues pertaining to case law and training. Finally, the medical panel makes recommendations for future research and other actions to be conducted.

Ultimately, the final report on neck restraints in policing provides a framework around which administrators can make informed decisions regarding:

- Whether or not to teach / authorize the vascular neck restraint,
- Development of course training standards and lesson plans,

- Application threshold within the use of force continuum,
- Training and recertification recommendations,
- Policy development,
- Risk management

History of Neck Restraints

The use of neck restraints in the policing environment is a recent event, historically speaking. During the 6th century (A.D.) the Buddhist priest Dharma identified several 'vital points' on the human body. Many of these points were discovered to reside in the neck. This knowledge was passed to the Shaolin monks in China and was incorporated into the Chinese martial arts of kung fu and wu shu. As the development of trade emerged between China and Japan, this knowledge began to influence many of the Japanese martial arts.

In the 15th century, King Hashi united the three kingdoms of the Ryukyu Islands and in order to maintain rule over these lands the use of weapons were forbidden amongst the citizenry. In was amidst this culture that the secret study of empty hand combatives flourished.

In 17th century Japan the development of ju-jitsu saw further training and refinement in the study of the various neckhold techniques all of which came to be globally referred to as '*shimewaza*'. In 1882 ju-jitsu master Jigoro Kano developed the art of Judo (which means literally, *gentle way*) and it is here we see the creation of a martial art with a focus on sporting competition. Kano's vision of Judo excluded many of the more dangerous techniques inherent in ju-jitsu, however the various shimewaza techniques were included in Judo and remain an integral part of international Judo competition to this day.

During the later part of WWII many American servicemen serving in the Japanese theatre became exposed to Judo and began to study and practice the martial arts. In the late 1940's and 1950's many of these servicemen returned to the United States and entered law enforcement as a civilian career. Martial arts training and techniques including the use of neck restraints subsequently became imbedded in law enforcement use of force training and were introduced into policing.

In the 1960's and 1970's neck restraints were commonly taught in many police agencies across North America as a martial arts-based technique and the technique was used operationally with great regularity. In the 1980's the use of the neck restraint in policing came under the microscope as a result of a series of fatalities following the law enforcement use of the technique. In a study commissioned by Justice Wallace Oppal in 1993, the reports' author Gil Puder offers three explanations why neck restraints were attributed to deaths:

1. *a shallow understanding of the techniques used, drawn predominantly from judo and ju-jitsu practices;*
2. *inability to accurately transmit knowledge across language barriers (ie. From Japanese to English);*

3. *training and research in use of force practices having a low priority for agency administrators.*[3]

It is also important to consider that during the 1980's when many of these deaths occurred, the medical community (including coroners and pathologists) did not typically embrace the notion that a subject could succumb to a complex constellation of signs, symptoms and situation features; rather death was ascribed commonly to the event occurring most closely to the subject's death. Thus, it was common for the proximate event, usually police restraint, to be implicated directly for the subject's death rather than the subject's underlying medical conditions, state of drug intoxication or acutely agitated state. During the early and mid 1990's this same paradigm was observed with subjects that died following exposure to OC spray and conducted energy devices have been implicated since their inception. Extensive research has now been conducted into the medical effects of OC spray with good medical evidence that OC spray should be exonerated as a potential direct cause of an adverse medical outcome.

Concomitantly, there has been a dramatic increase in medical literature surrounding the acutely agitated state in which many subjects present. The state of an altered level of consciousness coupled with impaired perception and cognition has now been recognized by a large number of medical practitioners as a state of *excited delirium*.

When a subject dies in a state of excited delirium during the police restraint process, there is typically very little evidence gathered at autopsy that points to the cause of death. This being the case, forensic investigators are left to examine the 'proximate event' or that which occurred immediately prior to the subject's death. As a result, there have been many cases where the proximate event – the mode of restraint – is held responsible for the death even when little or no pathological evidence exists to demonstrate that causal relationship. Over the past three decades, restraint modalities have been modified, invented, reinvented and even abandoned with virtually no change in the incidence of death proximal to police restraint. Yet, deaths in custody continue to be ascribed to the modality of restraint. Even when the features of subject presentation and death are strikingly similar and the mode of restraint dissimilar, the restraint continues to be implicated as the proximate cause of the death. The risk inherent in this type of causation was identified in research over 2500 years ago when the term '*post hoc ergo propter hoc'* was coined. This Latin phrase which means literally 'after this, therefore because of this' identifies the fallacy of logic that ascribes causation from one event to another when there is nothing more than order or sequence. This cause-and-effect rationale, also called 'coincidental correlation' which links a subjects death to the mode of restraint simply because the one occurred directly following the other, is a serious issue for law enforcement administrators. Police agencies and individual officers have been found responsible and criminally and civilly liable for subjects' deaths due to a false perception of cause when only sequence exists.

As a result of extensive civil action against some law enforcement agencies administrators became understandably sensitive to the use of neck restraints by their officers. Additionally, utilization of the term "choke hold" or "strangle hold" by laypersons, the media and legal personnel without distinction between neck restraint involving the airway vs. neck restraint involving only the vasculature of the neck made for easy confusion and implication of the holds as necessarily harmful. Coincidentally, during the late 1980's and early 1990's oleoresin capsicum spray (OC spray) was making inroads

[3] Neck Restraints as a Use Of Force; report to the Policing in BC Commission of Inquiry; Mr. Justice Wallace T. Oppal, Commissioner; Gil Puder; 1993/08/20

into the policing culture and was being touted as a 'panacea' which would practically eliminate the need for officers to engage in hand to hand combat with subjects. As a result of OC spray's rapid adoption by police agencies, many administrators used this as an opportunity to either prohibit or significantly restrict the use of the neck restraint.

However, OC spray was found to have limited effectiveness on certain categories of subjects (such as those under the influence of drugs, emotionally disturbed or strongly goal oriented individuals) and therefore officers still found themselves engaging in empty hand combatives against violent individuals, many of whom were not responsive to standard pain compliance techniques.

More recently, the development of conducted energy devices such as the Taser® has resulted in some agencies adopting the device and eliminating the neck restraint as a viable option. The lessons of history afforded by OC spray are doomed to be repeated as the availability of any device or tool - regardless of that tool's wide utility - has failed to completely eliminate the need for officers to use empty hand tactics.

The availability of appropriate empty hand physical control techniques will likely always be required because:

1. Violent events by their very nature often occur spontaneously, at extremely close distances (within arms' reach) and seemingly without warning to the officer(s) involved, practically eliminating the option of employing an intermediate weapon, and
2. Devices and tools are mechanical or electronic contrivances that are prone to failure either due to malfunction or user error, and
3. There remains a certain category of individuals (such as previously mentioned) on which intermediate weapons such as OC spray and even conducted energy devices will not be effective.

This is not to imply that mechanical or electronic devices are not feasible options for police agencies as they are responsible for reducing the degree to which hand to hand combatives are required; however administrators and trainers must realize that an appropriate balance is required in the use of force training paradigm.

Types of Neck Restraints

In the sport of Judo all neck restraint variations are referred to under the global term *shimewaza.* Within this grouping, neck restraints can be further segregated into two categories; carotid (or vascular) and respiratory.

Respiratory Neck Restraints

The respiratory or 'arm bar' neck restraint is facilitated by applying direct mechanical pressure or compression over the structures in the anterior portion of the throat. Although this technique also can result in compression of the carotid arteries (leading ultimately to unconsciousness) the pressure created on the front of the throat also causes asphyxiation by compressing the tracheae and restricting or inhibiting the subject's ability to breath. There are several different variations on respiratory restraint techniques and many of them are still utilized safely in the sport of Judo, some of which include:

- *mae hadaka jime* also known as the guillotine choke.
- *hadaka jime* also known as the rear naked choke
- *katate jime* or the one hand choke

In law enforcement however, the arrest of a violent individual is a dynamic event without the benefit of a referee and the application of respiratory restraints (intentionally applied or inadvertently applied) have lead to serious bodily harm or death of subjects. Compression of the anterior structures of the throat can lead to serious injury to the cricoid cartilage, the thyroid cartilage, the hyoid bone, the larynx, and the trachea. When improperly applied with an upward pulling motion, respiratory neck holds have been implicated in vertebral fractures.

The goal of applying a neck restraint is to obtain subject compliance (either voluntarily or involuntarily). However, restriction of the airway is likely to increase the physical resistance of the subject due to the perceived inability to breathe. A person who is unable to breathe will not be concerned with conscious compliance since the overarching concern to the midbrain will be to recover the breathing apparatus at the expense of all other cognitive behaviour; thus leading to increased resistance against restraint. The hold must also be held for a protracted period of time as loss of consciousness induced by airway occlusion is not a rapid event. Neck restraints that rely on airway occlusion are therefore counter intuitive to the effective restraint process

The medical experts and law enforcement trainers involved in this project all opined that a respiratory neck restraint is likely to cause serious bodily harm or death and therefore any neck restraint that permits compression of the structures in the anterior portion of the neck should not be authorized for routine use. The obvious exception for application of a respiratory type neck hold is in deadly force encounters when the use of such force and other such forces can be clearly justified.

Vascular Neck Restraint (VNR)

A vascular neck restraint is a technique that applies lateral compression to the vascular structure of the subject's neck resulting in partial or complete occlusion of the carotid arteries as well as occlusion of the jugular veins. A properly applied VNR will not compress or harm the structures located in the anterior portion of the throat nor is it likely to cause harm to the cervical vertebrae; the subject's ability to breathe is not adversely affected during VNR compression. The subject is likely to experience varying degrees of pain or discomfort due to the compression and stimulation of various nerves that are affected such as the Hypoglossal nerve, the Brachial Plexus Origin and possibly the Supra scapular nerve.

Types of Vascular Neck Restraints

Currently in law enforcement there are two typical variations of the vascular neck restraint (VNR):

1. *Katajuji-jime* or bilateral vascular neck restraint, and
2. *kesa gatame* or shoulder pin restraint

1. Bilateral vascular neck restraint

During this VNR application, the arm of the arresting officer encircles the subject's neck in such a manner that the crook of the elbow, or antecubital fossa, is placed over the anterior portion of the neck. The biceps region of the upper arm and the forearm compress both sides of the neck simultaneously. The non-restraining arm of the officer assists with bilateral compression and stabilization of the head and neck by grasping the hand or wrist of the restraining arm. As a result of the fulcrum effect created by the biceps and forearm, there is minimal pressure placed directly on the anterior throat structures and airway compromise will not occur. Pressure applied to the back of the subject's head locks the chin in the elbow pocket and prevents the hold from becoming a respiratory restraint.

When properly applied under maximal compression the typical subject will experience loss of consciousness within 7-15 seconds.

Figure 1
Katajuji-jime
Bilateral Vascular Neck Restraint.

2. Shoulder pin restraint

The shoulder pin restraint, a form of VNR taken from the Judo technique of *kesa gatame,* requires the restraining officer to place one shoulder under one of the subject's shoulder girdle forcing the subjects arm up vertically. The officer then places the wrist of the restraining arm along the opposite side of the subject's neck, just below the mandible and the elbow of the restraining arm is placed over the subject's sternum. The non-restraining hand then reaches behind the subject's back and grasps the restraining hand. Compression is applied by using the inside of the restraining wrist to squeeze the neck downward at a 45˚ angle towards the subject's sternum.

When properly applied under maximal compression the typical subject may be rendered unconscious within 20 seconds.

Figure 2
Kesa gatame (shoulder pin) restraint being applied.

Vascular Neck Restraint – Physiological Processes

The VNR affects various structures of the head, neck and upper torso. When the officer applies the VNR to the subject, bony structures, cartilage, muscles, circulatory system and the nervous system are all affected to various degrees. It is a combination of these factors together that makes the technique capable of rendering the subject unconscious.

Bony Structures

The seven cervical vertebrae are present in the portion of the subjects' neck where the VNR is applied. When properly applied, the VNR will not adversely affect these bony structures. The subject's sternum is also affected as the officer applies pressure downward and inward on the subject's chest with the elbow of the encircling arm. The clavicle is affected as the officer applies downward pressure when transitioning the subject from a standing to a seated position.

The hyoid bone is a small 'horseshoe' shaped bone located deep in the throat under the tongue. A fractured hyoid bone is one of the common indicators of potential strangulation that forensic examiners (coroners) look for at autopsy. Not all injuries to the hyoid bone are as a result of strangulation attempts. A properly applied vascular neck restraint will not adversely affect the hyoid bone as there is no compression on the subject's airway. If the neck restraint is not a VNR but instead is a respiratory choke such as a bar-arm restraint across the front of the subjects throat a fractured hyoid bone is a very real possibility. The mandible is another bony structure affected by the VNR as the lateral compression will apply pressure to both sides of the subject's mandible. This results in discomfort to the subject as nerves located in this region are compressed against the bony process of the mandible. This discomfort can assist in obtaining voluntary compliance in subjects that are responsive to pain stimulus.

Cartilage

The trachea, which contains the thyroid cartilage and cricoid cartilage, is located in the region of the neck where the VNR is applied. The thyroid cartilage sits just above the cricoid cartilage and can be felt as a firm area just at the "Adam's apple". Just below the Adam's apple, the firmer cricoid cartilage can be felt which is the only ring of cartilage that completely encircles the trachea. Below the cricoid cartilage, are the remaining rings of the trachea, which are semicircles of cartilage, closed at the front but gapped at the back. The tracheal rings are more compressible than the thyroid and cricoid areas. The trachea is commonly referred to as the 'windpipe' and is the structure that allows for the passage of air to and from the lungs. A properly applied vascular neck restraint will result in only minimal pressure on these structures; damage or injury is extremely rare. Damage to these structures is easily appreciated on autopsies.

Muscles

The sternocleidomastoid complex originates on the sternum and clavicle travels upwards along the side of the neck and inserts on the mastoid process of the skull. The trapezius originates on the C-Spine and has attachments to the skull, scapula and the clavicle. The application of the VNR may result in temporary muscle soreness as a result of compression following a maximal compression application. These muscular structures will not likely be injured as a result of a VNR application.

Circulatory

1. Arteries: arteries carry oxygenated blood away from the heart. They are thick muscular-walled vessels and are the high-pressure aspect of the circulatory system. The arteries that flow in or near the neck are the subclavian, carotid and vertebral arteries. Arteries in the neck are not easily compressed without specific and direct pressure. Only the carotid arteries are directly affected by the VNR.

   Arterial blood is supplied to the brain chiefly through the internal carotid and the vertebral arteries. The vertebral arteries are not easily compressed because of the bony vertebral structures that they pass through at the back of the neck. The carotid arteries are occluded by the compression of the sides of the neck by the VNR application.

2. Veins: veins carry deoxygenated blood back to the heart; they are the thin-walled, low pressure aspect of the circulatory system and are easily occluded by external pressure. The veins involved in the VNR application are the external and internal jugular veins. The venous return from the brain is chiefly accomplished through the internal jugular and external jugular. These veins are surrounded by muscle tissue are readily occluded by cervical pressure.

Nervous System

There are numerous nerves that travel along the sides of the neck. The only affected nerve that *may* contribute to unconsciousness is the vagus nerve. The vagus nerve is one of many physiologic structures involved in controlling the heart rate and blood pressure. Artificial stimulation of the vagus nerve by external compression on the carotid bulb can result in a lowering of the heart rate.

The VNR results in compression of the carotid arteries, compression of jugular veins and compression of the carotid bulb, which stimulates the vagus nerve. The totality of these effects results in a decrease in blood supply to the brain, which in turn leads directly to altered levels of consciousness. Application of the VNR at maximal compression typically results in unconsciousness in 7-15 seconds, and consistently within 10 seconds. It must be understood that different subjects are affected by the technique in different ways and some subjects may not be rendered unconscious at all (no technique is 100% effective). At any rate, if the officer has not obtained either voluntary subject compliance or involuntary subject compliance (unconsciousness) after 30 seconds of application, the officer should disengage (discontinue the VNR) and consider other options where possible.

Terminology

A vascular neck hold is not a choke hold during which the intended mechanism of action is disruption of air flow/ventilation due to obstruction of the trachea or other upper respiratory structures or anterior neck structures. The vascular neck restraint is not an arm bar hold or a mechanical neck hold during which a similar obstruction of the trachea is anticipated to occur. Application of a vascular neck restraint does not include the application of a mechanical restraint such as bars, rods, bar-like devices, batons or flashlights. Vascular neck restraint does not gain control of the subject through pain or compression of the anterior structures of the neck.

It is imperative during review and utilization of vascular neck restraint that terms such as choke hold, “choking the subject out”, strangle hold, neck hold and head lock are not intermingled or interchanged in either formal or casual written or verbal discussion with the concept of a properly applied vascular neck restraint. It is partially the careless reference to vascular neck restraint using terms implying other mechanism of action that furthers misunderstanding both at the application and interpretation level of many situations. Police applications of restraint technology such as a vascular neck restraint are deserving of a professional and consistent nomenclature to separate them from the variable, inconsistent and often incorrect applications of restraint methodology by non police persons. Similarly, vascular neck restraint has also been commonly called the carotid sleeper hold in police training and publications. The authors recommend that this terminology, although basically correct in its physiologic suggestion, be abandoned due to the ease with which lay persons may confuse the terminology with the variable neck hold techniques used in professional wrestling. If specific reference to the carotid mechanism is desired, it is preferable to simply utilize the term carotid hold or carotid restraint.

Neurological Implications of the Vascular Neck Restraint

There is a significant physiologic difference between ischemia (inadequate blood flow) and hypoxia (inadequate oxygenation) when one considers an organ and its blood supply. It is important to understand that ischemia and hypoxia are not the same process. Restricting the blood flow to the brain will have immediate yet potentially reversible results; the effect of a low oxygen supply to the brain depends on the duration and severity of the low oxygen state.

The brain survives quite well and for many minutes without adequate oxygen. High altitude climbers (such as Everest expeditions) undertake significant physical exertion with severely compromised blood oxygen concentrations without the immediate expectation of acute neurological deterioration. Similarly, persons suffering from severe lung diseases that lower the body's ability to oxygenate the blood are able to carry out their activities of daily living without suffering recurrent losses of consciousness. However, cases of suffocation or drowning are fatal because the brain is deprived of oxygen quickly and completely over a period of several minutes. Because the body's blood supply is usually well oxygenated prior to the suffocation or drowning, it takes the brain tissue time to use up the available oxygen in the blood and suffer damage when more oxygen does not become available in the circulating blood. While the actual time required for such an injury to occur is variable and dependent on the overall health and physical state of the victim, most laypersons are familiar with the notion that complete lack of oxygen in the blood for approximately 6 minutes will likely result in a permanent brain injury or death.

Limitation of blood flow to the brain (ischemia of the brain) has more immediate consequence. An ischemic state is said to occur when there is inadequate blood flow to supply the needs of the organ in question. Blood may be perfectly well oxygenated but if it does not get to the organ, the organ cannot function normally. Temporary brain ischemia is actually well known to the public as nearly everyone knows someone who has fainted. In medical terms, a fainting spell is called a syncopal episode.

Syncope (fainting):

The cerebral cortex (or thinking part of the brain, also known to physicians as the forebrain) relies on blood supplied through four large arteries that enter the head. The major blood flow to the cerebral cortex comes through the carotid arteries in the front of the neck, and the remainder of the blood flow comes through the vertebral arteries that pass through a channel in each vertebra at the back of the neck. If there is inadequate blood flow through the carotid arteries to allow the cerebral cortex to function, the vertebral arteries can supply enough blood to maintain vital brain functions but are unable to supply enough blood on their own to maintain an alert state for the individual.

When both of the forebrain (cerebral cortex) vessels have a rapid and complete loss of blood flow, unconsciousness occurs in seconds rather than minutes. The loss of consciousness is due to the interruption in blood flow, not a drop in the oxygen content of the blood.

The most common example of this phenomenon is the simple faint. An individual experiences an unpleasant stimulus (such as visiting a family member in hospital or having their own blood drawn), which stimulates the parasympathetic nervous system. In young, healthy individuals with a large and effective vagus nerve, a drop in heart rate

and blood pressure ensues. Victims have the sensation of dizziness and “graying or blacking out”. If the victim fails to immediately heed these warnings by lying down, but instead remains upright, there is not enough blood pressure to move the blood up and into the cerebral cortex. The cerebral cortex does not get enough circulating blood to maintain an awake state and the victim faints and falls to the floor, often sustaining lacerations or bruises in the process. The person does not have a cardiopulmonary arrest but their loss of consciousness is sudden and complete. However, they regain consciousness nearly immediately and recall most, if not all, of the events surrounding the fainting spell.

Persons who experience recurrent episodes of fainting are often tested formally for their heightened vasovagal response (neuromediated syncope) by way of a tilt-table test. The physician’s objective in carrying out the procedure is to induce the conditions that produce the faint. In persons with neuromediated syncope who faint while undergoing tilt table testing, the complete loss of consciousness can last for 30-60 seconds and all recover completely. Inducing a loss of consciousness is not considered an adverse outcome, but helps to document the presence of the syndrome.

Virtually all causes of syncope in the ambulatory population are reversible. Despite the dramatic nature of a faint and the near hysteria that develops in bystanders when an individual loses consciousness, a loss of consciousness is not synonymous with impending death or a “near death experience”. Syncope in itself does not invoke irreversible consequences.

Medical research surrounding induced bilateral carotid artery occlusion, its symptomatology, and natural course does exist. In cutting edge research for its time, Rossen, et al, published a study of induced complete cerebral vasculature occlusion in 1945. The study was completed on male subjects who were incarcerated at the time of the study. Subjects who participated in the trial were exposed to rapid and complete occlusion of the vessels on both sides of the anterior neck by virtue of application of a rapidly inflating pneumatic neck cuff. Loss of consciousness was complete and occurred nearly universally within 6 seconds and was virtually always achieved in well under 30 seconds. The investigators determined that the effects of complete carotid occlusion were completely reversible even following 100 seconds of complete vascular neck occlusion. While much of the study’s methodology and ethics could be criticized under modern standards, no further body of evidence does or will exist to document the predictable and reversible course of transient loss of consciousness following occlusion of bilateral carotid arteries in ambulatory volunteer subjects. All subjects in that study were able to walk from the room of their own accord within 2 minutes of regaining consciousness.

Conversely, vascular neck restraint in North America has been heavily criticized for its hypothesized immediate and devastating cardiopulmonary and neurological effects. None of those claims have been supported by known physiological effects of transient carotid occlusion or by case reports, case studies, medical anecdote or more formal medical research.

Ischemic stroke (cerebral vascular accident):

Ischemic stroke or cerebral vascular accident is another sort of brain ischemia but much more localized to an individual vessel supplying any part of the brain. The carotid and

vertebral arteries branch once they enter the brain to send blood flow throughout the brain tissue. When one of those vessels becomes occluded (blocked) either partially or completely, injury can occur to the area of the brain supplied by that particular vessel. The severity of the injury depends on the degree of the blockage, the length of time the blood vessel is blocked and the amount of tissue supplied by the blood vessel.

Most people are aware of the concept of a major stroke, which occurs when an artery supplying a large area of the brain is blocked. In persons with atherosclerosis, the carotid arteries can become partially occluded because of the buildup of plaques in the artery walls. People experiencing such blockages are unaware of the blockage until the blood flow is reduced enough to limit the function of that part of the brain supplied by that particular vessel. Strokes can also occur when small bits of plaque or blood clot flow into smaller arteries, limiting the blood flow to a particular zone. A transient ischemic attack or "ministroke" is said to occur when the neurological defects resolve spontaneously; patients are considered to have had a cerebrovascular accident or "stroke" when the sensory or motor deficits do not resolve and there is CT scan evidence of brain tissue changes.

Persons suffering ischemic strokes do not usually present for medical care in an unconscious state. This is because a stroke usually only involves one artery or blood vessel at a time, and the ability of the cerebral cortex to maintain an awake state is facilitated by blood flow through the remaining arteries. For example, if a person had occluded a blood vessel on the left side of the brain in one of the small branches of the left carotid artery, there would still be blood supply to the cerebral cortex through both of the vertebral arteries and the other carotid system as well as the unaffected branches of the left carotid system to maintain alertness. Thus, the person is still awake and the symptoms they exhibit are specific to alterations in function of the affected area only. Symptoms usually include speech deficits, changes in sensation and/or loss of muscle activity. Persons very rarely become unconscious, although there are those who do. Those who do are those persons who have massive destruction of a whole half of the brain or the brainstem. These presentations are rare. Post mortem pathologic evidence of such destruction is not subtle in these cases.

It is very difficult to induce an ischemic stroke from external sources. However, there are two events involving manipulation of the neck that may lead to development of brain injury that will be discussed here.

Carotid sinus massage is a technique performed by physicians to slow the heart rate of individuals who are symptomatic from a fast heart rhythm (tachydysrhythmia) or to demonstrate development of a slow heart rate in individuals suspected of having carotid hypersensitivity syndrome such as elderly persons with recurrent unexplained falls or faints. In carotid sinus massage, the physician massages the patient's carotid artery on one side of the neck at the level at which the carotid bulb exists. Stimulation of the carotid bulb sends impulses to the nervous system mimicking a high blood pressure. The nervous system then sends messages to the cardiac reflexes to slow the heart rate and lower the blood pressure. This allows the physician to transiently slow the heart rate enough to evaluate the underlying rhythm on the cardiac monitor.

It is important to understand that the use of carotid sinus massage does not commonly induce unconsciousness when applied in medical situations. Bradycardia, or slow heart rate alone is not usually enough to cause a person to lose consciousness. If the blood pressure drops, most people still do not lose consciousness as the application of the

massage is one sided and for a short duration – the brain still gets enough blood flow to maintain a conscious state. Even in elderly persons suspected of having recurrent syncope because of carotid sinus hypersensitivity, carotid sinus massage is often performed multiple times to try and demonstrate it. In those who have carotid hypersensitivity, even direct carotid sinus massage may not slow the heart in up to 30%.

Carotid sinus massage is performed on one side of the neck at a time. This is done not for fear of inducing some sort of fatal dysrhythmia, but rather so that limitation of the blood flow into both carotids at the same time does not induce a simple fainting spell. Unlike the tilt table test, it is not the intent of the physician to induce a faint, rather to slow the heart rate enough to evaluate the heart rhythm.

In a minority of elderly subjects with preexisting carotid artery narrowing, carotid sinus massage can further limit the already reduced blood flow up the carotid artery inducing a transient ischemic attack or even a stroke. Again this does not induce unconsciousness but rather localized neurologic changes appropriate to the area of the brain involved and those changes are usually transient following carotid sinus massage. Neurological changes are not seen in young, previously healthy individuals who undergo carotid sinus massage because of a fast heart rate.

There are only a few case reports of ischemic stroke from carotid sinus massage performed in hospital and all of those cases involve elderly persons. There is no good scientific evidence to determine the exact incidence of stroke from carotid sinus massage despite its being performed thousands of times daily in hospitals across North America, although the incidence is thought to be approximately 0.1%. Such a lack of evidence for such a common procedure suggests that the induction of a stroke or focal neurologic deficit is indeed, rare.

However, rarity of an event does not render it impossible and the authors are aware of a single case of a law enforcement officer who became unconscious during a training session in which he both applied and received VNR at a limited duration and intensity. While he was not receiving VNR at the time of his collapse, the officer trainee subsequently died. No autopsy was performed although it is known that the officer had a previous history of a stroke and had previous carotid surgery to remove plaque from within his carotid artery. Unfortunately neither his employer nor his trainer were aware of this history, a history which suggested a potentially higher risk profile than that of the general population. Such a history is uncommon in young individuals.

Because of the possibility of carotid artery disease and potential neurological changes as described previously in this report, the authors of this report suggest that use of VNR be limited in visibly elderly persons. Utilization of a visible indicator is reasonable as the ability of police officers to ascertain a correct history regarding known cerebrovascular disease is profoundly limited and the presence of cerebrovascular disease is not anticipated in young individuals. This finding, coupled with the known epidemiology of atheromatous cerebral vascular disease leads the authors to make recommendations to limit application only in elderly subjects and only when other restraint methodologies are not available or practical.

The second type of neck manipulation that has been described as associated with stroke or other neurologic changes is forced rotary movement of the head and neck inducing dissection (tearing) of the inner wall of one of the four major arteries that enter the head. Dissection of either one of the carotid arteries or the vertebral arteries from neck

manipulation utilizing rotary motion/head turning is possible. Many persons voluntarily "adjust" their own necks, twisting their necks by pulling their chins around with their hands. Chiropractors frequently perform more eloquent neck adjustments as part of their routine professional practice. Chiropractic neck manipulation with adverse outcomes is thought to occur in 1/300,000 neck manipulations at most according to neurologists and as infrequently as 1/5,800,000 according to chiropractic study. There are individual case reports of persons sustaining vertebral artery or carotid artery neck dissections during falls, motor vehicle accidents and the like. There are no reports of vertebral or carotid artery dissection after police neck restraint nor are there any published pathological reports of the same.

The signs and symptoms or carotid or vertebral artery dissection must be considered for their relevance in the context of application of a vascular neck restraint for police reasons. In the past, sudden in-custody death with the sudden loss of vital signs in an individual following restraint application has been suggested to potentially result from artery dissection induced by the application of a neck hold. However, the signs and symptoms of carotid or vertebral artery dissection include a delayed presentation for medical assessment as the individual later develops headache and localized sensory and motor neurologic abnormalities. Patient presentations of vertebral or carotid artery dissection are not sudden cardiac and respiratory collapses. Pathological evidence of carotid or vertebral artery dissection is not usually elusive. This knowledge leads the educated observer to consider vertebral or carotid artery dissection an unlikely suspect in death of individuals following police application of a vascular neck restraint.

***Seizures*:**

Most persons who experience a fainting spell (either on their own or in a tilt table test) have a few stiffening, jerky movements of the arms and/or legs called myoclonic jerks, which are often misinterpreted as seizure activity. These movements are a function of the loss of cerebral control of the limbs and are not indicative or predictive of the onset of epilepsy or any other seizure disorder.

In Rossen's study of complete carotid occlusion in 1945, nearly all subjects experienced syncopal convulsions and myoclonic jerks which were always self limited and predictable. In practical terms for application of neck restraint, even if a subject's myoclonic jerks or syncopal convulsions were interpreted by the officer applying the restraint to be combative behavior, the movements last only for seconds and are thus unlikely to provoke significant prolongation of the hold.

Spinal cord and vertebral bony injury:

The human spinal cord is susceptible to damage incurred through stretching, kinking or shearing and is particularly easily injured if the integrity of the vertebral structure in the neck is compromised. Forces necessary to cause dislocation or fracture of the cervical spine are inconsistent with the mechanism of the properly applied vascular neck restraint. During correctly applied VNR there is no distraction of the neck, but instead the subject's head is flexed forward with the officer's arm under the subject's chin. There are no extreme ranges in motion in the neck induced by correctly applied VNR.

There are no medical reports of cervical spine fracture following vascular neck restraint in the published literature. A single legal case reviewed makes mention of a possible injury to the neck as a result of a VNR application. In that case, (The Queen vs. Magiskan, Ontario case heard in 2003 for an event that occurred in 1997) there were multiple comments over whether the subject had incurred a cervical spine fracture during a neck hold. In review of the case details, the alleged radiographic findings involved calcification of the posterior ligaments of the neck at C7, which is not radiographic evidence of an acute cervical spine fracture. There was dispute over whether the X-ray findings preceded the restraint event and the medical treatment of the subject following the event was not consistent with the treatment of an acute cervical spine fracture. The VNR was applied transiently in an effort to induce the subject to let go of a steering wheel in a vehicle, was not used to full compression and was not used to try and physically remove the subject from the vehicle by the neck.

Neck holds other than a correctly trained and applied VNR may have indeterminate forces on the neck, including neck holds applied for the purposes of extricating subjects from vehicles and under furniture. Variations of, adaptations to and utilization of attempted VNR from other than the standard rear application of the hold are impossible to evaluate for their cervical spine safety.

Cardiac Implications of the Vascular Neck Restraint

Much speculation has been generated surrounding the ability of a vascular neck restraint to generate a significant cardiac dysrhythmia that specifically leads to the loss of life in the individual subjected to the hold. In truth, the proof of or refutement of the existence of a specific life threatening cardiac dysrhythmia immediately prior to collapse of individuals subjected to police restraint is unlikely to be possible post mortem. The heart leaves no specific trail of evidence surrounding isolated cardiac dysrhythmia. An arrhythmia is not the same thing as a "heart attack" (myocardial infarction) despite consistent confusion of the two in the media, in lay person publications and in court proceedings. Coronary artery disease, myocardial infarctions and abnormal structural changes in the heart are easily detected at autopsy, Documentation of cardiac arrhythmias as isolated events can only be achieved on a cardiac monitor in a live state.

Since the final stage of all deaths in all mammals culminates in the termination of the heart's electrical and mechanical function regardless of the actual etiology of the original demise, the final rhythm of any dying heart is asystole. However, the actual cause of the terminal rhythm may or may not be easily elucidated.

Evidence surrounding the sudden deaths of individuals in custody and the existence of specific cardiac dysrhythmias is scarce. A few individuals have succumbed following police restraint in the presence of advanced life support personnel while on a cardiac monitor. None of the cases of adverse events following VNR reviewed for this report were on a cardiac monitor at the time of their demise. In each of the cases of death, police recognized a breathless and pulseless state and began CPR until life support personnel arrived.

Faced with a lack of a body of evidence to assess the characteristics of cardiac dysrhythmias in the population who have an adverse event or die proximal to the application of police restraint, attention must be turned to the concept of biologic plausibility. In other words, does the proposed causal relationship follow known biologic/physiologic processes, pathologic processes and patterns of disease in causing the event in question.

Frequently, investigators of sudden death after application of a neck restraint or a VNR have cited various abnormal baroreflexes as potential causes of collapse, fatal dysrhythmia and death. The recurrent themes in these findings have been the implication of carotid hypersensitivity syndrome, the carotid reflex or abnormal sensitivity of the vagus nerve induced by the vascular neck restraint as causal in the person's death. The biologic plausibility of these baroreflexive events occurring in significant enough fashion to induce a loss of consciousness due to a fatal cardiac dysrhythmia in most individuals subjected to a vascular neck hold must be assessed.

Carotid sinus and the baroreflex:

Simply described, human beings have pressure responsive receptors (baroreceptors) in their arteries to help regulate blood pressure. The best known of these baroreceptors are located in the aortic arch and in the carotid arteries. The carotid sinus is a pressure sensitive area located at the bifurcation of the internal and external carotid arteries in the neck. It is the more dominant of the pressure sensitive areas and the predominant stimulator of the baroreflex.

The baroreflex induced primarily through the carotid sinus is a complex set of physiologic steps by which humans regulate their blood pressure. In normal blood pressure states, the carotid sinus senses the presence of a normal state and the baroreflex fires to send a message to the brain stem that the blood pressure is adequate and no further adjustments are necessary. If the blood pressure drops, such as with hemorrhage or other hypovolemic states, the baroreceptor slows its firing and the brainstem responds by inducing the sympathetic nervous system to stimulate heart rate and stroke volume (heart contraction) to increase the blood pressure.

Stimulation of the carotid sinus with external pressure mimics a higher pressure state, causing the baroreceptors in the carotid sinus to fire more. The increased firing of the baroreceptors stimulates the brain stem to activate the parasympathetic nervous system (vagus nerve) to transiently slow the heart rate and lower the force of the heart's contraction.

In normal healthy individuals the baroreceptor reflex is both rapid and discerning, protecting the individual from wild swings in blood pressure and from over responsiveness to external stimuli. We have all felt the sudden lightheaded sensation of standing up too quickly, but it resolves rapidly and most of us do not faint. Were it not for this rapid discernment capability, human beings could not engage in such activities as play wrestling, gymnastics, aerobics classes, standing on their heads or wearing tight clothing around the neck.

Many cardiologists (and the cardiologist and the neurologist involved in the writing of this report) agree that the primary mechanism by which the vascular neck restraint induces rapid loss of consciousness in healthy persons rests with the occlusion of blood flow to the brain directly and not with significant disruption of baroreceptors or abnormal vagal nerve stimulation. In normal healthy individuals, direct and specific stimulation of the carotid sinus does not induce clinically significant, sustained changes in heart rhythm or blood pressure. This lack of response is so predictable that normal healthy individuals are commonly used as control subjects to evaluate diagnostic procedures such as tilt table testing or carotid sinus massage. Simply put, normal subjects in vascular neck restraints applied by police officers do not faint because of abnormal and persistent changes in heart rhythm or blood pressure. Their loss of consciousness, which occurs in seconds, is predominantly due to the ischemic forebrain physiology previously discussed.

There are individuals in whom syncopal syndromes are problematic and in whom alterations in the carotid feedback mechanism exist. There are two groups of individuals who enter this realm. The first is that group of young individuals with neuromediated (vasovagal syncope) and the second is persons over age 55 who have carotid hypersensitivity syndrome.

Neuromediated syncope

The concept of neuromediated syncope encompasses a number of disturbances of cardiovascular control. Patients with neuromediated syncope generally dilate their blood vessels in response to stress rather than constricting them. Most people with neuromediated syncope have onset of troublesome fainting from about age 13 and go on to have multiple syncopal events over many years.

Experimental studies suggest that sudden interruption of blood vessel tone is responsible for the sudden vasodilation of peripheral veins leading to the decrease in blood return to the heart. Hyperactive vagal nerve responses are seen only occasionally and are reported to be a response to the drop in blood pressure rather than the instigator of it. The causes of true vasovagal syndrome are thought to be a complex interplay between stretch receptors in the wall of the heart, paradoxical activation of baroreceptors and other neuro-endocrine processes. These disturbances are characterized by inappropriate drops in heart rate and dilation of both arterial and venous systems.

Vasovagal syncope, as opposed to carotid sinus hypersensitivity and other syncopal syndromes is extremely common. Patients who have neuromediated syncope are advised that people with multiple syncopal events prior to diagnosis are more likely to have further fainting events. While neuromediated syncope remains a diagnostic and therapeutic challenge, it is not a fatal condition. Drug therapy and behavioral therapy are aimed at reducing the unpleasant occurrences to improve the quality of a person's life, but are not necessary to prevent fatal outcomes.

Induction of a fainting episode (such as performance of a tilt table test or inducing a startle response) in a person with known neuromediated syncope is not a fatal event and does not lead to fatal cardiac dysrhythmia.

Carotid hypersensitivity syndrome

Slow heart rate (bradydysrhythmia) is the cause of syncope in 3-10% of persons over age 55 who seek medical care for fainting episodes. Thus, carotid sinus hypersensitivity is investigated when persons, typically over 55 (although there is one case report of a 47 year old woman), present with unexplained repetitive syncope. It is not investigated in young persons with syncope as a general rule. Even when carotid sinus hypersensitivity is expected to be present, physicians still apply carotid sinus massage in an attempt to uncover the underlying slow heart rhythm. The carotid sinus massage is considered positive if the patient experiences more than 3 seconds of asystole in response to the carotid sinus massage. In up to 30% of patients with suspected carotid sinus hypersensitivity, direct carotid sinus stimulation fails to generate the bradydysrhythmia. Even in the higher risk individuals with carotid sinus hypersensitivity, carotid sinus massage is still considered safe and there is only a single case report of carotid sinus massage inducing ventricular tachycardia in many decades of cardiac research.

While baroreceptor feedback mechanisms in carotid hypersensitivity syndrome and in neuromediated syncope may play some part in the loss of consciousness of specific individuals undergoing neck restraint, it is not anticipated to be fatal in either. If simple stimulation of the carotid sinus and its baroreceptors were fatal in individuals known to have recurrent syncope, therapeutic maneuvers such as carotid sinus massage and tilt table testing would have unacceptably high fatality rates and would have been abandoned decades ago. Additionally, carotid sinus hypersensitivity syndrome is not rampant in the general population and is generally investigated only in individuals over age 55 with a clear history of recurrent and unexplained syncope.

In the three legal cases reviewed in which the potential for carotid hypersensitivity syndrome was suggested as a potential mechanism for an adverse outcome due to neck restraint, even in the absence of a reliable history of recurrent unexplained syncope, the age of the individuals involved makes the contribution of carotid hypersensitivity

syndrome profoundly unlikely. While carotid sinus hypersensitivity has been detected in up to 23% of elderly persons who are reportedly asymptomatic, the same pattern has not been detected in young individuals less than 55 years of age.

Respiratory Implications of the Vascular Neck Restraint

Vascular neck restraint, when properly applied does not impinge the airway. Persons lose consciousness because of lack of cerebral perfusion not because of an occluded airway. Conversely, arm bar holds are by their nature primarily respiratory holds as are other neck holds applied from the rear of the subject which utilize implements other than a bent forearm to effect the pressure application. Primarily respiratory holds are ineffective at compressing the vessels in the neck and are expected to take minutes rather than seconds to be effective. There have been many cases in which holds other than the VNR have been applied, usually by non police personnel such as security guards and bouncers. Often the details of those cases suggest that a primarily respiratory type hold rather than an appropriate VNR has been used.

Untrained individuals do not understand correct technique and physiology of the VNR and do not recognize signs that the hold is other than a VNR. Untrained individuals do not have the understanding to tactically reposition should an attempted VNR be ineffective in several seconds. Similarly, trained individuals must recognize that adaptations of VNR technology to suit personal preference or adaptation to unusual circumstance necessarily change the integrity of the hold and its intended outcome and what was intended to be an “adapted” VNR is not a VNR. For example, frontal application of a neck hold, regardless of the intent of that hold is not application of a VNR and the adaptation does not confer a similar degree of safety to VNR.

Much discussion has been undertaken surrounding the likelihood of a VNR evolving into a different method of neck restraint during a difficult and prolonged struggle. It is certainly true that prolonged struggle is exhausting for all concerned and an individual officer would find it difficult to maintain effective maximal compression of a VNR for more than 30 seconds in a violently struggling individual. An appropriately trained individual should recognize that VNR will be effective at maximal compression well within that time line. If the subject is not rendered unconscious, then either the hold is not being applied at maximal compression or the subject is insensitive to VNR. Either way, the hold should be abandoned and tactical repositioning undertaken if possible. In situations that are life threatening for the officer or bystanders, the concept of repositioning may not be possible and the nature of the hold may be irrelevant.

Untrained individuals such as security guards and bouncers have no formal standardized instruction in the proper applications of or expectations for VNR and would not be sensitive to indicators of a failed application. Untrained individuals must not attempt neck holds. Holds learned in martial arts classes should not be condoned as adequate training for application in a professional situation by police officers or other individuals. In cases in which VNR is thought to have evolved into a respiratory hold, there should be pathologic evidence to suggest airway injury has occurred. Similarly, review of the events of the case prior to the adverse outcome can help investigators understand the circumstances under which the restraint process was undertaken and when problems began to arise. Specific attention must be paid to the technique of the hold to anticipate its expected outcome.

Medical Implications of the Vascular Neck Restraint – Specific Risk Groups

While the authors of this report agree that application of a properly trained and applied vascular neck restraint confers very little physiologic risk to the general population, certain medical conditions may increase the risk of many activities, including being restrained. These abnormalities may be known or unknown to the subject in question or to the passersby involved at the scene. Most abnormalities in physiology are not physically apparent to the police officer or others on approach of the violent individual requiring restraint. Relevant and appropriate health information is seldom available to the officers at the scene.

Officers have no medical training and should anticipate that subjects fall under the characteristics of the general population unless overwhelming evidence or clues presented to the officer suggest otherwise.

The following risk groups are identified in this report because of their potential (although not proven) increased risk specific to the application of a VNR and because of their potential identifiability for officers with no reliable medical information and no medical training. While the risk to individuals on the whole is anticipated to be low for the application of VNR, common sense would dictate that even a low risk procedure might be of higher risk in the following individuals.

It is understood that some of the risk groups identified below that would seem to be easy to determine still may or may not be inherently identifiable by officers at the time of the necessitation of force application. After the fact judgments once specific details come available about an individual are common, however police officers can only act on information readily available to them at the time of the event.

1. The obvious/visibly elderly.

The obvious elderly are defined as the group of people readily identifiable visually as being older than 65 by any average member of the population. Characteristics such as grey/white hair, frail body habitus, decreased mobility, and style of dress may be visual clues. It is essential to note that different ethnic groups age differently and as the population retains its propensity for vigorous physical activity, plastic surgery and other cosmetic enhancements, it may not be possible for police officers to correctly identify all elderly subjects.

Violent confrontation with elderly subjects is a real and tangible possibility for police officers as the current population ages. Pathological conditions such as Alzheimer's and other dementia syndromes can result in increases in violent outbursts and acute confusional states in the public venue, in private homes and in institutionalized care settings. Additionally, the characteristics of the population that is aging are changing. The baby boomers responsible for much social discussion and upheaval in the 1960's and 1970's will begin turning 65 years of age in 2011. Medical studies in Department of Veteran's Affairs facilities and by the Drug Abuse Warning network in the USA report that even 20 years ago, 2% of all methadone maintenance program patients in New York City were over the age of 60. Contrary to the theory that maturation results in recession of drug habits, drug abusers who continue a drug habit for more than 5 years do not decrease their drug dependency as they age. In studies of alcohol and drug dependence in Veteran's Affairs facilities, 13.7% of subjects over the age of 55 had drug dependency or drug induced psychosis; another 52% had alcohol abuse or dependency.

In spite of these data and because of the increased likelihood of cerebrovascular and carotid artery disease (including carotid hypersensitivity syndrome) as well as degenerative disorders of the cervical spine such as advanced osteoarthritis and severe rheumatoid arthritis, the obvious elderly are at potentially higher risk profile for adverse neurologic events following application of VNR and should be excluded from its application unless other restraint options are either unavailable or inappropriate. While it is recommended at this time that obviously elderly subjects are not exposed to VNR by police officers, whether other restraint methodologies confer a greater degree of safety as compared to the potential, but unverified risk of VNR is unknown.

2. Obvious pediatric subjects.

Pediatric subjects are generally considered to be persons under the age of 18. As children continue to mature at younger and younger ages both with physical stature and styles of dress and behavior, it is increasingly difficult to differentiate between older children and young adults. However, the pediatric cervical spine is at increased risk of bony instability compared to adults in children under 10 years of age but the bony profile of the pediatric cervical spine achieves adult characteristics by age 10. Thus, officers are generally cautioned against applying VNR to pediatric subjects suspected of being under 11 years of age.

To the uninformed, it seems unlikely that children will encounter police officers in a violent confrontation. However it must be recognized that illicit drug use, including the use of stimulants, by school aged children is a burgeoning problem. In the 2005 version of the USA's Department of Health and Human Services, Substance Abuse and Mental Health Services Administration survey on drug use in the United States, school surveys for recreational drug use revealed that 9.9% of school aged children aged 12-17 were current illicit drug users. Of those, 6.8% used marijuana, 3.3 used prescription drugs for nonmedical reasons, 1.2% used inhalants, 0.8% used hallucinogens and 0.6% used cocaine (smoked, injected or snorted). In children aged 12 to 13 years, 3.8% reported previous use of illicit drugs with a similar profile. In another study, McCabe et al documented drug use in students from Grade 6 to 11 and 4.5% of their sample reported previous use of stimulant drugs. These data have been consistently documented by other authors in the USA and Canada as well.

This documentable risk of illicit drug use in the pediatric population makes violent confrontation a real possibility. While appropriately applied VNR is not anticipated to cause extreme range of motion of the neck in any subject, the possibility for cervical spine hypermobility in young children suggests its use should be restricted in persons less than 11 years of age. Whether VNR is less safe than other restraint modalities in children remains to be seen. Revision of this recommendation, which is based on potential rather than demonstrated risk, may be required as illicit drug use and violent confrontation increases in the pediatric population.

To avoid confusion and the attempt to arbitrarily assign an age to a child involved in a violent encounter, it is recommended that VNR not be applied to obvious pediatric subjects unless other restraint options are either unavailable or inappropriate. Police officers cannot reliably detect chronological age in children who physically do not appear to be under the age of 11 and who are not accompanied by persons aware of their actual age. It is profoundly difficult to differentiate whether a child is 10 vs.12 by visual clues alone. The only helpful clue, if known, may be the grade of school the child is

attending. Most 12 year olds are attending middle school, and most 11 year olds are in Grade 6 or lower. This information may not be readily available. In those cases, the reasonableness standard of the situation and the individuals involved should be employed.

3. Obvious or known Down's syndrome

Police officers are commonly called to respond to violent outbursts in group homes or other institutional housing for persons with mental disability who are partially or completely integrating into societal structures. Police officers do not have extensive training in the recognition of various types of mental and physical disability and are reliant on the information given them at the scene to determine best courses of action for specific individuals. Many individuals with Down's syndrome live their lives successfully and independently and have no interaction with police other than that expected in normal day to day functions However, some individuals with Down's syndrome require ongoing care and are subject to behavioral outbursts that could be construed as violent.

Persons suffering from Down's syndrome have a wide variety of physical, mental and communicative disabilities and dysmorphisms not always readily recognizable as Down's syndrome to the average person or police officer. Many normal individuals have similar physical features to persons with Down's syndrome without the same physiologic risk profiles. Down's syndrome persons can often be identified visually as having low set ears, almond shaped eyes with creases at the corners by the nose, and a recessive chin often with a slack jawed or protruding tongue appearance. Down's syndrome persons may or may not be of short stature with a tendency toward truncal obesity. Cognitive and speech deficits are often mistaken for outbursts or violent behavior, and the infantile response mechanisms of many cognitively impaired individuals may lead them to attempt to flee to safety when confrontation erupts. Much caution is indicated in all interactions with cognitively impaired individuals.

Persons suffering from true Down's syndrome may be at increased risk of neurologic and cardiac events if exposed to VNR because of congenital instability of the Atlanto-occipital ligamentous structure in the upper cervical spine as well as abnormalities in upper and lower airway structure and a high likelihood of congenital structural heart disease. While appropriately applied VNR is not anticipated to put stress on the Atlanto-occipital ligamentous complex in any individual, because Down's syndrome patients do have greater than normal degrees of laxity in this area, it is recommended that application of neck holds be generally avoided in this population where possible.

It is common for attendants in group homes and other housing to have incomplete knowledge of the tenants various disabilities and medical histories. It is recommended that VNR not be used by police officers when they strongly suspect the presence of a visible developmental syndrome.

Other physical abnormalities or cognitive impairments and other psychiatric illnesses without physical abnormality are not the same as Down's syndrome and are not subject to the same restrictions.

4. Visible obvious pregnancy.

It is important to note that not all pregnancy is recognized by the woman herself. First trimester and many second trimester pregnancies are indiscernible physically by passersby including police officers, paramedics, nurses and physicians. Emergency departments routinely perform pregnancy screening in women as up to 5% of female patients requiring care for abdominal pain, vomiting or traumatic injury have unknown or undeclared pregnancy. Physicians are unable to detect all pregnancy by simple bedside observation. In obese women, even late stage pregnancy may not be physically obvious.

Moratoriums on the application of VNR on all pregnant women are impractical and nonsensical for the utilization by officers on the street since reliable information is unlikely to be available to the officer at the time of the altercation. Officers cannot be expected to visually detect all pregnancy.

It makes little sense to restrict the use of VNR on all women engaged in violent, resistive activity on the speculation that an early, undetected pregnancy may exist. Such restrictions may place female subjects at increased risk. Faced with a limited number of force options, officers may have no choice in violent altercations but to escalate to more lethal force options if effective, safe techniques are removed from their use of force protocols.

Health of the unborn fetus is tied directly to the health of the mother. While pregnant women without underlying abnormal physiology are unlikely to be at greater risk from application of VNR than are non-pregnant women, maintenance of a normal physical state is always preferred in pregnancy. Thus, the application of the VNR is discouraged in the visibly pregnant woman.

4. Other abnormalities

Other disease processes or pathologies may be at higher risk than normal for application of restraint modalities including the VNR. However, many abnormalities are not known to the individuals themselves or the bystanders attending them and are not visible to anyone. Every possible medical anomaly cannot be identified as potentially high risk by police officers.

For example, it would be ridiculous to require that police officers do not get into high speed foot chases, or vigorous struggles and then restraint with subjects suffering from hypertrophic obstructive cardiomyopathy or valvular heart disease since neither the subject nor the police officer is likely to know that the pathology exists. Post mortem findings of structural heart disease in particular offer no practical ability to alter restraint applications since the pathology is undetectable at the time of the event.

Officers have no medical training and should anticipate that subjects fall under the characteristics of the general population unless overwhelming evidence or clues presented to the officer suggest otherwise. Many known medical ailments are not reported to the officers at the time of interaction and struggle and thus cannot be used effectively to guide officers' behavior and approach. The reasonableness standard for the situation as it presented itself to the officers must be employed in these circumstances.

"It is a blame-shifting phrase. It is a phrase that shifts the blame from the person exerting the force to the person that dies. Blame the victim."

-attorney Randy Daar, legal council in the case of the in-custody death of Randy Escobedo, Cincinnati.

"Most of the people who die in police custody die not from drugs or some mysterious syndrome but from police abuse." "Police have to learn to de-escalate confrontations with agitated people; they have to practice verbal judo. If 5-foot-2 female social workers and nurses can do it, then I am sure the cops can too."

- Van Jones, executive director, Ella Baker Human Rights Center, San Francisco.

The case of Toney Steele, who died in the custody of San Diego police, was discussed on ***60 minutes II*** and the concept of excited delirium was explored in the public media. In that case, officers were called to respond to a disturbance on a bus involving Toney Steele. On arrival they described Steele as "…ranting and raving, talking about people that weren't there". He was sweating profusely and subsequently became engaged in a fight with 4 officers in the middle of traffic. He was described as having superhuman strength, was eventually subdued in a maximal restraint position and put in the back of a squad car. On arrival at a nearby hospital, he was dead.

In interviews, Steele's mother rejects the notion of a state of excited delirium as an explanation for her son's death in the custody of San Diego police officers. While Steele's mother acknowledged his ongoing difficulties with illicit drugs, she did not believe it was what killed him "I call this police brutality," she says. "I just wondered how did they come to that conclusion? I don't believe that. Hog-tying and suffocation. He suffocated. That's what I believe."

Does excited delirium exist as a medical condition?

Critics cite the fact that excited delirium is not listed in the American Medical Association's list of medical diagnoses, the Canadian Medical Association's list of diagnoses or the DSM IV/V as evidence that excited delirium "does not exist".

If excited delirium is a true medical condition, why is it not listed as a diagnosis in these publications? Because it is not a diagnosis. It is a state of being or a condition for which many underlying explanatory diagnoses are possible.

The American Heritage Dictionary of the English Language, an easily accessible nonmedical publication, describes that making a diagnosis is the process of determining the cause of a disease or injury by evaluating the patient's history, the physical examination and relevant laboratory information. The final diagnosis for any patient's condition rests with the opinion generated by the physician carrying out the evaluation. Similarly, Webster's New World Medical Dictionary (2nd edition) determines that the word diagnosis, which originally meant "discrimination, a distinguishing, or a discerning between two possibilities" in ancient Greek, now corresponds much more closely with the concept of a differential diagnosis. A differential diagnosis for a condition is the list of

medical diagnoses that could be responsible for the patient's state for which they seek medical care.

For a true medical diagnosis to be identified, the root cause of a patient's presentation must be established. In other words, the list of potential differential diagnoses are considered and a final diagnosis chosen because of the features of the patients presentation and course of treatment. For example, many patients are brought to the hospital for evaluation because of shortness of breath. Shortness of breath is not a diagnosis; it is a symptom or state of being. The list of potential diagnoses for someone being short of breath is extremely long and ranges from simple conditions such as viral bronchitis, to commonly fatal conditions such as congestive heart failure or even severe asthma. If a person comes to the hospital very short of breath and then dies of infection in the lung, the diagnosis was not shortness of breath (the person's state of presentation), the diagnosis was pneumonia.

While critics like to refer to the lack of diagnosis status for excited delirium as a basis for their claim that the concept of excited delirium is a "cover up" term or "trumped up diagnosis", there can be no dispute that the concept of a delirious state is recognized by virtually every medical and paramedical professional. Delirium and its investigation is essential knowledge for all medical practitioners and delirious states are associated with a wide variety of medical conditions that result in the common findings of delirium: an altered level of consciousness with loss of both cognition (thinking and reasoning) and perception (input from the senses). In medical practice, delirium is recognized not as a specific diagnosis of its own but rather a clinical state for which the list of potential differential diagnoses is broad. Many a medical book chapter is dedicated to the investigation and diagnosis of delirious states and every medical dictionary defines it. Determining the specific cause or a delirious state often requires extensive medical investigation; the cause is often not readily apparent at first contact with the individual.

Some delirious states, such as those associated with fevers or the use of sedatives and pain killers are characterized by the loss of cognition and perception but have little or no increase in physical and/or mental activity. Evidence of excitement in human physiology can be observed in the vital signs with elevated temperature, heart rate and/or respiratory rate but may not be evident to the casual observer. Lay persons asked to describe delirium often imagine a person lying semi conscious, moaning in a bed of tangled sheets. This kind of delirium could be described as obtunded or quiet delirium and any parent who has had a child ill with high fever is familiar with its features.

However, illicit drug use, acute psychosis or mania, or a combination of psychiatric illness and illicit drug use can generate other kinds of delirious states. These delirious states are also defined by a loss of normal thinking and interpretation of sensory input but they are associated with a profound increase in physical and mental activity leading to the subject being described as extremely agitated or in a state of extreme excitation. Physiologic excitement in terms of elevated temperature, heart rate, blood pressure and/or respiratory rate may also be detected once physical examination is possible; however the agitated state of the individual makes these assessments impossible at the outset.

It is the combination of extreme physical exertion and a delirious mental state that leads medical practitioners to describe a subject's condition on the whole as consistent with "Excited Delirium" as opposed to a quietly delirious state. An excitedly delirious state has many potential causes (differential diagnoses). This large number of potential

causes generates some variation in the symptoms seen leading to difficulty in determining a consistent definition or set of features with which to describe excited delirium as a syndrome. For example, persons in a state of excited delirium from mental health problems such as acute psychosis may share some but not necessarily all of the features seen with some drug overdoses that result in an excitedly delirious state.

Members of the general public are familiar with the concept of excited delirium as most know of the “DT’s” as a consequence of alcohol addiction and withdrawal. True delirium tremens is an excellent example of an excited delirium state as persons suffering from delirium tremens are agitated, hallucinating, have high fever, high blood pressure and elevated heart rates. If left untreated, persons suffering from delirium tremens have a mortality rate approaching 35%. Even with medical treatment including sedation and blood pressure, mortality from delirium tremens is as high as 5%.

Excited Delirium has been recently described as “a state of extreme mental and physiological excitement, characterized by extreme agitation, hyperthermia, epiphoria, hostility, exceptional strength and endurance without apparent fatigue”. Some physicians may prefer a more general description such as “an altered level of consciousness combined with extreme physical exertion”, which allows for some variation in the symptom cluster but does not address the physiologic derangement which is simultaneously thought to be occurring.

The concept of excited delirium is not new. In 1849, Bell first described a “peculiar form” of delirium that was fatal in at least three quarters of those suffering it. With the advent of adequate psychiatric medications, Bell’s mania in its pure form (from mental illness alone) was described less and less in the medical literature until recreational sympathomimetic drugs and hallucinogenic drugs emerged on the forefront in the 1970’s.

Cocaine induced excited delirium is now a commonly seen variant of excited delirium which has received more academic scrutiny and first came to the attention of physicians in the early 1980’s as the cocaine epidemic gained momentum in the United States. The exact pathogenesis of excited delirium and cocaine induced excited delirium is unknown at this time but much work is being done by neurophysiologic researchers to determine its exact pathophysiology. Whether this phenomenon can be extrapolated to include methamphetamine induced excited delirium is unknown, although the extrapolation makes intuitive sense and has biologic plausibility.

Death of the agitated individual suffering cocaine induced excited delirium has not infrequently occurred while the subject is in police custody after being restrained to protect public interests. While it is tempting to suggest that persons suffering from excited delirium simply be allowed to “wind down”, there are public interest and subject specific reasons not to allow the subject to continue to run rampant. Usually, police engagement is requested as a result of property damage concerns, dangerous or threatening behaviors and commonly, real concerns about the imminent danger to the subjects themselves. Risk to the individual is not necessarily mitigated by containing the individual in a large space until such time as exhaustion sets in. Not only are property owners not content to watch police allow a subject to continue to destroy property, there is some medical evidence that suggests that progression to a state of exhaustion is, in itself, dangerous. Prior to effective treatment for the acute phase of mania or psychosis, death as a consequence of exhaustion in psychiatric patients was reported. In 1952, it was described that “sustained motor and mental excitement with continued activity for a

period of time" was a risk factor for sudden death due to excited delirium, prompting the subsequent development of the use of sedation protocols to control individuals and to mitigate potential risk.

Excited delirium (ED) is an acute condition with multiple potential underlying etiologies that can progress rapidly to cardiopulmonary arrest and death in individuals who are struggling violently and are then subdued either in the prehospital or hospital setting.

The typical scenario for a subject with excited delirium is a rapid onset of acute paranoia, followed by aggression toward inanimate objects, often glass such as windows, mirrors or automobile windshields and windows. This activity is frequently accompanied by a variety of bizarre activities including (but not limited to) disrobing, running, yelling, hiding, exhibitions of superhuman strength, extreme aggression to individuals, resistance to pain and physical restraint. The subject is usually male, often has a known psychiatric disorder, may show evidence of intoxication with cocaine or other illicit substances, fails to respond appropriately to external cues such as police presence, and usually demonstrates incoherent speech or incoherent screaming. Subjects very frequently exhibit profound struggling against officers and/or restraints for upwards of 15 minutes after restraints are applied despite the futility of such struggle, can be extremely hot to the touch (clinical hyperthermia) and may or may not have excessive sweating (diaphoresis). Individuals suffering from excited delirium are thought to be at risk of sudden death very soon after being physically and/or chemically restrained. Death of these individuals has occurred in the prehospital setting, in the care of EMS providers and in hospitals. Death in this syndrome occurs within seconds to minutes of a period of quietness that is misinterpreted as "giving up" or tranquility or the cessation of struggling. In pre-hospital reports of cases of death due to excited delirium, persons of police interest who have required restraint have progressed from extreme violence and agitation to death in a matter of minutes, with or without presence of emergency medical personnel.

Most reported cases of sudden and unexpected death proximal to restraint seem to involve young men in an "excited" state or one of "agitated delirium" as a result of psychiatric illness or intoxication from illegal drugs or both. These individuals are combative, violent, and often struggle, sometimes sustaining traumatic injuries as a result of confrontation with law enforcement before being subdued. However, no author has prospectively documented the frequency with which any of these features exist, or their association with sudden death in the prehospital setting. Lack of such information prevents adequate planning of investigational or interventional strategies.

Much attention has been paid to the method of police restraint when an individual suddenly dies proximal to police restraint. Theory generation and debate is widespread surrounding the rationale for these deaths as it relates to the use of force. Police agencies have been criticized and individual police officers have been charged criminally with unnecessary or unskillful use of force, and many revisions to police policy have been undertaken in an attempt to mitigate risk to subjects being arrested while still protecting the public interest by subduing unruly individuals. Multiple methods of restraint have been implicated in unexpected death. As police services change use of force tactics and methods, litigation follows that tries to criminally implicate each method. Yet, the incidence of sudden in custody death remains unchanged even as methods of restraint are abandoned in favor of allegedly "safer" methodology. As previously stated in this report, the only current known predictor of a change in the incidence of death in custody is a change in the pattern of recreational drug use in the community in question.

While discussions around restraint methodology used use by police abound in the current press, within each Canadian case of death following police restraint are also found the following situational and individual characteristics: male subjects, police activated for concerns of public or subject safety, subjects fleeing police or resisting interaction with police, erratic behavior, violent behavior, suspected or known drug intoxication, cessation of breathing immediately following a struggle, and the inability for the medical examiner to determine the specific cause of death. Unfortunately, the startling similarity of the context of these sudden deaths is largely ignored while the specific method of restraint is heavily criticized.

Thus, while much attention has been focused on the method of restraint, it is possible that features of the individual involved and the nature of the situation itself may also be predictive of outcome. It is possible that either the use of restraint methodology serves only as a marker for the severity of the situation, or that the restrain methodology may be implicated in specific subject presentation. Specific interest in methods of police restraint is currently focused on conducted energy device utilization, whereas interest in and criticism of vascular neck restraint, use of multiple officer restraint, pepper spray, position of maximal restraint use and lethal force such as firearms has been historically common. For example, in the 1990's the American Civil Liberties Union and other human rights activists advocated that pepper spray was the real killer in sudden death in custody. Currently their chief interest in restraint has shifted and lies with the criticism of conducted energy weapons, which were developed in part to replace other methods of restraint such as VNR.

No scientifically robust data exists to determine whether there are situational or individual features that predict a mortality outcome, or whether the existence of a certain set of features, such as excited delirium, might determine which method should or should not be used to subdue an individual. Whether it is the act of restraint itself and not specific measures of restraint that is problematic for individuals in an excitedly delirious state is unknown. Critics of police interventions and policy are quick to criticize each method of restraint of combative and violent individuals as it emerges. Some would argue that restraint should never be employed.

However, it is imperative for people to understand that a subject in a state of excited delirium is suffering from severe abnormalities in cognitive thinking and sensory perception. Traditional negotiation techniques are fruitless as the subject cannot interpret his own sensory input correctly or make appropriate judgments from it. The notion that such an individual can be 'talked down" reflects a disrespect for and inadequate understanding of delirious states.

Very often, lay persons and watchdog agencies admonish that the appropriate management of these individuals is to "transport them to hospital for medical evaluation." The simple question is "how?" Paramedics cannot transport violent, combative individuals in ambulances safely. Hospital staff will not enter into the care of agitated and violent individuals unless they can be first physically contained/restrained. Physicians, paramedics and even social workers do not engage in therapeutic talk relationships with incoherent, violent individuals. As a testimony to the difficulties of dealing with violent individuals and the effects of illicit drug use, police agencies are finding themselves more frequently summoned to hospitals for assistance in the physical containment of a violent individual in hospital emergency departments as hospital security staff become overwhelmed.

Even in hospital, physical restraint is a precursor to any attempt at chemical restraint or even the most basic medical evaluation since there is no safe method for delivering adequate sedatives from a distance. Paramedics and nurses do not attempt to give intramuscular injections or initiate intravenous line access in acutely violent individuals who are physically unrestrained. There is no treatment of these individuals without initial physical restraint.

Legal Review Summary and List of Court Recommendations

(For a list of the cases reviewed for this report, refer to Appendix C)

In case law specific to the utilization of any type of neck hold, can themes or recurrent occurrences be determined that reflect individual or situational characteristics anticipated to lead to adverse outcomes or legal proceedings?

During the extensive legal and civil review of incidents involving the vascular neck restraint undertaken for this research project, it has become evident that there is little consensus on the status of the VNR specific to policing. Another difficulty in interpreting these legal findings is that in many of the cases reviewed, those sitting in judgment made no distinction between 'choke holds or respiratory restraints' and 'carotid holds or vascular restraints'. In many of the cases reviewed, it is clear the triers of fact did not appear to understand the disparate medical risks involved between the two different types of techniques. Confusing one technique with the other may explain, in part, why some courts have reacted so strongly to the use of a vascular neck restraint. For example, some courts have held that the use of the 'neck restraint' constitutes deadly force however; the medical review of the vascular neck restraint does not support this view (as will be discussed later).

Another important issue that came to light during this review is that in many of the U.S. and Canadian cases which investigated the death of the subject following the application of the VNR, the issue of excited delirium syndrome is not well understood or considered. It is obvious that court systems tasked with determining cause or finding fault often favour a single-cause factor over a multifactoral cause and thus the proximate event of police restraint method is implicated even though there may be a lack of medical evidence for this determination. At a recent conference on the prevention of in-custody deaths, Dr Vincent DiMaio[4] discussed this issue specific to the need of the court system to find a 'villain' upon which blame can be assigned. Dr. DiMaio discussed the legal history of such cases from positional asphyxia and neck restraints through OC spray and currently the conducted energy device (Taser®). All of these confounding issues make it clear there does not exist a consensus of legal reviews based upon medical scientific fact that can provide guidance to administrators considering the use of the vascular neck restraint.

However, where police use of a neck restraint has led to legal action, the courts have generally tended to focus on four issues:

i. Was the use of a neck restraint reasonable and appropriate given the totality of the circumstances? In addressing this question the following are taken into consideration:

   - The risk of harm to the officers or others,
   - The level and type of resistance offered by the subject,
   - The goal of the officer in applying the neck restraint,
   - The perceptions of the officers involved in the incident

ii. Did the officers follow departmental policy?

[4] Dr Vincent DiMaio M.D. is the Chief Medical Examiner, Bexar County Texas; professor, Department of Pathology, University of Texas Health Science – San Antonio and co-author 'Excited delirium Syndrome'.

iii. Were the officers properly trained in the use of the technique and was the application consistent with that training?
iv. Did the officer act in good faith, conscious of their responsibility for public safety.

In reviewing the cases involving law enforcement use of vascular neck restraints which resulted in recommendations, most focus on training and policy considerations. The recommendations arising from Canadian litigation and inquires is summarized as follows:

i. Training on the use of the vascular neck restraint should be provided on a regular basis.
ii. In training, officers should be informed of the VNR's potential for adverse medical outcomes.
iii. The VNR should be limited by policy to situations where officers or others are in danger of physical harm.
iv. Police agencies should document all circumstances in which the VNR is used. This reporting data should be reviewed periodically to measure adherence to policy and to identify training issues.
v. Ongoing research should be conducted on the use of neck restraints and changes implemented where appropriate. (Although this recommendation was gleaned from the legal review, the medical experts tasked with reviewing the existing scientific research for this project unanimously indicated that no further research is required for making best-practices training standards and policy. With respect to the issue of restraint modality with subjects experiencing excited delirium syndrome, the international RESTRAINT study which is just in its infancy is seeking to address this concern.)

Selected Canadian Case Summary

1. Steward v. Martay, Supreme Court of British Columbia

- Unruly bar patron placed in vascular neck restraint by bar staff (bouncer)
- Subject (Steward) was rendered unconscious by the application of the VNR.
- Subject did not suffer adverse medical affects as a result of the VNR however; he sued the establishment and the bouncer for 'damages'.
- At trial, the bouncer (Carty) testified that although he had been a martial arts instructor at Royal Roads Military College he had minimal understanding of physiology of the VNR. On the other hand, Steward's family physician, Dr Conner, testified that the VNR "could have been very serious due to the fact that this kind of trauma could lead to the release of atherosclerotic plaques which could result in a stroke". In the absence of factual medical testimony to the contrary, the court was persuaded that the application of the VNR was excessive given the risk identified by Dr. Conner.
- The court held that in the absence of risk of physical harm to Mr. Steward the use of the lateral neck restraint was an unreasonable use of force
- General damages awarded in the amount of $1500.00. The claim for aggravated and punitive damages was dismissed since the plaintiff was found to have provoked the incident.

2. Bodner v. MacDonald, British Columbia Court of Appeal

- In this case, the decedent (Darrel Bodner) arrived at the condominium complex of his ex-girlfriend in an agitated state. He had been smoking marijuana and was intoxicated. He managed to gain access to the building and proceeded to bang and kick on the complainant's door.
- Bodner's ex-girlfriend contacted the complex security company and security officer McDonald was dispatched to attend. When McDonald arrived, Bodner had managed to gain entry to the complainant's apartment and was struggling with her husband.
- Bodner then began an unprovoked assault upon McDonald resulting in both of them falling to the ground. At this point McDonald managed to place Bodner in what he described as a "Choke Hold". McDonald applied compression until Bodner passed out; McDonald described applying the hold "forever". Bodner could not be revived and died a short time later.
- Although the coroners report was not available for this review, the court record indicates Bodner died from "external compression of the neck" and mentions the "…risk of cutting off the blood supply to the brain". It is not known if the restraint was a respiratory or vascular technique, or a neck restraint that was intended to be a vascular restraint and became a respiratory one.
- McDonald testified that he had no training in the application of a neck restraint.
- The trial judge found that absence an apprehension of grievous bodily harm the application of the 'choke hold' by McDonald was unreasonable.
- Damages were awarded to Bodner's estate in the amount of $104,610

3. R. v. Hartikainen, , Provincial Court of British Columbia

- The accused, Hartikainen, was stopped by a Nelson Police Department officer for erratic driving. The officer observed indications of impaired driving and asked Hartikainen to step from the vehicle, which he did voluntarily.
- Hartikainen was placed under arrest for impaired driving at which time he began walking towards the door of a nearby hotel. The officer advised him he was under arrest and to stop, however he continued walking towards the hotel.
- The officer grabbed Hartikainen by the jacket and a struggle immediately ensued with both the subject and the officer falling to the ground. While attempting to obtain control of the subject, the officer managed to call for backup on his police radio.
- While waiting for backup and still attempting to handcuff the accused, the officer was bit on the arm. When the backup officer arrived, OC spray was deployed directly into the subject's face and a neck restraint was applied. This allowed the officers to overcome the subject's resistance, obtain control and apply handcuffs.
- At trial on charges of assaulting a police officer and resisting arrest, defence put forth a motion for a judicial stay based upon the application of force by the officers. The trial judge dissented however and found that "*the officer took reasonable steps to stop him and bring him under control, and he continued to actively resist. It is one thing for an onlooker like Ms. Marshall who is the wife of the accused to say he did not appear to be putting up much of a struggle, and that the accused is harmless, but it is quite another thing to be a police officer confronting a hostile, uncooperative suspect that he does not know. The officer is required to make a split second decision to use only enough force to bring a suspect under control, not knowing if the suspect is armed, not knowing his history or mental condition, and after observing that the suspect is acting in a somewhat irrational manner given the situation*."
- The application for a judicial stay was dismissed and the accused was convicted of impaired driving, assault police officer and resisting arrest.

4. David Nicholl – Coroner Inquest – British Columbia

- In September and October of 1992 Mr. David Nicholl, a resident of Calgary Alberta began suffering delusional episodes imagining that his life was in danger and that he was being pursued. Mr. Nicholl left his work and following several days on the 'run' in this mental state he came to the attention of the Osoyoos B.C RCMP detachment on October 20th.
- Nicholl was taken by the RCMP for a psychiatric assessment following which he was deemed to be fit to release. Mr. Nicholls mother arranged for bus fare back to Edmonton and he was dropped off by the RCMP at a local coffee shop.
- At 1430 hours on October 20th, Mr. Nicholl began causing a disturbance on a Greyhound bus which had left Penticton. Nicholl began speaking about all the people who wanted to kill him, that he had AIDS and generally exhibiting behaviour which frightened the other passengers. The driver alerted the authorities and following arrival at the Kamloops Mr. Nicholl became physically aggressive with the driver and other

passengers forcing them to physically restrain Mr. Nicholls until the arrival of the RCMP a short time later.

- The RCMP officer, with the assistance of several other members of the public, was able to successfully handcuff Mr. Nicholl and place him into the rear seat of the police cruiser. Mr. Nicholl subsequently kicked out the rear passenger window of the police vehicle, began swearing and spitting and threatening to contaminate anyone who came near with AIDS.
- Mr. Nicholl was removed from the police cruiser by RCMP officers and his aggressive behaviour continued. An RCMP officer placed Nicholl into a carotid restraint, rolled him onto his stomach at which time other officers applied a 'hog tie' restraint following which the carotid restraint was released.
- Following the struggle and restraint by the RCMP, Mr. Nicholl was observed to be breathing. A few minutes later however when an RCMP supervisor arrived on scene Nicholls was found to have stopped breathing and that he had vomited. Subsequent to this, an ambulance arrived on scene and transported Mr. Nicholl to a local area hospital where he was pronounced dead.
- Following the autopsy, the pathologist rendered the opinion that Mr. Nicholl had died from 'cardiac failure secondary to stimulation of the carotid sinus'. The pathologist's report and findings were reviewed by a second pathologist (Laurel Gray, M.D.) who rendered an alternative opinion respecting the cause of death. Dr Gray stated that Mr. Nicholl had died from 'Asphyxiation due to aspiration of vomit'.
- The Coroner's inquest determined that the means of death was the result of police action in the administration of the carotid hold.
- The inquest made several recommendations which are summarized as follows (pertaining to the 'carotid hold'):
    - That all police academies institute a policy that anyone administering the carotid hold be certified in the technique with recertification every three years.
    - Certification must include awareness of the possible complications resulting from the use of the carotid hold, monitoring of vital signs and level of consciousness, and performance of basic life support techniques.
    - That a separate police reporting system be implemented to track the use of the carotid hold and any resulting complications

- It is interesting to observe that the recommendations made respecting the training and risks of the carotid hold by the RCMP were put forward despite the fact that no evidence was entered that the carotid hold was improperly applied in this instance and there was no observation of damage to the structures of the throat during autopsy to conclude that the hold was applied improperly.
- Following the death of Mr. Nicholl, the Commissioner for policing in the province of British Columbia directed an investigation into the use of neck restraints. The resulting report 'Neck Restraints as a Use of Force' (Gil Puder) was released on August 20th 1993. The report made several recommendations pertaining to the use of neck restraints by police in B.C. The report supported the continued training and use of neck restraints under the correct conditions. (Placing the neck restraint in the deadly

force category was not supported by the research conducted by Mr. Puder).

5. R. v. Magiskan – Ontario Superior Court

- On December 28, 1997 members of the Thunder Bay Police Department were dispatched to the scene of a domestic dispute with allegations that the male party had physically assaulted the female complainant.
- Upon arrival, the officers spoke with the complainant who pointed out the suspect of the assault, Mr. Boissoneau, who was now sitting in the drivers' position of his sport utility vehicle.
- The officers approached Mr. Boissoneau and advised him that he was under arrest for assault, grabbed him by the jacket and asked him to exit the vehicle. Boissoneau refused to exit the vehicle and responded to the officer's request with profanity. The officer observed that Mr. Boissoneau clearly exhibited signs of alcohol impairment.
- Following several repeated requests to exit the vehicle which were not complied with, the officer attempted to physically remove Boissoneau. During the struggle to remove him, one of the officers deployed OC spray into Mr. Boissoneau's face which had no effect. One of the officers punched Boissoneau several times in the kidney area and struck him with a baton on the arm and leg, to no effect.
- One of the officers moved around to the passenger side of the vehicle, entered, and attempted to apply a 'choke hold' however the officer could not obtain proper positioning and abandoned the attempt. Boissoneau was eventually removed from the vehicle and handcuffed. The duration of the struggle lasted approximately six minutes.
- During the struggle, Boissoneau's girlfriend Patricia Magiskan (the original complainant) intervened and attempted to prevent the officers from completing the arrest. Magiskan grabbed one of the officers by the shirt and attempted to pull him away from Mr. Boissoneau. Following the arrest of Boissoneau, the police arrested Magiskan for Obstruction.
- At trial, Magiskan was convicted of Obstruction and subsequently appealed to the Ontario Superior Court. On appeal, the judge held that during the arrest of Boisseneau, the use of force against him was unreasonable and therefore unlawful and that Magiskan was within her right to intervene to prevent an assault from occurring.
- The appeal judge noted that the officers were not at risk of physical harm and therefore the use of a 'choke hold' was not warranted. The officer had not been taught the technique at the police academy and had no other formal training.
- The conviction for obstruction was set aside and returned to the lower court.

6. Laufers v. Toronto Police Force – Ontario Court of Justice

- On December 4th, 1987 Mr. Juris Laufers was stopped by members of the Toronto Police Force for impaired driving. When the officers attempted to arrest Laufers, he pushed one of the officers and attempted to run into his residence. A violent struggle ensued which required the strength of four police officers to finally subdue Laufers.

- Once handcuffed and placed into the rear of the police vehicle, Mr. Laufers attempted to kick out the rear window of the cruiser.
- At the police station, Laufers was described by the breathalyzer technician as an extremely difficult subject and one who did 'the exact opposite of what he was requested to do' On four separate occasions Laufers intentionally pushed the breathalyzer machine and following completion of the breath tests (157 mg% and 161 mg%) Laufers became belligerent and refused to leave the breathalyzer room.
- Two officers physically removed Laufers and placed him into a cell and it is the activities which took place from this point that gave rise to a complaint against two officers for 'unnecessary violence' contrary to the Code of Offences of the Ontario Police Act. These two officers were subsequently found guilty of misconduct by the Public Complaints Commissioners Board of Inquiry. The convictions were appealed to the Appeal Division Court.
- After being placed into the cell, Laufers grabbed one of the officers' shirts and ripped it removing the epaulette and metal number pin from the uniform. The officer asked Laufers to return the property however he refused to do so. Concerned that Laufers now had possession of a sharp pin that could be used as a weapon against himself or another person, the officer attempted to pry the item from Laufers hand, however Laufers lodged himself under the cell bench.
- One of the officers, S/Sgt Magda, reached under the bench and attempted to apply what he described as a "one handed carotid restraint". At this point Laufers grabbed the officer by the testicles causing Magda to release his hold and jump back. The two officers were able to extract Laufers from under the bench and after a vigorous struggle managed to place him onto his stomach and apply handcuffs and leg shackles.
- At the initial inquiry into the use of force by the officers, the Attorney General called medical evidence into the carotid restraint which was tendered by Dr. Yaphe. Yaphe testified that the potential risks of the carotid hold were:
    - 'If a person has arteriosclerotic disease, plaque could be dislodged, move to the brain and cause a stroke.'
    - 'If a person's blood supply is tenuous, a clot could form.'
    - 'With intoxicated persons, the application of pressure to the carotid arteries is dangerous and potentially life threatening because persons do not have the appropriate reflexes to guard his or her airways'
- Two police trainers and a civilian Judo expert were called to testify with respect to the application of the carotid restraint, training issues and history within policing in Ontario.
- The appeal court held that the Board made an error in law when assessing the force used by the officers.
    - There was no law, regulation or ordinance prohibiting the use of the carotid restraint.
    - The potential for contamination from Laufers through blood borne pathogens including his attempts to bite the officers was a serious consideration.
    - The appeal judge stated "*were the subject officers obliged to let Laufers, this intoxicated, strong, belligerent complainant have 'one free bite' before they used appropriate force in order to handcuff*

him, fulfill their duties under the regulation?….In my view, the Board condemned the use of the carotid artery restraint because it was 'potentially dangerous'. Most physical force has the like potential."

- In handing down his decision, the appeal judge stated that the Board failed to ask the proper legal question and therefore could not have arrived at a proper legal conclusion. "*The board failed to view the totality of the circumstances from the perspective of: 'It is the belief of the police officer, in light of all the circumstances, that is important'* (citing R. v. Bottrell)*. In my view the board should have asked itself this crucial legal question regarding each subject officer: 'Having regard to all the circumstances as they existed at the time the force was used and having regard to the belief of the police officer, in the light of all those circumstances, has the prosecution proved beyond a reasonable doubt that the subject officer was not acting on reasonable and probable grounds when he applied the force that was utilized?' In view of his conduct, force was required to handcuff Laufers so that he could be searched. Violence? Perhaps. 'Unnecessary violence?' Not in view of all the circumstances. The appeal is allowed and the finding of misconduct against each appellant is quashed*"

Applying medical principles and known medical literature to inquest and legal proceedings. Sample Case Study

The Samuel Hogan Case, Queensland, Australia. April 11, 2004.
Case review summary published, August 2005.

Investigated by the Crime and Misconduct Commission of Queensland (CMC)

Critique of the arguments and discussion of this case is carried out to illustrate the complexities of understanding expert medical testimony and the ease with which the summarization of medical testimony inherently changes both the nature of that testimony and the conclusions drawn from it. There is no doubt that the essence of the medical testimony put forth during the course of this investigation is not well reflected in the summary document. However, implausible theories generated in that summary document have gone on to be used as precedent evidence in the assessment of other cases. The intent of this discussion is not to re-investigate the case itself, but to illustrate how medical possibility, as testified by the forensic investigator, inappropriately becomes interpreted as medical probability and subsequently holds the actions of the officers responsible in absence of argument for the plausibility of such a nexus.

Thus, the following discussion is provided to try and illustrate the inherent dangers and misconceptions in evaluating such events.

Summary of details of the initial event as published in the case review of the death of Samuel Hogan:

Samuel Hogan, 20 year old male, suffering acute psychotic episode. Locked his uncle in the house, refused to allow uncle to call police, and exhibited such marked signs of mental disturbance that neighbors called police.

Mr. Hogan was found by police, walking on the edge of a busy highway. He became agitated on their approach, pushed past them into the road. Mr. Hogan was then described by the officers as becoming aggressive and he and two officers engaged in physical struggle. Mr. Hogan and the officers were on the ground with Mr. Hogan kicking at officers; he was sprayed with Capsicum spray (OC) with no effect. After much struggle, he was subsequently handcuffed and then while officers tried to put him in the car he got out of one of the handcuffs and resumed violent struggling and allegedly ultimately had his hand on one of the officers' firearm. He was immediately put into a lateral vascular neck restraint (LVNR®) by one of the officers. Despite application of the LVNR®, Mr. Hogan continued to become more and more violent, with an ongoing struggle for some minutes and all becoming exhausted. LVNR® was described as "having no effect whatsoever" and he just kept struggling even more.

Mr. Hogan was sprayed again with pepper spray by one or both officers to no effect. At that time the LVNR® is described as being applied "more forcefully". Mr. Hogan stopped struggling immediately and was handcuffed. A transport van was requested with both officers asserting that he was conscious and breathing when the van was called.

Mr. Hogan was noted to be coughing, which the officers thought to be a response to the pepper spray. The situation progressed very quickly to Samuel Hogan's eyes rolling

back and officers detecting no pulse. Officers uncuffed him and began CPR, a passing doctor helped until paramedics arrived.

Samuel Hogan now exists in a persistent vegetative state secondary to hypoxic brain injury.

The CMC investigation tried to ascertain whether the lack of oxygen to the brain was caused by a cardiac arrest, or whether the lack of oxygen caused Samuel to have a cardiac arrest. In the testimony surrounding this case, theories put forth by the Director of Queensland's forensic unit are summarized by the author of the report and are written to suggest that Sam Hogan's brain did not get enough oxygen for several possible reasons:

1. His heart *stopped pumping sufficient blood to his brain following a cardiac arrest due to his exertions* (and perhaps a partial or full blockage due to the neck restraint)

2. His heart stopped pumping blood altogether, or in sufficient quantities, because of *accidental stimulation of his carotid sinus nerve* during the application of the neck restraint.

3. A *fully effective neck restraint was held for at least four minutes* during which time he would have been limp and unconscious within 30 second of it being properly applied. (it was not held for any time after he lost consciousness)

It is likely and evident by the appended written opinion by Dr. Hoskins that his testimony was much more eloquent and appropriately worded than is reflected in the summary document.

The discussion that follows is limited to the details as they are available for the case and do not represent an exhaustive discussion of medical physiology. The discussion of this case in this format is subject to the same difficulties as discussing these cases in legal venue with layperson interpretation of medical facts. Medical theories and knowledge bases and concepts of human physiology are complex processes, poorly served by summaries.

However, in an attempt to generate a document that is widely available and understandable and relevant to the venues during which discussions of restraint physiology are undertaken, the following discussions of the summary of the particulars of this case are made.

Key points:

In the case of Samuel Hogan, discussions ensued about the timing of the events and some implausible theories are documented in the summary document.

1. There is discussion that the cardiac arrest happened ***either during or just after*** the altercation.

It does not make biologic sense that the cardiac arrest occurred *during* the struggle. In the summary document of this case (page 9), "it is possible that Samuel Hogan had the cardiac arrest during the fight, and that his struggle for breath was interpreted by the

officers as his continuing to fight. This may or may not have been during the time the VNR was applied"

This argument does not make biologic sense. A person whose heart ceases to beat (cardiac arrest) does not 'continue to struggle for breath" for a period of minutes with efforts strong enough to require the physical restraint of two officers who describe him as becoming more and more violent. A person with a fatal dysrhythmia that degenerates into cardiac arrest loses consciousness and all motor tone within seconds as cerebral perfusion stops.

Even if Mr. Hogan experienced syncopal convulsions as a result of either the syncopal spell induced by VNR or a cardiac arrest with lack of perfusion to the brain, those movements would last a few seconds, not the minutes apparently described by the officers in the case.

The officers describe that once Mr. Hogan was subdued he was handcuffed and observed to still be breathing and coughing as the transport van was called. These facts belie the presence of cardiopulmonary arrest at that time. Cardiopulmonary arrest indicates cessation of heart and lung function. Subjects do not continue to breathe if they are in cardiopulmonary arrest.

The cardiac arrest clearly happened after the altercation when the officers noted that Samuel was not breathing, had no pulse and was unconscious.

2. Another implausible theory is generated in the discussion, that "Samuel could have had a ***'silent' cardiac arrest while continuing to breathe*** in the recovery position, until eventually he stopped breathing and this was noticed…" The summary document then states, "During this time, ***oxygen reaching the brain would have been limited by the cardiac arrest."***

The summary article states that this theory is presented as a medical possibility and no more. As it is written, it is NOT a medical possibility.

People do not have silent cardiac arrests during which they continue to breathe. When the heart stops, blood stops perfusing the cerebral cortex and brain stem rendering vital functions absent. When respiration ceases (within seconds) oxygen stops entering the blood and hypoxia begins. Breathing stops within seconds not minutes.

The misuse of the term "cardiac arrest" in this summary document is an excellent example of the difficulties in having layperson juries, judges and lawyers understand and interpret the intricacies of medical physiology particularly in complicated cases like Mr. Hogan's. What the medical expert, Dr Hoskins, was referring to was an arrhythmia; during which blood flow to the brain was decreasing as less and less blood pressure could be maintained. Brain damage is not induced unless the blood pressure is not restored, such as when the person's heart finally stops beating. Implementation of CPR is designed to circulate blood to the vital organs until the heart can be restarted.

There is little doubt that deterioration of perfusion to Samuel's brain, which was prolonged, resulted in his brain injury and persistent vegetative state. However, short lived arrhythmias or losses of blood pressure, which subsequently return to normal do not result in permanent brain damage in most individuals.

Persons who suffer recurrent syncope at home from ventricular dysrhythmia or transient asystole do not suffer irreparable brain damage as a result. Many patients with malignant dysrhythmias such as ventricular tachycardia or torsades des pointes have multiple episodes of syncope when the brain fails to get enough blood pressure to maintain an awake state. When the malignant dysrhythmia terminates (often as a result of the fall to the floor), the patient regains consciousness without brain damage.

Similarly, in electrophysiologic studies to detect malignant dysrhythmias in patients with recurrent syncope, it is standard practice to electrically stimulate the heart into a malignant dysrhythmia and then defibrillate the patient after he or she loses consciousness because of it. Patients wake with normal cerebral function immediately after their rhythm is restored. There are no published case studies of persistent vegetative state being induced during EP study in the world.

The important concept is that during the onset of a malignant dysrhythmia the brain does not do without oxygen, it does without blood pressure. When the blood pressure falls the person is not able to maintain a conscious state and they lose consciousness just like a simple faint.

Partial blood flow to the brain because of arrhythmia does not generate brain damage unless and until that arrhythmia is prolonged and degenerates into cardiac arrest. At that time the subject's tachydysrhythmia (fast heart arrhythmia) or bradydysrhythmia (slow heart dysrhythmia) deteriorates into a fatal rhythm such as ventricular fibrillation. At the onset of the fatal dysrhythmia the brain no longer receives any blood flow, respiration stops and no new blood or oxygen (since the subject has stopped breathing) enters the brain. If the subject does not have a perfusing heart rhythm reestablished or CPR performed, the brain cells begin to die.

The investigation and summary of the events leading to Samuel Hogan's brain injury and loss of productive life would have been better understood with the summary document introducing the concept that it is likely that Samuel had a malignant cardiac dysrhythmia that was not immediately recognize because he was continuing to breathe. Blood flow to the brain would be reduced during this arrhythmia and would not return to normal if the arrhythmia was not recognized and treated.

It is important to note that police officers are incapable of detecting cardiac arrhythmias other than detecting a weak or absent pulse. The documentation of cardiac arrhythmias requires application of ECG (electrocardiographic) monitoring and the correct interpretation of the recorded rhythms. This requires the attendance of advanced life support capable emergency response staff such as paramedics. Emergency medical technicians, first responders and other basic life support capable rescuers do not have ECG interpretation capabilities, nor do police. Automated external defibrillators do have the capability to recognize malignant dysrhythmias that require cardioversion.

In the Samuel Hogan case, the police officers did recognize the onset of cardiac arrest. Samuel Hogan was unconscious but breathing at the end of the struggle as the transport van was summoned. Rapidly afterward, the officers noted that his breathing pattern changed, his eyes rolled back and his pulse stopped. He stopped breathing. CPR was initiated in an attempt to keep Samuel alive. These events fit with the picture of the recognized onset of a cardiopulmonary arrest.

3. The medical expert testifying in this case advised the review panel "***it is equally possible that the cardiac arrest occurred after the final struggle finished*** and during the period between the call for a van and a call for an ambulance. If the cardiac arrest were in the nature of arrhythmic beating there would be no symptoms experienced by Samuel until he lost consciousness". This is correct medical reasoning.

Further analysis of this case rests with the discussion of what contributed to Mr. Hogan's having an arrhythmia and subsequent cardiac arrest. The theories presented in this case for what may have prompted Mr. Hogan to have a life threatening dysrhythmia and then a cardiac arrest requiring CPR will be discussed. The theories will be discussed from least plausible to most plausible. It is important to remember that medical *possibilities* do not represent medical *probabilities* in most cases. Discussion will utilize the concepts discussed in the physiology sections of this report.

1. One of the theories suggested and summarized in the case document states "that his heart stopped pumping blood altogether or in sufficient quantities ***because of accident stimulation of his carotid sinus nerve during the application of the neck restraint"***. Mr. Hogan was a 20 year old male with a history of either diagnosed or undiagnosed psychiatric issues. There is nothing in his history that suggests he was a victim of recurrent syncope prior to his encounter with police although this data may easily be missing from the summary document. However, he is not in the appropriate age group to experience hypersensitive carotid syndrome. There have been no published cases of carotid hypersensitivity syndrome in persons in their 20's in decades of cardiac research.

Recall from the previous cardiology section of this document that normal healthy volunteers without history of recurrent syncope are routinely used as control subjects for carotid sinus stimulation investigation specifically because they do not experience dramatic and sustained alterations in heart rate or blood pressure with direct and intentional stimulation of the carotid sinus. Thus, this theory put forth as a potential cause of Mr. Hogan's cardiopulmonary arrest is really conjecture based on known disease physiology in a different patient population. As such, for this case, this theory infers an implausible risk to the application of vascular neck restraint in this and other individuals with a similar demographic profile. This theory, offered in the case of Mr. Samuel Hogan's irreversible brain injury, should be discarded as implausible and should not be subsequently used as evidence that carotid hypersensitivity is a likely mechanism by which VNR induces unconsciousness in similarly aged individuals.

2. Another theory put forth in the summary of this case is that "***A fully effective neck restraint was held for at least four minutes*** during which time he would have been limp and unconscious within 30 second of it being properly applied. "

The officers in this case described applying VNR and Mr. Hogan continuing to struggle. Then the force of application of the VNR was subsequently increased and Mr. Hogan lost consciousness. The officers described immediate release of the VNR upon loss of consciousness.

The first impression from the statement above is that the officers rendered Mr. Hogan unconscious with the initial application of the VNR and then continued to hold it for an additional 4 minutes despite his being limp and unconscious. Even a casual read of the details of the case reveal that this is not what is described.

A more accurate impression of the statement above was that a fully effective neck restraint was not in place for the first four minutes or Mr. Hogan would have been unconscious.

VNR, when applied correctly at maximal compression, should render a subject unconscious in 7-15 seconds as the cerebral cortex stops receiving an adequate blood pressure to maintain a conscious state. When a maximally applied VNR or LVNR® is carried out, officers should be able to anticipate this effect consistently.

However, if the VNR is not applied to full capacity, then cerebral blood flow does not completely cease through the two carotid arteries. The person is able to maintain and awake and goal motivated state because the cerebral cortex receives enough blood flow to do so. In practical policing, officers may not always apply the VNR to its maximal effect, planning instead to subject the resisting person to a graying out or partial loss of consciousness thereby invoking compliance on the part of the subject so as to avoid completely fainting. In many police agencies, VNR is taught using gradations of applications with the notion that losing consciousness is not a pleasant process and subjects may be spared the discomfort if they comply as a result of partial application of the VNR or LVNR®. Should the subject fail to comply, the application of the VNR is extended to its full capacity and the subject rapidly loses consciousness.

Whether the officers initially applied VNR in hopes of gaining compliance without full compression is unclear. It seems unlikely that the officers in the Hogan case were attempting to apply a graded compression. It seems more likely that they would have tried to apply the hold maximally given the details of the case.

If maximally applied VNR is not successful, then three scenarios may exist:

a) The VNR cannot be maximally applied

In persons with smaller physical structure than the assailant or resisting person, it can be difficult to achieve complete obstruction of the carotid arteries particularly if the hold is attempted to be applied using a single forearm without the squeezing action generated by the use of the officer's second arm and hand. Some individuals with particularly muscular necks may not be able to have their vascular neck structures compressed through VNR. While many smaller officers rely on the VNR as an excellent restraint technique some simply do not have the physical strength or endurance to effectively use the hold.

b) The subject may not be sensitive to VNR.

All advanced level trainers have encountered a normal healthy police recruit who cannot be rendered unconscious by VNR even when applied by a master instructor at its maximal capacity. It is likely that these individuals have aberrant circulation to the forebrain through the posterobasal and vertebral artery systems that render them protected from the 2 vessel ischemic forebrain model previously discussed that explains how VNR renders people unconscious. If these individuals exist in police recruit classes, they exist in the general population as well. For this reason, officers are trained that if they are not successful in rendering the subject unconscious with the application of VNR in the first 30 seconds of maximal application they should tactically reposition and reconsider other force options where possible.

c) What is thought to be a VNR is not a VNR or has deteriorated into another sort of neck hold

In cases of prolonged or extremely violent struggle, it could be possible for the subject to get out of the correct position for application of an appropriate VNR. In these cases, the intended VNR could become an arm bar or tracheal hold which achieves loss of consciousness through asphyxia. For this reason, officers must be taught and subsequently utilize the concept that if a subject is not rendered unconscious within 30 seconds of application of the VNR, it is not working and is either ineffective or not a VNR. In this case officers must consider tactically repositioning or engaging in another sort of restraint/force option if the situation allows.

A respiratory hold is applied with the intent of restricting the person's air exchange and thus deprive them of oxygen, eventually rendering them unconscious. Respiratory holds are not commonly sanctioned as appropriate police restraints in standard police practice. Rendering someone unconscious from asphyxia is not a rapid process as tissues have the reserve of supply in already oxygenated blood to draw from when further respiration is obstructed. The heart continues to pump; the subject continues to struggle and only succumbs when all oxygen reserves have been used and no more follow. Asphyxial death from strangulation takes minutes not seconds. Cerebral hypoxia is a real possibility in prolonged application of a respiratory hold.

The details of the VNR application in the Samuel Hogan case as they are published are insufficient to judge whether the intent of the officers was to apply it in a gradated fashion or it was improperly applied. There is little doubt that the application of the VNR was not effective in the early minutes of the case.

It is possible that what was intended as a VNR became another neck hold such as a respiratory hold. The case details as presented do reflect the violent and ongoing nature of the struggle and reflect that at least one officer felt Samuel Hogan's hand on his firearm. Both officers were subject to physical harm and the potential loss of life should Mr. Hogan gain access to a firearm. In that situation, police agency policy may enable officers to use any force means necessary to gain control of the subject, even if the VNR has slipped into a respiratory hold. If the officer cannot tactically reposition, he or she may have no choice but to carry on with potentially lethal force measures.

While the VNR is not expected to invoke serious bodily harm or death when applied maximally in most subjects, the details of this case suggest that the struggle with Mr. Hogan was not characteristic of application of an effective VNR and that prolonged struggles were an issue. In any case, the details of Mr. Hogan's case do not reflect a course of events suggestive of an appropriately applied, effective VNR.

3. The most plausible theory generated in this case is that Mr. Hogan's "***heart stopped pumping sufficient blood to his brain following a cardiac arrest due to his exertions (and perhaps a partial or full blockage due to the neck restraint***)".

In reviewing the available details of this and other similar in custody death cases it is likely that the combined effects of Mr. Hogan's acutely agitated state, his underlying psychosis, the depth and duration of the struggle and the requirement for a protracted neck hold application in the absence of a viable alternative are all participatory in an integrated fashion in Mr. Hogan's demise. Mr. Hogan's vegetative state as suggested in

the report is consistent with the state of other victims of cardiac arrest in whom some cerebral perfusion occurs due to CPR efforts carried out on scene. However, generalized hypoxic injury damages too many cells in the cerebral cortex for the victim to regain normal cerebral function. The brainstem functions are preserved; the victim continues to breathe and maintain blood pressure but does not regain consciousness.

Mr. Hogan's demise is very similar to other individuals who have become acutely agitated and subsequently become engaged in long and violent struggles with police officers. Historically, all methods of restraint have been suggested as problematic when events such as that surrounding Mr. Hogan have occurred. Previous theories regarding the concept of multiple officer restraint and positional asphyxia have been thoroughly proven false by modern experimentation and expert review as discussed by Dr. Hoskins in this case. Similarly, the notion that Capsicum spray induces a profound hypoxic state due to bronchospasm or tracheal edema has been discarded, as appropriately discussed and referenced by the medical expert, Dr. Hoskins, in this case. Currently, the association of conducted energy devices, chosen as a hopeful replacement for VNR and other close proximity restraint, with the in custody death of agitated individuals is being hotly contested in the legal arena. Medical experts are becoming more and more united in the stance that the features of the subject's presentation and subsequent struggle are more likely where the answers lie when investigating in custody death than in specific restraint methodologies.

When the criteria for causality are applied to cases such as Mr. Hogan's and other in custody adverse events and deaths, removal of any single restraint methodology has not changed the incidence of sudden death in custody following restraint application by police officers. Despite the discarding by some police agencies of the vascular neck restraint in favor of pepper spray and conducted energy technology, deaths are still occurring within those and other agencies under strikingly similar conditions as Mr. Hogan's' but without the application of VNR. Hill's criteria for causality require that for a factor to be causal, removal of the factor should remove the outcome. It is unlikely that VNR is specifically causal if its removal as a restraint technology does not result in a change in the incidence of death following restraint.

What remains from the Samuel Hogan case is the sad demonstration of a young life lost to societal contribution, the legal and civil prosecution of individual officers given the task of apprehending persons in acute agitated states, the loss of the public trust in police agencies and the expenditure of large amounts of public funds due to a maximal emphasis on blame laying for restraint methodology with little emphasis on the similarities of detail between this and other cases.

Appropriate epidemiologic research has still not been completed to more accurately determine the relative risk of death for individuals restrained as part of police custody. Mr. Justice Wallace T Oppal, Commisioner of Inquiry and Mr Gil Puder in Use of Force Research generated a comprehensive report for the BC Commission of Inquiry surrounding Neck Restraint as a use of force in 1993. That document was thoughtful, rational, and considerate and makes similar recommendations to our report. No new medical information points to an increased level of risk than that described in the Oppal Report. The Oppal Report suggested that while the VNR (and other restraint methodologies) could be associated with a deadly outcome (unanticipated death), VNR did not constitute deadly force as grievous bodily harm or death were not anticipated with its application.

Good scientific methodology dictates that the time for postulation is over and that adequate assessment of the risks in the population in which restraint is intended to be used is long overdue. A restraint method which has no known basis for fatality cannot be appropriately evaluated for its risk profile if it is not utilized.

Exhaustive data does not always exist for all treatments, interventions or procedures. Often, assessment of the biologic plausibility of an event's effects on an outcome is the first step in evaluating whether a causal relationship can or does exist. At other times, it may seem as though a biologic plausibility exists but when the factor or event is removed or was never in place, the outcome still happens, casting significant doubt on whether the event in question has any causal effect on the outcome. Such is the case in restraint methodology.

Discussion of Research Questions and Conclusions:

While an in depth review of the literature was undertaken, experts were limited by the paucity of published case reports in the medical literature, despite consideration of all articles involving types of neck restraint or neck holds and all data available in English and non English publication. There are no published case series or systematic reviews published by medical experts that either implicate vascular neck restraint as causative of an adverse event or outline the risk of vascular restraint in the police environment.

To overcome the limitations of the evidence available, all cases available in police and legal literature were dissected in detail with every aspect of the case reviewed as available. The authors of this report did not rely on the conclusions drawn by the results of case reports or of judicial findings, but reviewed all the details of each case independently to assess for associations, confounding elements and causal relationships within the confines of the data as it exists. At the time of the writing of this report no accessible database exists of prospective data collected at the time of the application of force event, including VNR by the police service of record. Many police agencies are now beginning to collect such data which will vastly improve the ability for appropriate researchers to evaluate the real risk profile of VNR.

Recommendations from this report apply only to a properly applied vascular neck restraint in the hands of trained and certified police personnel. Recommendations from this report do not apply to untrained police personnel or other individuals not practicing under the guidelines of a specific law enforcement agency with a written and specific use of force policy/guideline.

The authors of this report make the following conclusions and recommendations based on scientific principles and the notion of causation. In short, there must be a documented biologically plausible threat to the safety of the subject physiologically and that threat must be borne out consistently in documented cases or studies surrounding utilization of a technique in order for experts to find a causal relationship. This methodology of analysis is similar to the legal terms for imposing an injunction on a person or procedure. From Nava vs. Dublin, US court, 1997: to impose an injunction “there must be alleged a real and immediate threat as opposed to merely conjecture or hypothetical threat.”

1. In persons undergoing restraint utilizing vascular neck restraint what is the physiology by which a properly applied vascular neck restraint causes loss of consciousness?

The predominant mechanism by which vascular neck restraint induces unconsciousness is through diminished cerebral cortex circulation through the carotid arteries. Transient loss of the blood flow renders the cerebral cortex temporarily unable to maintain an awake state for the individual and is responsible for the VNR’s effectiveness in 7-15 seconds after maximal application. Vagal nerve stimulation with resultant decline in heart rate and blood pressure in considered secondary in the induction of the syncopal spell by VNR.

Further physiologic studies of how VNR works are unlikely to contribute more to the understanding of the risk profile of VNR during practical application.

2. In persons undergoing restraint utilizing vascular neck restraint are there clinical or situational markers to guide officers to know when vascular neck restraint has been effective and can be discontinued?

VNR applied at maximal compression will render susceptible to VNR unconscious well within 30 seconds of its application and usually within 7-15 seconds. Persons rendered unconscious with VNR may have several myoclonic jerks that are interpreted as struggle, but these will last seconds not minutes and will self terminate very quickly. Ongoing struggle is a sign that VNR is not being effective.

If a person continues to struggle for more than 30 seconds following application of VNR, one of the following conditions exists:
i) The subject is not sensitive to VNR and likely has anomalous cerebral circulation allowing maintenance of the awake state despite carotid occlusion. VNR should be abandoned and the officer should tactically reposition if possible.
ii) The VNR is not at maximal compression and full carotid occlusion has not occurred. The officer should tactically reposition if unable to achieve maximal compression easily.
iii) What is though to be a VNR is not being applied properly and is not a VNR. Respiratory holds are not effective within seconds and the subject will struggle for minutes and in an increasing manner despite maximal compression if a respiratory hold has been inadvertently applied or the VNR has deteriorated in technique. The officer should tactically reposition if the VNR is not successful within seconds and the ability to tactically reposition exists.
iv) An adaptation of VNR is being utilized rather than true VNR, thus the hold is not a VNR. The hold should not have been applied in this manner and must be discontinued immediately unless there is threat of death or grievous injury to the officer or bystanders.

3. In persons undergoing restraint utilizing vascular neck restraint is there medical evidence to suggest that application of a vascular neck restraint is expected to cause grievous bodily harm or death?

There is no medical evidence to suggest that application of a vascular neck restraint is expected to cause grievous bodily harm or death in the general population. All research, case law and anecdote available regardless of outcome was reviewed in order to over emphasize the degree of risk and to intentionally bias the reviewers to finding a problem. The authors of this report considered use of VNR in the context of the trained and untrained individual, correctly and incorrectly applied to find consistency in theme or outcome that biased the outcome against the safety of VNR. The authors anticipated that if there were clear association or causation between VNR and death of subjects in custody or grievous bodily harm there should be an over representation in the medical literature or at least in case law and anecdote. There was no prevalence of such findings.

Conversely, the assumptions in many legal decisions regarding the lethality of VNR are not based on appropriate medical reasoning or interpretation of medical testimony nor in the differentiation between VNR and other types of neck holds. Further research is needed to fully evaluate the risk of VNR and other restraint modalities across the wide variety of subjects encountered in police interactions with the public. Holds not in use will not be evaluated; the risk profiles of other modalities may or may not be safer than VNR in general applications.

In medical terms, the review undertaken in this report is Level 4 evidence surrounding police use of vascular neck restraint in that it is reliant on a few available cases and a single randomized study of induced loss of consciousness. The recommendations made

in this report this constitute Grade D medical recommendations from the experts involved because of the troubling inconsistency in the reports available.

It is unlikely that there will ever be Level 1 or 2 medical evidence gained in this area from randomized, controlled clinical trials as the nature of the restraint process and policing as well as the subjects themselves precludes the ability to randomize one technique against another scientifically. However, as police data gathering continues to improve and become standardized, adequate cohorts and series could be evaluated in future, improving the level of available evidence to Level 3. Once such data exists, and as further data emerges, the recommendations from this report will need to be revisited.

Medical experts, coroners, medical examiners and contributors of legal opinion must be responsible to such changes in knowledge and keep abreast of them. One cannot offer expert opinion if one's knowledge base is antiquated or inadequate.

The authors acknowledge and understand that evidence gathered subsequent to the publication of this report may either nullify or support the findings of this review in future. While the purpose of this report is not to generate specific police policies, the authors believe that prudent police practice should be responsive to the literature but not over-reactive to anecdote, sensationalism or individual case reports.

In terms of the use of force continuum in Canada, a lethal event occurring when a modality is anticipated on the whole to have non lethal application does not constitute the application of deadly force. When VNR is appropriately trained and applied, the majority of individuals would NOT be expected to sustain grievous bodily harm or death.

4. In persons undergoing restraint utilizing vascular neck restraint are there specific situations in which grievous bodily harm or death may be anticipated?

There are specific identifiable individuals in whom the risk of injury from application of VNR is anticipated to be higher than the average population. The ability to identify these individuals rests specifically with an officer's ability to identify the individuals physically through visual inspection as belonging to the risk groups. Higher risk may (or may not) be encountered if VNR is applied to the visible elderly, visibly pediatric subjects, obviously pregnant women, or persons with Down's syndrome.

Other risk groups cannot be physically identified by officers and likely have very low incidence in the population encountered by police. No degree of increased risk has been specifically defined in any risk group nor consistently discussed in the medical literature. Therefore, exhaustive moratoriums on all potential yet physically unidentifiable risk groups are impractical and nonsensical.

5. In case law specific to the utilization of vascular neck restraint or any other type of neck hold, can themes or recurrent occurrences be determined that reflect individual or situational characteristics anticipated to lead to adverse outcomes?

There are 3 key points in the answer to this research question: a) case law difficulties b) lay person application of neck holds and c) police application of vascular neck restraint.

Case law themes:

Case law reviewed for the purposes of this report revealed a consistent theme of conjecture and supposition based on either very little medical evidence to support a physician's claim of danger, or incorrect assimilation of medical information in the determination of which individual or situational characteristics of VNR application led to or could lead to adverse outcomes. During court proceedings and inquests, medical opinions and discussions of physiology are often further summarized and condensed such that the physiology implicated as causal is no longer even plausible. This practice leads to widespread misinterpretation of the true implications of VNR in the legal system.

Rather than a consistent finding of difficulty with VNR specifically, we identified consistent errors in the presentation and evaluation of evidence which fell into several categories of error:

i) Possibility vs. probability:

Consistently in review of case law, we found an overdependence on the concept of medical possibility rather than an assessment of the probability of the event actually occurring or being a factor in the specific case under evaluation. Medical experts called to testify are seemingly asked to expound on every potential physiologic process that could be involved in anyone's demise. Seldom is that medical testimony adequately interpreted in light of the event at hand.

As an example, Laufers vs. the Toronto Police Force, heard in the Ontario Court of Justice surrounding an event in December of 1987. Pathologist testimony at the original Public Complaints Commissioners Board of Inquiry suggested that VNR be considered as lethal force because of the possibility that a) atheromatous plaque could be dislodged from the carotid arteries of the subject involved, leading to devastating neurological outcome b) application of VNR could result in the formation of a blood clot "if a person had questionable blood flow" and c) obstruction of the airway of a drunken individual during an induced syncopal episode would occur since a drunk person would not have the "reflexes" to protect his airway.

Even the minimal medical data available in the summary of this case renders all of these theories as highly improbable in this and similar cases. While pathologists during testimony are often called to cite all potential medical possibilities, it is extremely important to evaluate their probability and the strength of their true association with VNR.

There is a remote possibility an embolic event because of disruption of atheromatous plaque in the arteries of the neck IF the subject is of advanced age. There is no *expectation* of grievous bodily harm or death from this mechanism in younger individuals unless those individuals have known underlying carotid artery disease/atheroma or stroke. A propensity of medical data surrounding the epidemiology of stroke supports this conclusion as opposed to the possibilities raised in the Laufers proceedings.

Manual occlusion of the carotid could possibly generate local thrombus (clot) IF there were significant pre-existing reduction in the carotid artery blood flow. While remotely possible, the exact correct conditions would have to occur simultaneously and would be highly improbable in a young person. There has never been a case report, series or study in the medical literature documenting carotid artery thrombus from a vascular neck restraint or manual compression of the carotid arteries in a young person.

In terms of alcohol intoxication rendering a person incapable of protecting his or her own airway, such a loss of airway reflex is seen in individuals who are in an obtunded state as a direct result of alcohol intoxication. An individual in such a state of intoxication is unlikely to put up a fight that results in application of VNR. An intoxicated individual who is capable of extreme physical exertion and struggle and violent interaction with police over a prolonged period of time certainly has the brainstem reflexes to control their own airway. Again, the possibility of a drunken person not maintaining his airway is introduced without discretionary review of the details of the case. Mr. Laufers clearly demonstrated a level of function that would not lead the average police officer let alone a physician to believe that he would be incapable of managing his own airway.

The definition of lethal force determines that lethal force exists if there is the *expectation* of death or grievous bodily harm following the application of the force in question. In the individual in question in the Laufers case, the outcome of devastating neurological event from plaque disruption, carotid thrombus or airway obstruction while medically remotely possible was certainly not to be expected.

In reviewing court documents, many legal proceedings inferred that police agencies and individual police officers should develop policies and implement procedures based on the notion that profoundly remote possibilities await at every turn when VNR is applied. Such manner of thinking suggests that officers consider every conceivable negative outcome no matter how rare or improbable and avert all unexpected adverse events. Such requirements would render VNR and all other restraint techniques such as handcuffing useless in a practical sense.

However, it is exactly the discussion of probability that should lead to the proper assessment of any restraint technique in terms of its potential lethality. There are many medical “possibilities” that, when assessed using an appropriate consideration of the details of the event in question, medical physiology and the real epidemiology of the disease process become immediately irrelevant. Overdependence on individual anecdote, a bias toward the reporting and investigation of lethal events with no attention to successful restraint procedures and a failure to appreciate the multifactoral nature of processes leading to death in custody creates the perfect environment for misinterpretation of events and a complete disregard for appropriate statistical evaluation of causation or risk.

ii) Precedence of evidence, propagation of misinformation:

Pathophysiologic processes that are remote medical possibilities (but are extremely improbable) are often cited in a case as described above. The problem is then compounded as errors made in the first case discussion are not limited to the initial case being investigated. Decisions made during that judgment, are subsequently brought forward as evidence for the “potential fatality” of the restraint process in ensuing cases. This practice further propagates misinformation regarding lethality and the medical evidence surrounding lethality.

For example, in Lyons vs. the City of Los Angeles, both lawyers and judges (not physicians) suggested that Mr. Lyons was “nearly choked to death” when he lost consciousness during the application of the VNR. In the simplest physiologic terms possible, loss of consciousness is not synonymous with death or a near death

experience. Yet, a transient loss of consciousness (the intended effect of application of VNR to its maximal capacity) as experienced by Mr. Lyons is equated with being near death by one of the judges participating in the case. It seems that the courts fall victim to the same hysteria that the general public does when someone loses consciousness.

Legal counsel acting on behalf of Mr. Lyons also stated that there was "undisputed risk" regarding the lethality of a carotid hold and that "more than 15 cases of death due to carotid restraint have occurred in Los Angeles since 1975". The notion of "undisputed risk" is not available in any publication of any scientific merit that we encountered. While deaths in custody have been reported, a "undisputed risk" has not been substantiated by our exhaustive review of the relevant pathophysiology and virtually all available literature on the utilization of vascular neck restraint.

The Lyons vs. Los Angeles court proceeding led to an injunction imposed against the utilization of the carotid hold by the relevant police agency. Even though that injunction was subsequently reversed by the US Court of Appeals, the notion of lethality from the Lyons case (based on the judges assessment of a loss of consciousness being a near death experience and acceptance of a lawyer's speech as evidence of undisputed risk) was subsequently used as precedent evidence of clear lethality in an unrelated appeals case, Nava vs. the City of Dublin, October 1996.

iii) The complexity of events surrounding in custody death and the difficult concepts supplied in medical testimony are incongruous with the judicial system's need to assign a single cause to events.

Any appropriate assessment of the risk of VNR will consider both the complexity of the events leading up to an in custody death and the complex nature of medical information. Appropriate conclusions can only be drawn surrounding the death of a subject when confounding events such as the underlying state of the individual, drug intoxication, psychosis, duration of the behavior leading to the confrontation, duration and nature of the struggle and use of multiple methods of restraint are considered. The focus on the method of restraint exclusively despite overwhelming similarity of other consistent features such as an agitated state, underlying psychosis and drug intoxication disregards appropriate conditions of causality in favor of a more convenient judicial finding of proximate cause. There may be individuals in whom the combination of features makes death more likely. Whether this increased risk is relevant to VNR application is unknown at present.

Lay person and untrained applications:

From information available as the public record, we reviewed all 5 available cases in which the individual being restrained by the neck for any length of time either died (4 persons) or was left in a persistent vegetative state (1 person) following a struggle. In one of the deaths, a neck hold of undetermined description was applied by an untrained security guard and held "forever" according to the security guard without recognition of the ongoing struggle by the victim. This case illustrates the dangers in the applications of neck restraint by untrained individuals.

Untrained individuals must never attempt to restrain an individual in any sort of neck hold unless there is risk of grievous harm or death to the restrainer or a member of the public. Untrained individuals do not know appropriate procedures or the safeguards for ensuring

that a safe procedure does not become an unsafe procedure inadvertently. Trained individuals can appreciate when a hold is effective or ineffective and respond appropriately. Risk reduction is only achieved through proper training and implementation.

Cases of untrained or civilian application of “neck holds” cannot and should not have bearing on the development of policies and procedures for police application of vascular neck restraint other than to recognize that the application of neck holds with no training is a recipe for disaster.

d) Police applications:

Only a standardized, appropriately trained and implemented vascular neck restraint carries the safety profile and medical implications of a vascular neck restraint. Personal style adaptations, hold modifications and frontal approach applications under less than ideal circumstance render the hold subject to the increased risk and unpredictable outcomes of both the untrained VNR and respiratory neck holds. Even trained individuals may not resort to the procedure style or application of their preference and assume that the risk profile is similarly low.

Improper technique, which would seem to be inclined to draw the most attention, seems to escape scrutiny as every hold that involves the neck is considered a “choke hold”. The hold described in Laufers vs. Toronto Police does not represent a carotid hold in any way shape or form due to its single handed anterior approach to the neck using a pincer grasp. Whether the officer in question believed he was applying some sort of carotid restraint, he was not applying VNR. While investigation of whether the hold the officer used was appropriate and dangerous might have been relevant, use of this case as evidence for the potentially lethality of VNR is not appropriate since the hold was not and could not be confused with true VNR.

In terms of professional police application of vascular neck restraint, four cases of death or persistent vegetative state revealed the following:

In two of the four cases, death of the subject occurred after protracted struggle using multiple methodologies of restraint. In both, the subject was exhibiting symptoms of extreme psychiatric distress and abnormal physical behavior for a protracted period of time before the struggle and VNR application. In one of those, the LVNR was attempted but immediately abandoned without any meaningful application as the officer recognized that he was unable to get into proper position to effect the hold. In the 2nd of the two, a paranoid and delusional subject underwent a short but intense physical struggle and short duration VNR application after which he was successfully handcuffed. He appeared to stop breathing 3 or 4 minutes after the application of VNR and CPR was started by the officers. He could not be resuscitated.

In the case of the subject who was left existing in a persistent vegetative state a prolonged and ineffective struggle by two officers against the subject was undertaken, there was application of attempted VNR for an unknown length of time and then the hold was “increased”. The subject was witnessed to be breathing following cessation of the struggle but subsequently rapidly deteriorated and died.

In each of these last 4 cases, features of the struggle and the death are extremely similar to other sudden deaths in custody that have occurred without the use of VNR.

While there is an intuitive association between the restraint process and the subsequent death of the individual, whether the specific modality can be implicated as causative has yet to be proven. It is interesting to note that conducted energy device technology (Taser®) and capsicum spray were both developed in hopes of eliminating death following to empty handed restraint techniques such as VNR. The incidence of in custody death has not diminished despite the cessation of use of VNR by many police agencies in favor of these "safer" modalities. There is a current high level of interest in pursuing each new method of restraint as causative in subjects' deaths while overlooking the strikingly similar features of the subject's presentation and that of the physical struggle.

The state of excited delirium discussed by medical experts as being responsible for severely abnormal physiology in the subject being restrained was cast off as 'cover up' in cases of death following multiple officer restraint, VNR, pepper spray and now in Taser® related events. Yet, the state of the individual remains the most strikingly reproducible chain of events in cases of in custody death. There is little doubt that the process of requiring restraint and in effecting restraint on some individuals is inherently more dangerous than for others, the difficulty lies in defining that risk if methods of restraint are cast off in favor of the next best tactic without defining the risk profile of the first.

6. In persons undergoing restraint utilizing vascular neck restraint or other neck holds, do databases or other recording systems exist that document characteristics of the vascular neck restraint including numbers of utilizations and number of adverse events?

Police agencies have begun to recognize the importance of being able to evaluate isolated anecdotal events against the denominator of exposures of a restraint methodology in the populations they serve. To date, no prospectively collected, widely accessible national or international data base exists that documents the number of altercations in which police personnel find themselves, the number and types of restraint methodologies used, and the successful as well as the adverse outcomes.

Police agencies that have begun to systematically collect their own data are to be commended for their diligence and responsibility in doing so. They are cautioned to utilize the expertise of trained epidemiologists in assessing their information such that common errors of judgement made by simply evaluating percentages and single incidents do not result in improper termination of or adaptation of procedures and policies through a misunderstanding of the statistics of risk and incidence.

Civilian oversight groups, watchdog agencies and the public must be similarly cautioned that reporting of only adverse outcomes serves to inflate the level of risk associated with an event and cannot be generalized to the total population in whom restraint methodologies are utilized as the denominator of exposures goes unreported. Such reporting is little more than fear mongering and has no scientific basis. Similarly, the estimation of a risk profile is a function of the frequency of events and the length of time during which the estimate is made. Precise estimates of risk require the evaluation large numbers of exposures over long periods of time in a varied population.

Voids in the literature and Future Research:

One of the most critical aspects in the incorporation of any use of force methodology into police practice is a clear understanding of the injury potential from using that force. In order to competently address this issue, police administrators are turning to the principles of medical research to assist them in making informed policy decisions. Fortunately, the days of accepting vendor claims of safety or efficacy at face value are quickly disappearing as responsible risk management practices embrace independent scientific research.

Risk management is not synonymous with abandonment of policies and procedures as a result of single adverse outcomes. Medical experts participating in this report feel that the injury potential from appropriate application of VNR is low in the physiologic sense. Regardless of previously published legal decisions to the contrary, medical reviewers involved in this report found nothing about the physiology of the properly trained and applied vascular neck restraint that suggests that VNR should or does fall into the realm of deadly force for the bulk of the population encountered in police interaction. There are specific risk groups in whom, for specific physiologic reasons, VNR is not recommended as the restraint technique of first choice; those populations are defined elsewhere in this report. However, it is anticipated that agencies may choose to train and implement VNR within their use of force policy/procedure with appropriate guidelines. Such implementation has anticipated physiological safety but, like all restraint methodologies and procedures, is not exempt from all risk. Training and implementation must reflect respect of the concept of unanticipated adverse outcomes.

Further physiology-based research into how and why properly applied vascular neck restraint generates subject compliance is unlikely to answer questions regarding risk profile in the population who is exposed to VNR. Rather, properly conducted epidemiologic research into risk profiles will lead to appropriate answers in defining the relative risk of the restraint process in the population in question. Only restraint methodologies used in practice can be evaluated; VNR will likely be one of those restraint methodologies in many police services. In order to define the risk profile, the hold will have to be evaluated for its performance in the relevant population across a wide variety of subject characteristics and types of encounters.

However, in order to determine the exact risk profile of VNR, research may not simply be an accounting exercise with evaluation by untrained analysts. Simple calculation of frequencies of events is unlikely to yield proper conclusions, particularly if the data collection period is short or the number of cases evaluated is small. In order for epidemiologic research to lead to accurate conclusions, data must be systematically collected and evaluated correctly using the principles of epidemiologic evaluation with consideration for the confounding and interacting elements in the restraint process on the whole.

The current environment of overreaction to isolated anecdotal events cannot help but create a reactionary state in which potentially valuable and low risk technologies are abandoned in favor of the next best touted alternate with an unproven profile. While police personnel and the general public are significantly affected emotionally by the death of a person in custody, this type of modification in practice in response to isolated events is dangerous for all concerned.

Evaluation of policies and outcomes must consider the context of the situation on the whole and the known body of evidence at the time of the event. Research is a dynamic process and more data will become available over time. However, policy making and procedure implementation occurs at the current moment meaning evaluators of outcomes must be responsible to the state of known research at the time. Commentators and evaluators of police procedures such as judicial investigators and coroners' offices must be responsible to the research as it evolves and keep current as new evidence emerges and old theories are rejected.

As described clearly in this report and other recently published scientific reports, the focus of subjects who suffer serious injury or die during the arrest process or in custody is a serious issue for law enforcement administrators. It is estimated that approximately 12 to 15 persons die in police custody in Canada every year (although this number may be greater since there is no National database for collating this information), each death generates great public criticism and debate and much pressure for reform of technique. Yet, the incidence of death has not changed despite major alterations in restraint methodology; the only predictor of a change in incidence to date has been a change in the illicit drug use profile of the community in question.

The literature review conducted for this National Study on Neck Restraints in Policing has revealed that in many in-custody death investigations, pathology reports, and legal hearings, conclusions are often drawn based upon pseudo-science, refuted medical research and sometimes completely erroneous conclusions drawn from summarizations of medical testimony. The testimony of medical experts is subjected to paraphrasing and summary as lay person lawyers, judges and juries struggle to understand complicated medical physiology and multifaceted processes. In some cases, medical physiology that is remotely possible but highly improbable for the events under discussion is erroneously embraced as the summative simple answer to a complex and highly emotionally charged question surrounding a death in custody. Often, the question of probability is abandoned in favor of the simpler one of possibility, however unlikely. Not only is this practice not based on an appropriate scientific approach, but the implications for this are significant and widespread. Individual officers can find themselves charged criminally or civilly, agencies are often sued resulting in potentially large settlements, and agency policies and training practices are changed. Not infrequently, agencies have discarded or severely restricted the use of a viable technique or practice placing officers at potentially higher risk of physical harm and/or legal exposure. Families are left with the feeling that an police officers intentionally harmed their loved one or that testimony of medical experts amounts to a "cover up" as the lay press and even judicial or inquiry summations/findings oversimplify the issues.

Summary of Report Recommendations:

1. Nomenclature

For ongoing implementation and evaluation of vascular neck restraint, it is highly recommended that consistent and definable nomenclature for vascular neck restraint is used. The term vascular neck restraint, or its abbreviation, VNR, should be used. Agencies implementing the copyrighted LVNR® should adhere to that specific terminology[5]. Police applications of restraint technology such as the vascular neck restraint are deserving of a professional and consistent nomenclature to separate use of this restraint technique from the variable, inconsistent and often incorrect attempts at restraint of a person's neck by untrained and non-police persons. There is a distinct and definable difference in application technique, physiology of effect and anticipated outcome between a vascular neck restraint and other types of holds involving the neck. Appropriate and consistent nomenclature assists in clarifying those differences.

Conversely, sloppy terminology and casual reference by any individual to vascular neck restraints as a choke hold, a strangle hold, a neck hold or "choking the subject out" serves only to confuse the goal of the restraint, the physiology behind it and the anticipated outcome. The similarity of the term "carotid sleeper hold" to descriptions of neck and head holds used in professional wrestlers/public entertainers adds to the confusion and belies the caution with which vascular neck restraint is used in police circumstances. The term "carotid sleeper hold" should be abandoned.

2. Injury Potential / Medical Considerations

This report finds that, while no restraint methodology is completely risk free, there is not medical reason to routinely expect grievous bodily harm or death following the correct application of the vascular neck restraint in the general population by professional police officers with standardized training and technique. The medical ramifications of application of various and sundry neck holds by untrained individuals and non police personnel cannot be evaluated or anticipated in detail except to say that a lack of a standard approach changes the risk profile of the technique for the worse. Professional application of the standardized vascular neck restraint should not be governed by the medical implications of lay person attempts at "neck holds" as the medical implications are likely to be vastly different.

Most police officers have no formal medical training and must anticipate that subjects fall under the normal physiologic and medical characteristics of the general population unless overwhelming evidence or clues presented to the officer suggest otherwise. Good policy guidelines will enable officers to apply appropriate techniques with appropriate discretion, thereby minimizing risk.

[5] The LVNR® is a registered trademark of the National Law Enforcement Training Center (NLETC), Kansas City, Missouri.

Use of VNR should be avoided, where possible, in the presence of the following visible risk groups:

1. The obvious elderly.

2. Obvious pediatric subjects.

3. Obvious or known Down's syndrome (Trisomy 21)

4. The obviously, visibly pregnant woman.

3. Issues Arising from Court Proceedings:

In reviewing the cases involving law enforcement use of vascular neck restraints which resulted in recommendations, most focus on training and policy considerations. The recommendations arising from Canadian legal cases are summarized as follows:

i. Training on the use of the vascular neck restraint should be provided on a regular basis.
ii. In training, officers should be informed of the VNR's potential for adverse medical outcomes.
iii. The VNR should be limited by policy to situations where officers or others are in danger of physical harm.
iv. Police agencies should document all circumstances in which the VNR is used. This reporting data should be reviewed periodically to measure adherence to policy and to identify training issues.
v. Ongoing research should be conducted on the use of neck restraints and changes implemented where appropriate. (Although this recommendation was gleaned from the legal review, the medical experts tasked with reviewing the existing scientific research for this project unanimously indicated that no further medical research is required for making best-practices training standards and policy. With respect to the issue of restraint modality with subjects experiencing excited delirium syndrome, the international RESTRAINT study which is just in its infancy is seeking to address this concern.)

4. Training Considerations

The vascular neck restraint is a technique which is employed in dynamic, violent and rapidly changing events. In order to become competent in the use of this type of psychomotor skill[6], officers require initial training that as closely as possible reflects the conditions on which the technique will be applied in the operational environment. In this respect, training should begin with static, closed-motor instruction to master the proper application of the VNR, graduate through open-motor training and ultimately provide the opportunity for dynamic motor (stimulus response) or scenario-based training.

[6] Muscle movement produced by action of the mind or will.

Officers should demonstrate the consistent ability to maintain the proper positioning of the VNR against a training partner who struggles against the restraint. This will decrease the probability of the VNR inadvertently becoming a respiratory restraint which increases the risk of harm to the subject.

Officers should demonstrate that they are able to continuously monitor the correct positioning of the VNR and once any improper positioning is identified either immediately obtain the correct positioning or discontinue the VNR.

Officers should demonstrate that they understand and are able to apply the concept of disengaging from the neck restraint and either tactically repositioning or transitioning to other force options if the VNR has not achieved the desired result within 30 seconds.

As with all law enforcement use of force options, the goal of applying any restraint is to obtain subject compliance. With this in mind, officers should understand that the objective of the VNR is not to obtain unconsciousness but to obtain subject compliance. Officers should be taught to monitor the subject during the VNR application for signs of subject compliance and, should such compliance be forthcoming prior to unconsciousness, maximal compression should cease. In the case of voluntary compliance, the officers should maintain control of the subject and transition to handcuffing control using the agency-specific subject control and handcuffing techniques. In those circumstances where the subject continues aggressive behaviour against the VNR contrary to the professional verbal direction of the officer, maximal compression will likely result in involuntary compliance (unconsciousness) with 10-15 seconds.

Officers should be taught the signs and symptoms of unconsciousness so that such behaviour can be immediately identified. Once unconsciousness is identified, the officer applying the VNR should:

- Discontinue compression but maintain control of the subject,
- Place the subject in the appropriate position for prone handcuffing and once handcuffed,
- Move the subject into a proper side-lying recovery position and,
- Continuously monitor the subject for vital signs (primarily respirations) and,
- Ensure the subject regains consciousness within 30 seconds and provide verbal reassurance and,
- Where vital signs are absent or the subject does not regain consciousness within 30 seconds, alert emergency medical personnel and begin appropriate lifesaving measures.
- Following the application of a VNR, subjects who complain of pain or discomfort which is more than transitory should be allowed to seek medical attention at the first reasonable opportunity.

During training, officers should be afforded the opportunity to assume a triple role as the restrainer, the restrained and an observer officer.

VNR training should include a classroom session which discusses and which the learner should be tested for comprehension of:

- The difference between respiratory and vascular restraints,
- The medical risks inherent to respiratory and vascular restraints,

- The identification of higher-risk subjects pertaining to VNR application,
- The identification of subjects who may be experiencing excited delirium syndrome and the associated medical emergency of this condition,
- Signs and symptoms associated with both voluntary (conscious) compliance and involuntary (unconscious) compliance,
- A review of pertinent Canadian legal action (criminal, civil and fatality inquiries) respecting the law enforcement use of neck restraints.
- A discussion of the use of the VNR which is consistent with the sections of the Criminal Code of Canada authorizing the use of force by peace officers.
- A discussion of agency-specific restrictions and/or prohibitions concerning the application of the VNR
- Agency-specific reporting and documentation procedures

Finally, as with all psychomotor skills, those that are not used consistently will deteriorate over time and those motor skills which are more complex will deteriorate more quickly. The legal review revealed several cases where the officers were not re-trained in the VNR technique on a regular basis (typically since the initial academy training) and this was associated with a deterioration of the officer's skill in applying the technique. Agencies incorporating the VNR are advised to consider the importance of frequent and mandated recertification training to maintain officer's competency.

5. Use of Force Context

As mentioned previously, the VNR is not consistently placed within a use of force context in the Canadian law enforcement environment. The medical experts who contributed to this study opined that a properly applied VNR by a trained law enforcement officer is unlikely to result in serious injury or death.

The Criminal Code of Canada and related case law best describes deadly force as 'any force that is likely or intended to cause death or grievous bodily harm'. The medical research reviewed for this study does not support the placement of the VNR within the deadly force category. Plainly stated, the VNR, when properly applied, is neither likely nor intended to cause serious medical outcomes. However, that statement does not imply that VNR application can be considered risk free. All modalities of law enforcement restraint carry with them an inherent risk of significant, unintended medical consequences. This concept does not render restraint modalities inappropriate for use particularly when the context of the situation indicates that restraint is appropriate. With respect to the VNR, it is the consensus of the medical panel that a reasonable, properly trained officer could apply a VNR without apprehension that it would result in serious bodily harm or death.

VNR is simply a high level of 'Empty Hand' or 'Physical Control' technique and should be so referenced within the existing spectrum on the National Use of Force Framework (and similar frameworks / models). VNR should be reserved for use in restraining and controlling actively aggressive or assaultive subjects where no other reasonable restraint options would be effective or could be considered given the totality of circumstances.

6. Research interpretation and future direction

Risk management is not synonymous with abandonment of policies and procedures as a result of single adverse outcomes. Training and implementation must reflect respect of the concept of unanticipated adverse outcomes.

Further physiology-based research into how and why properly applied vascular neck restraint generates subject compliance is unlikely to answer questions regarding risk profile in the population who is exposed to VNR.

Properly conducted epidemiologic research into risk profiles will lead to appropriate answers in defining the relative risk of the restraint process in the population in question. In order to determine the exact risk profile of VNR, research may not simply be an accounting exercise with evaluation by untrained analysts. Simple calculation of frequencies of events is unlikely to yield proper conclusions, particularly if the data collection period is short or the number of cases evaluated is small. In order for epidemiologic research to lead to accurate conclusions, data must be systematically collected and evaluated correctly using the principles of epidemiologic evaluation with consideration for the confounding and interacting elements in the restraint process on the whole.

Despite a heavy societal sentiment that physicians in general are “all knowing”, not all physicians are credible experts in all fields of medicine. Detailed knowledge regarding many facets of human physiology may only be found at the specialist and sub-specialist level. All physicians must keep abreast of current medical research and the changes within it to be considered adequate practitioners and expert witnesses. Evaluation of policies and outcomes must consider the context of the situation on the whole and the known body of research at the time of the event with recognition that research is a dynamic process and both data and theories change over time.

Commentators and evaluators of police procedures such as judicial investigators and coroners’ offices must be responsible to the research as it evolves and keep current as new evidence emerges and old theories are rejected. Medical investigators and expert witnesses are not credible if their knowledge bases are antiquated.

The authors recommend the following future action be taken:

1. A National medical/law enforcement study be conducted that focuses on the relationship between persons restrained by police and the correlation to harm (injury and death). Currently there is no study or database that can assist officers or administrators in measuring the potential for harm between the various types of force options available.
2. A joint medical/law enforcement study on the issue of excited delirium and restraint methodology be conducted. This study would permit administrators to make best-practices policy and training decisions based upon the most current research in order to maximize the survivability potential for subjects experiencing excited delirium who must be restrained by police.
3. A standing National Medical Advisory Board be created and resourced. This Board would act as an independent, objective oversight group that would be an available resource to all law enforcement agencies in

Canada. The board would be accessible to provide timely information to agencies with respect to:

iv. Immediate involvement into in-custody death investigations. To liaise with the pathologist or coroner of jurisdiction and ensure all necessary measures are taken and current science is applied to arrive at sound medical conclusions.
v. Review of medical reports or records in use of force investigations where the complainant alleges significant injury.
vi. Assist agency researchers, trainers and administrators with medical reviews of new technologies, use of force systems or agency practices and policies.

Supported by the Canadian Association of Chiefs of Police (CACP), the National Medical Advisory Board could be attached to and accessed through the Canadian Police Research Centre.

Glossary of Terms

ANS: Autonomic Nervous System

Arrhythmia: Any variation from the normal rhythm of the heart beat, including sinus arrhythmia, premature beat, heart block, atrial fibrillation, atrial flutter, pulsus alternans and paroxysmal tachycardia.

Atherosclerosis: The progressive narrowing and hardening of the arteries over time.

Bar arm hold: A restraint technique in which the forearm is placed straight across the front of the neck.

Bifurcation: Split into two parts.

Bradycardia: A slow heart action.

Carotid: Pertaining to the carotid artery.

Carotid artery: A key artery located in the front of the neck that carries blood from the heart to the brain.

Carotid hold, carotid sleeper hold: A restraint technique in which symmetrical force is applied by the forearm and upper arm to the front of the neck such that there is compression of only the carotid arteries and jugular veins and not the trachea.

Carotid occlusion: The act of closing the carotid artery.

Carotid sheath: The dense fibrous investment of the carotid artery, internal jugular vein, and vagus nerve on each side of the neck, deep to the sternocleidomastoid muscle; the layers of cervical fascia blend with it.

Carotid sinus reflex: A normal reflex relating to the carotid sinus syndrome, which results from hypersensitivity or hyperactivation of the carotid sinus.

Carotid sinus: A slight dilation in the carotid artery at its bifurcation into the external and internal carotid arteries, it contains baroreceptors (pressure sensors) that when stimulated, will cause a reflex slowing of the heart, vasodilation and a fall in blood pressure.

CBF: Cerebral or coronary blood flow.

Cerebral anoxia: A reduced supply of oxygen to the brain.

Cerebral ischemia: Deficiency in blood supply to the brain.

Choke hold: A restraint technique in which the forearm is placed straight across the front of the neck. The term is sometimes incorrectly used to refer to the carotid hold, particularly in the legal context.

Clonic seizure: A seizure characterised by repetitive rhythmical jerking of all or part of the body.

CNS: Central nervous system

Contusion: A bruise, an injury of a part without a break in the skin.

Cricoid cartilage: The lower most of the laryngeal cartilages, may be palpated just below the thyroid prominence Adjacent the cricoid cartilage and the first tracheal ring is the cricothyroid membrane, a site used for rapid emergency airway access (cricothyroidotomy).

Deleterious: harmful often in a subtle or unexpected way

Doppler: An augmented listening device for the purpose of detecting the pulse in an extremity. Use in the evaluation of peripheral (occlusive) vascular disease.

Dysrhythmia: Defective rhythm.

Ecchymosis: A small haemorrhagic spot, larger than a petechia, in the skin or mucous membrane forming a nonelevated, rounded or irregular, blue or purplish patch.

EEG A graphic record of the electrical activity of the brain as recorded by an electroencephalograph. Also called encephalogram.

Electroencephalograph: A system for recording the electric potentials of the brain derived from electrodes attached to the scalp.

Esophagus: That part of the alimentary canal between the pharynx and the stomach; the gullet.

Hematocrit: haematology, investigation> Relative volume of blood occupied by erythrocytes. An average figure for humans is 45ml per cent, i.e. A packed red cell volume of 45ml in 100ml of blood.

Hemorrhage: The escape of blood from the vessels, bleeding.

Hyoid bone: A U-shaped bone lying between the mandible and the larynx, suspended from the styloid processes by slender stylohyoid ligaments..

Hypoglossal nerve: The hypoglossal nerve enervates the muscles of the tongue.

Hypoxia: Reduction of oxygen supply to tissue below physiological levels despite adequate perfusion of the tissue by blood. (cf. Anoxia).

Ischemia: A low oxygen state usually due to obstruction of the arterial blood supply or inadequate blood flow leading to hypoxia in the tissue.

Intervertebral discs: The intervertebral discs or nucleus pulposus are a fibro-cartilaginous disc that lie between the vertebral bodies in the spine.

Keto-steroid: A steroid-like chemical which is a by-product of the breakdown of certain steroids. They are found in urine and measuring them can give a good indication of the level of androgen production in the body. The major ketosteroids are: androsterone, etiocholanone and oestrone.

Judoko: Practitioner of Judo.

Jugular: Of or pertaining to the throat or neck; as, the jugular vein. Of or pertaining to the jugular vein; as, the jugular foramen

Lateral vascular neck restraint (LVNR®): This is a type of carotid hold technique developed by Jim Lindell of the National Law Enforcement Training Center.

Laryngeal nerve: Branches of the vagus nerve (the tenth cranial nerve). The superior laryngeal nerves originate near the nodose ganglion and separate into external branches, which supply motor fibres to the cricothyroid muscles, and internal branches, which carry sensory fibres. The recurrent (inferior) laryngeal nerve originates more caudally and carries efferents to all muscles of the larynx except the cricothyroid. The laryngeal nerves and their various branches also carry sensory and autonomic fibres to the laryngeal, pharyngeal, tracheal, and cardiac regions.

Micropipometer: An instrument for measuring minute changes in the volume of a part as a result of blood flow into or out of it.

Mucosal: Pertaining to a mucous membrane.

Neck restraint: An upper body restraint hold used by police to overcome resistance on the part of a suspect. From a medical perspective, there are two kinds of holds: carotid holds and respiratory holds.

Neuropsychological: Pertaining to neuropsychology.

Neuropsychology: A branch of psychology which investigates the correlation between experience or behaviour and the basic neurophysiological processes. The term neuropsychology stresses the dominant role of the nervous system. It is a more narrowly defined field than physiological psychology or psychophysiology.

Parasympathetic: Pertaining to a division of the autonomic nervous system.

Petechial: Characterised by, or pertaining to, petechiae

Petechia: A pinpoint, nonraised, perfectly round, purplish red spot caused by intradermal or submucous haemorrhage.

Phrenic nerve: The motor nerve of the diaphragm. The phrenic nerve fibres originate in the cervical spinal column (mostly c4) and travel through the cervical plexus to the diaphragm.

Psychometric: Assessment of psychological variables by the application of mathematical procedures.

Salivary gland: Any of the saliva-secreting exocrine glands of the oral cavity.

Sickle cell disease: Disease common in races of people from areas in which malaria is endemic. The cause is a point mutation in the allele that codes for the beta chain of haemoglobin with a substitution of (valine for glutamic acid at position 6. The defective haemoglobin (HbS) crystallizes readily at low oxygen tension. In consequence, erythrocytes from homozygotes change from the normal discoid shape to a sickled shape when the oxygen tension is low and these sickled cells become trapped in capillaries or damaged in transit, leading to severe anaemia.

Sphygmomanometer: An instrument used for determining arterial blood pressure indirectly. The two types are aneroid (dial face) and mercury (column).

Sternocleidomastoid: This is one of two muscles located on the front of the neckwhich serve to turn the head from side to side.

Subcutaneous: Under the skin.

Submucosal: Situated under a mucous membrane.

Syncope: A temporary suspension of consciousness due to generalized cerebral ischemia; a faint or swoon.

Thrombosis: The formation, development or presence of a thrombus.

Thrombus: An aggregation of blood factors, primarily platelets and fibrin with entrapment of cellular elements, frequently causing vascular obstruction at the point of its formation. Some authorities thus differentiate thrombus formation from simple coagulation or clot formation.

Tonic seizure: Sustained contractures of skeletal muscle as occur during convulsions.

Trachea: The windpipe. A fibrocartilaginous tube lined with mucous membrane passing from the larynx to the bronchi.

Tracheal rings: The 16 to 20 incomplete rings of hyaline cartilage forming the skeleton of the trachea; the rings are deficient posteriorly for from one-fifth to one-third of their circumference.

Transient unconsciousness: unconsciousness lasting only a short time

Vascular: Pertaining to blood vessels or indicative of a copious blood supply.

Vertebral artery: Paired arteries which supply the muscles of the neck, spinal cord and cerebellum.

Vagus nerve: The vagus nerve enervates the gut (gastrointestinal tract), heart and larynx. Lesions of the tenth nerve usually result in a horse voice, but may also cause difficulty in swallowing or talking.

Appendix A – National Study on Neck Restraints in Policing in Canada Law Enforcement and Medical Team Members.

Alain Aquilino
Use of Force Instructor
Montreal Police Department

Alain Aquilino became a police officer for the Montreal Police department in 1999. After becoming a firearms instructor in 2001, Alain worked in the downtown area of Montreal, until 2004 at which time he became a member of the Tactical intervention Unit as well as an instructor in defense tactics and vehicle interceptions and foot pursuits.

Since 2006, Alain has been a Defense and Tactics master instructor assigned to the Use of Force Unit of the Montreal Police Department and instructs at the Quebec Provincial Police Academy. Alain has participated as a member in Provincial and National use of force committees and research projects.

Ronald Belanger
l'École nationale de police du Québec

Ronald Bélanger has been employed in the use of force area of police training for the past 29 years. Beginning as a defensive tactic instructor for 17 years with l'Institut de police du Québec, he was then appointed its Use of Force Coordinator, then Use of Force Manager. Since 2001 he has been appointed Consulting-expert in use of force with l'École nationale de police du Québec. He has been responsible or a member of many national and provincial committees dealing with a number of subjects related to police intervention. A certified trainer in a number of subjects related to the use of force, Mr Bélanger holds a bachelor's degree in physical education form l'Université du Québec à Montréal. He is a master in Tae kwon do and recognised expert witness in use of force.

Pierre Brassard
École nationale de police du Québec

Pierre Brassard attended the Royal Military College of Canada, graduating in 1971. Pierre has served in the Canadian Armed Forces as a logistics officer in Canada, as well as in Egypt under the aegis of the United Nations. His military experience was mostly in vehicle fleet management and safety as well as in field transportation planning. While serving, he attended the École nationale d'administration publique of the Université du Québec, where he obtained a Master's degree in Public Administration.
Upon leaving the Armed Forces in 1987, he joined the l'Institut de police du Québec, where he managed the information systems until the fall of 2000. As the newly reorganised École nationale de police du Québec was creating a research department, Pierre undertook the installation of its watch service, while also conducting research in such police related fields as less-lethal weaponry (plastic bullets and conducted energy devices), use of force, as well as vehicular traffic policing.

Sergeant Chris Butler
Calgary Police Service

A 21-year law enforcement veteran, Chris is currently the sergeant in charge of the delivery of all officer safety, subject control tactics, emergency vehicle operations, Incident Command and Strategic Communication training for the Calgary Police Service. Chris has been certified as an instructor or instructor-trainer in numerous firearms, combatives, less lethal/chemical agents and emergency vehicle operation techniques. Chris has made presentations at National and International law enforcement conferences on a variety of topics.
Chris has been qualified at Provincial and Federal court as an expert in firearms safety, police firearms training, law enforcement use of force training and evaluation and is certified as an instructor in Verbal Judo and Neuro Linguistic Programming (NLP) and is also certified in Hypnosis and Hypnotherapy

Constable Chris Edge
Edmonton Police Service

Chris has served thirteen years with the Edmonton Police Service mainly in an operational capacity. Chris is currently the control tactics instructor within Officer Safety Unit responsible for curriculum design, research and development of equipment and tactics, as well as training and recertification of in-service officers.
Chris is certified as an instructor in a variety of subject control tactics disciplines.

Dr. Christine Hall

Dr. Christine Hall received her MD from the University of Calgary in 1996 and completed her 5 year residency in Emergency Medicine in the Royal College of Physicians and Surgeons (FRCP) Program in Emergency Medicine at the University of Calgary Faculty of Medicine from 1996 to 2001. During her residency, Dr. Hall completed a Master's Degree in Clinical Epidemiology and completed her thesis in 2003 as a staff physician.

Upon completion of her residency, Dr. Hall became a full time Emergency Department physician at the Calgary Health Region. She was the Division Chief of Research, the coordinator of Resident Research, a member of the Adult Research Committee for the Calgary Health Region, a member of the departmental executive for the Department of Emergency Medicine, Calgary Health Region and also served as the Program Director for the FRCP Program in Emergency Medicine during her tenure at the Calgary Health Region. Dr. Hall was a clinical lecturer at the University of Calgary Faculty of Medicine. Dr. Hall also served as a flight physician with the Shock Trauma Air Rescue Society of Alberta for 6 years. She is now an emergency department physician at the Vancouver Island Health Authority.

Dr. Hall has been participating in the investigation of sudden in custody death for several years and is the Principal Investigator for the RESTRAINT Study, a multicenter, international epidemiologic study of features surrounding the use of restraint in police interactions; an effort funded by both the Canadian Police Research Centre and the National Institute of Justice (USA). Dr. Hall collaborates in this research effort with notable experts in the field such as Drs. Ted Chan, Gary Vilke, Bill Bozeman and Deborah Mash. Dr. Hall has contributed to the understanding of excited delirium syndrome and in custody death evaluations through her presentations at seminars and

conferences, participation as an expert witness at relevant inquests and investigations and in her ongoing research efforts. She has participated in several reviews of restraint methodologies including the CPRC technical report surrounding the use of conducted energy weapons.

Dr. Michael D. Hill, MD MSc FRCPC
HSF Alberta/NWT/NU Professorship

Dr. Michael D. Hill received his MD from the University of Ottawa in 1993 and pursued residencies in both internal medicine and neurology before studying clinical epidemiology at the University of Calgary. Dr. Hill's commitment to educating the public about signs and symptoms of stroke are evidence of his dedication to public awareness and patient-based, compassionate healthcare.

Dr. Hill is the recipient of many awards and recognitions for his work in stroke research, teaching and clinical medicine. A world-renowned physician and researcher, Dr. Hill is also a respected Associate Professor in the Department of Clinical Neurosciences at the University of Calgary. His research involving acute stroke treatment has revolutionized stroke care in Canada and has become the gold standard around the world. In 2004, Dr. Hill was selected as the Michael S. Pessin Stroke Leadership Prize winner. This prestigious award recognizes those who have demonstrated a passion for learning and expanding the field of stroke research.

Joel Johnston
Use of Force Coordinator
British Columbia

Joel is an Economics graduate of Simon Fraser University, and a 22 year police veteran with the Vancouver Police Department. He has worked in the Patrol Division, Traffic Enforcement, and Training Section for 8 years as the Department's Control Tactics Coordinator, was a founding member and supervisor with the Crowd Control Unit and spent his most recent 7 years as a fulltime Emergency Response Team Squad Leader, Training Coordinator and Officer-In-Charge. Joel is currently on secondment to the British Columbia Ministry of Public Safety & Solicitor General as the Use of Force Coordinator for the province of BC. Joel is a lifetime martial artist with a third degree black belt in Shotokan Karate and is a practicing mixed martial artist. He has been a frequent contributor to a variety of national and international law enforcement publications for the past 12 years.

Kelly Keith
Atlantic Police Academy

Kelly Keith is a 19 year veteran of policing. He has worked with Winnipeg Police, Victoria Police and was seconded to the Justice Institute of British Columbia as a Use of Force, Physical Training Instructor. He is currently an Inspector with the Atlantic Police Academy instructing Physical Fitness, Officer Safety, Use of Force, and Firearms. Kelly has numerous Instructor Certifications in Use of Force and Firearms. He is a second degree black belt in Jiu-Jitsu, a certified personal trainer, strength and conditioning instructor and sports nutritionalist specialist.

Chris Lawrence
Ontario Police College

Chris is the Team Leader of the Defensive Tactics Training Section at the Ontario Police College in Aylmer, Ontario. Chris began his police career in 1979 and has experience working in Patrol, Underwater Search & Recovery, Marine Operations, Tactical & Rescue Unit, Criminal Investigation Bureau and Training. Chris has a graduate degree in leadership and training at Royal Roads University, is a Technical Advisor to the Force Science Research Institute, Minnesota State University-Mankato, a Research Partner with the Canadian Police Research Centre, and a columnist with PoliceOne.com. He has testified regarding use of force training and subject control in Canada and the United States.

Annik Neufeld
Use of force Senior Instructor
Montreal Police Department

Annik Neufeld became a police officer with the Montreal Police department in 1992, after graduating from the University of Montreal with a Bachelors degree in Criminology with a minor in juvenile social services, pertaining to court pre-sentencing analysis.
She completed the police institute training with honours for overall academic performance and earned her black belt in the martial art of Kyokushin Karate. In 1998 she became one of two use of force Instructors for the Montreal Police Department. In 2000, Annik became a Master Instructor and began training police instructors at the Quebec Provincial Police School, as well as within in her own organization…
She is responsible for the implementation of a wide variety of new training programs involving patrol officers, sergeant-detectives, lieutenants, special units personnel, prison guards and civilians involved in police work.
She is involved in several use-of-force committees, provincially and nationally. In June 2004, she was given the opportunity to be an active member on the CPRC Steering Committee for the Conductive Energy Devices.

Steve Palmer
Executive Director
Canadian Police Research Centre

Steve first became Director of the CPRC in 1998 and then assumed the position of Executive Director in 2004. In this role, he is responsible for the strategic direction, national and international relationships and ensuring that the organization is focused and responds to the needs of the law enforcement and first responder communities.
Steve is a Director of the Society for the Policing of Cyberspace (POLCYB). POLCYB is a not-for-profit society based in British Columbia, whose goal is to enhance international partnerships among public and private professionals to prevent and combat crimes in cyberspace.
Since March 2005, Steve also serves as a Director with Women in Defense and Security (WIDS), a national Security Organization promoting defense and security, affiliated with the Canadian Defense & Securities Industries Association, providing its members with opportunities for professional development and networking, and in doing so cultivating the advancement of women in leadership roles in government and industry professions across Canada.

Dr. Robert Sheldon

Dr. Robert Sheldon is known internationally for his seminal studies on the diagnoses, natural history, and treatment of vasovagal syncope. He received his PhD in Molecular Biology at the University of Colorado in 1973. After studies at the Laboratory for Molecular Biology, Cambridge (UK), he received his MD from the University of Toronto in 1981. In 1988 he completed training in cardiology at the University of Calgary, where he was appointed Assistant Professor of Medicine. He has been Professor of Medicine since 1997, and is now Vice President Research of the Calgary Health Region and Associate Dean Clinical Research of the University of Calgary.

His contributions range from participation in the discovery of polyadenylic acid sequences, through molecular genetics, to discovering the receptor for antiarrhythmic drugs. He leads an active clinical research group studying aspects of human vasovagal syncope and our understanding of heart rate control. He reviews for many journals and funding agencies, and is a member of the Governing Council of the Canadian Institutes of Health Region.

Sergeant Bruce Stuart
Royal Canadian Mounted Police

Sergeant Stuart is a 17-year member of the RCMP. He is currently assigned to the Operational Policy Unit of the National Criminal Operations Branch responsible for all use of force matters. This includes developing all policies and conducting needs analysis and implementation of new equipment and training. Previous to coming to Ops policy Bruce worked in British Columbia in General Duties in very small detachments to the Countries largest detachment, Surrey Detachment where he was the NCO in charge of training.
Sergeant Stuart is an Instructor Trainer in the Conducted Energy Weapon, Basic Firearms Instructor and Public and Police Safety Instructor. Bruce has been involved in

the development and revision of lesson plans used for training and provided a Legal Articulation lecture for all Investigators Courses within British Columbia for the RCMP.

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Appendix C – Legal Cases Reviewed

Canada

1. Neck Restraints as a Use of Force
   Report to the Policing in B.C. / Commission of Inquiry
   Mr. Justice Wallace T. Oppal, Commissioner
   1993-08-20

2. Charles Steward and Terrance Noonan v. Michael Martay
   Supreme Court of British Columbia
   Docket C901487
   1993-04-27

3. Drda v. R.
   Supreme Court of British Columbia
   Docket CC891894
   1990-11-16

4. R. v. Hartikainen
   Provincial Court of British Columbia
   Docket 17344
   2003-02-28

5. Bodner v. MacDonald
   British Columbia Court of Appeal
   Docket CA021882
   1997-06-23

6. David William Nichol
   Coroner's Court of British Columbia
   Coroner's inquest
   Case 92-560-0210

7. R. v. Magiskan
   Ontario Superior Court
   Docket 00-0038
   2003-10-17

8. Laufers v. Toronto (Metropolitan) Police Force
   Ontario Court of Justice – General Division
   1992 O.J. No. 2222
   Action No. 1031/90

United States

1. Los Angeles v. Lyons
   U.S. Supreme Court
   Docket 461 U.S. 95 (1983)
   No. 81-1064
   1993-04-20

2. Nava v. City of Dublin
   U.S. 9th Circuit Court of Appeals
   No. 95-16209
   1997-07-28

3. Partee v. Coburn, Sutherland, Bradshaw and Benton Township
   United States District Court, Western District of Michigan
   No 1:04-CV-728
   2005-11-15

4. Ombudsman's Report
   Boise, Idaho
   Complaint Investigation and Findings
   OMB04/0226
   2005-06-13

5. Ombudsman's Report
   Boise, Idaho
   Complaint Investigation and Findings
   OMB05/0190
   2006-05-15

6. Sorrells v. City of Dallas
   United States Court of Appeal
   45 Fed.Appx 325
   No. 01-10610
   2002-07-10

Other Cases

1. Crime and Misconduct Commission
   The Arrest of Samuel Hogan: A CMC Investigation
   Queensland, Australia
   August 2005

Neurological Considerations on the Vascular Neck Restraint

Michael D. Hill, MD MSc FRCPC

Introduction

The lateral vascular neck restraint (LVNR) is a martial arts based procedure now commonly taught by police forces across North America. In brief, it is a method of bilateral carotid artery and jugular vein compression designed to induce syncope. Compression is achieved by a single arm, with the airway in the crook of the elbow. The purpose of the following discussion is to provide some neurological considerations to the discussion of the safety of this technique.

Literature

A review of the medical literature (PubMed, EmBase) failed to reveal any reports of neurological injury with the application of this specific technique.

Context

There are several possible issues that arise from physiological considerations:
1. Syncope
a. Role of brain injury in secondary cardiac arrest
2. Seizure
3. 2-vessel forebrain ischemia
4. Stroke
a. Ischemia
b. Hemorrhage
c. SAH
d. Carotid and vertebral artery dissection
5. Spinal cord injuries

Syncope (Fainting)

Syncope and pre-syncope occur when not enough blood reaches the brain for a long enough time. After only 3-5 seconds of absent blood flow to the brain, unconsciousness ensues. The time will vary as the degree of blood flow. During syncope, it is common for patients to have clonic jerks, mimicking a seizure. This is called myoclonic or convulsive syncope.
The commonest causes of spontaneous syncope are cardiac arrhythmias (eg. the heart beating too fast or too slow). However, the brain influences the heart and in some situations may cause arrhythmias. In situations of induced syncope, such as the LVNR, it is possible that patients could develop secondary cardiac arrhythmias.

Seizure

A seizure is an electrical storm of the brain. It may be focal, affecting only one part of the brain and by extension one function of the brain, or it may be generalized. Members of

the public will have typically only seen generalized seizures (so-call Grand Mal seizures) either in life or on film. Seizures may occur for multiple reasons. They may be induced by ischemia (low blood flow), such as would be expected to occur in the LVNR.
In the setting of the LVNR, police officers could encounter both or either of myoclonic syncope or a full-blown seizure as a result. In general, seizures will result in movements which are involuntary.

Stroke

There are two broad types of stroke – ischemic (lack of blood flow) and hemorrhage. Ischemic stroke comprises 85% and hemorrhage 15% of all stroke.
The brain is particularly sensitive to ischemia – lack of blood flow. However, it is important to note that it is relatively impervious to low oxygen, when the blood flow is adequate. Witness man's ability to climb to the top of Mt. Everest without oxygen supplements. A classic model of stroke is the rodent 2-vessel forebrain ischemia model. This is exactly analogous to the LVNR. In this model, rodents will develop ischemic damage after many minutes of bilateral carotid artery occlusion.
In man, there are four vessels bringing blood to the brain – the 2 anterior carotid arteries and the 2 posterior vertebral arteries. In the vast majority of the population has an intact collateral blood flow circulation in the brain. This means that even with a carotid artery occlusion, blood flow is preserved due to collateral flow from the posterior (vertebrobasilar circulation), so that even while symptoms may occur (eg. syncope), the brain blood flow is not dangerously low so that stroke damage occurs.
Ischemic stroke may be caused rarely by dissection of the craniocervical arteries. In Calgary, 1-4% of ischemic is due to dissection every year. A majority of dissections are spontaneous without identifiable cause. However, a proportion of ischemic strokes due to dissection are clearly related to trauma; there is not doubt than neck trauma, even minor neck trauma is associated with dissection leading to stroke. In this context, LVNR could be associated with craniocervical artery dissection.
Rarer still are hemorrhagic strokes caused by dissection. In such cases, a dissection has been full thickness resulting in a dissecting pseudoaneurysm. Rupture of the pseudoaneurysm may result in severe bleeding.

Spinal Cord Injury

The last consideration with any neck hold is the risk of spinal cord injury. In the context of the LVNR, when done correctly, there is no risk of spinal cord injury. Spinal cord injury would require excessive force to occur. However, it is clearly, important to train officers in technique to avoid distraction and torsional movements of the upper cervical spine to prevent spinal cord injuries.

Summary

For the officer applying LVNR –
a) There are no reports of stroke and direct neurological injury from this procedure in the medical literature
b) Theoretical risks include:
a. Seizures

i. With/without associated aspiration
b. Ischemic stroke due to dissection
c. Hemorrhagic stroke due to dissection
d. Spinal cord injury

In general, I would expect such injuries to be rare. However, the purpose of the national registry would be to try to put numbers beside this list. This is a laudable effort.
Finally, clearly technique matters greatly. Good technique will much less frequently result in the problems described above.

Cardiology Considerations of the Vascular Neck Restraint
Dr Robert Sheldon MD PhD FRCP(C)

This is a review of the vascular neck restraint from a cardiovascular perspective. In preparing this we addressed 5 questions:

1. What is VNR?
2. How does it work?
3. Is it safe?
4. Why do people die?
5. What next?

I. VASCULAR NECK RESTRAINT

Vascular neck restraint (VNR) is a physical technique used to bring under control subjects thought to be endangering themselves and others, and is used when less aggressive techniques cannot be used successfully. It is based on a Judo technique in which the neck of the subject is compressed in the crook of the arm of the subduing officer, sparing the trachea. The purpose is to compress the carotid arteries and jugular veins, thereby inducing fainting. It is usually effective within seconds, and subjects usually recover very quickly.

II. MECHANISM OF VNR IN CAUSING FAINTING

There are 5 main considerations in the mechanism of VNR. It has been suggested that VNR might cause cerebral asphyxia by inadvertent airway occlusion; it may cause cerebral congestion and deoxygenation by jugular venous congestion; it might induce hypotension and bradycardia by the carotid sinus reflex; it might cause hypotension by the Valsalva mechanism; and it might simply partly occlude the carotid arteries.

Cerebral asphyxia due to airway occlusion is highly unlikely. Properly done, VNR deliberately spares the airway. As well, subjects neither recall nor exhibit airway distress or pain before losing consciousness.

Cerebral venous congestion is not a widely recognized cause of syncope in the cardiovascular literature, and remains a speculative possibility.

Carotid sinus reflex hypotension and bradycardia might cause syncope in the subjects. The carotid sinus is located at the junction of the internal and external carotid arteries beneath the angle of the jaw. It contains sensors that help regulate blood pressure and heart rate, and external pressure usually reduces heart rate and blood pressure to a small extent. In some older subjects these drops are big enough to decrease cerebral perfusion to the extent that people faint. This is rarely true in young people. If this reflex causes syncope when VNR is applied, then bradycardia – a slow pulse rate – should be observed. Most studies are small, and in most of them pulse rate measurement was not foremost on anyone's minds. Nonetheless, the few studies that report heart rate noted that it increased, not decreased. Therefore the carotid sinus reflex may play only a small role in VNR.

However it does raise the issue of the safety of carotid sinus compression, which VNR probably does. The evidence is that adverse events occur in about 0.1% of cases, and these are mainly neurological complications. Notably, these are studies of calm, older subjects with compression on only one side of the neck, and with near perfect placement. These caveats prevent us from concluding that bilateral carotid compression in agitated young subjects, under conditions that might prevent perfect placement can never cause a neurological complication; however, the risk of such an event is anticipated to be extremely small.

The Valsalva manoeuvre is forced strain against closed airway, like the response to severe constipation. It decreases venous blood return to heart, thereby reducing cardiac output. Although there are few reports of subjects inadvertently performing this manoeuvre, this could explain the reduced pulse pressure noted in some studies of VNR.

Finally, syncope with VNR could be due simply to **partial carotid artery occlusion**. This occlusion need not be complete in order to reduce cerebral blood flow to the level where it no longer supports consciousness.

In summary, the mechanism of unconsciousness due to VNR is not clearly known. Most likely it is due to a combination of carotid occlusion, carotid reflex, and Valsalva manoeuvre.

III. VNR: SAFE OR DEADLY?

There are two kinds of safety studies of VNR. Some of the studies are of small groups of subjects in well controlled circumstances, and some are case reports of adverse outcomes. The first groups of subjects include judo participants, law enforcement officer volunteers, and young (usually male) volunteers for the party “fainting lark” trick. There are essentially no deaths in these studies. However the numbers of participants are small, the conditions are relaxed and ideal, and optimal restraint is feasible. How much we can learn from these studies is debatable.

The second group of subjects is composed of those who died during or shortly after real-life VNR. The issues that complicate the analysis of these events include the agitated state of mind of the subjects, unknown clinical drug use, street drug use, possible occult heart disease, possible inadvertent tracheal restraint, and occasional subsequent prone restraint. Generally, we know very little about the true adverse rate due to VNR. We know little about the frequency of VNR use; the reasons for VNR use; and the number of deaths during its use. There is no consistent agreement about which deaths should be included in analyses, and there is some inadvertent use of tracheal restraint in the VNR death cases. Some of the reported restraint durations are certain and others are less so; some VNR situations are simple and others are not; and some post-VNR situations are optimal and others are not.

There is a similar lack of clarity about post mortem reports. Some deaths that seem to be due to neck bar use are not associated with pathologic findings of airway injury. Therefore finding that airways are not injured in VNR-related deaths does not exclude the use of neck bars or tracheal restraint. Furthermore, review of jury findings does not leave overwhelming confidence in the accuracy of their clinical conclusions.

Nonetheless, not all on VNR deaths involve asphyxia, drug use, subsequent prone restraint, airway trauma, prolonged use of VNR, or late deaths. There truly do appear to be deaths in the setting of the use of VNR that cannot be explained by known risk factors. It is unknown what specific role VNR has or does not have in those events.

IV. MECHANISM OF DEATH DUE TO VNR

From a cardiovascular perspective some of the VNR deaths would be deemed to be **Presumed Arrhythmic Deaths.** That is, the subjects were previously relatively well, and died suddenly in the absence of otherwise apparent causes. All appear in relatively stressful situations.

The most common cause of sudden cardiac death is ventricular fibrillation, and extremely fast and irregular heart rhythm. Its underlying causes include high levels of adrenaline and noradrenaline, existing and fairly severe heart disease, very slow heart rates, blocked coronary arteries, drugs that alter noradrenaline or specific electrical pores on the heart, and uncommon genetic mutations.

Most of these factors may be present in cases of VNR-related deaths. Elevated adrenalin and noradrenalin are very likely present during mania, agitated delirium, and agitated paranoia. Stimulant drugs such as cocaine either mimic adrenalin, or enhance its levels. There are reports of enlarged hearts and old myocardial infarctions noted during post mortem examinations. Interestingly there is a recently recognized syndrome of acute and focal myocardial enlargement at times of emotional stress, known as Takotsubo syndrome. This develops within hours and takes weeks to months to resolve. Heart rate slowing could occur transiently during carotid sinus compression. Coronary arteries can be blocked reversibly during cocaine use, and atherosclerotic coronary disease is rampant among middle-aged men, who constitute some of the recipients of VNR. Some clinically prescribed drugs alter the electrical pores on heart cells, and statistically we can be comfortable that some recipients of VNR will have genetic mutations that predispose to fatal arrhythmias.

To summarize: many VNR-related deaths could be classified as presumed arrhythmic deaths, and the setting of the use of VNR contains many factors seen to predispose to ventricular fibrillation. Some VNR-related deaths may be due to ventricular fibrillation.

V. WHERE TO NEXT?

There are several next steps.

First, we must **learn the real extent of the problem.** This should involve a prospective, inclusive, multicenter, well-documented epidemiologic study of the use of VNR. We enthusiastically endorse the upcoming registry of VNR use and recommend that privacy and confidentiality be guaranteed to officers who participate, even if the particular use of VNR does not adhere to national or regional guidelines. It is critical that we sample reality as it truly is, rather than as guidelines hope to shape it.

Secondly, the **outcomes should be compared** with those of Tasers and firearms, the two most likely alternates to VNR use.

Third, the **Canadian public needs to understand** the results, and the type and magnitude of the problem that they address.

Finally, and in the interim, situations that prompt the use of VNR should be deemed to be **medical emergencies**. Subjects should be monitored, if possible, after they have been subdued for appearance of late arrhythmias.

Appendix E – Levels of Evidence

With respect to the prevention of harm from a specific intervention (treatment, procedure, drug) in medicine, the following are considered to be levels of evidence to be used in evaluating the outcome and potential harms of interventions. The best evidence is level 1 evidence with clinical trials carried out specifically surrounding the intervention in question. Level 5 evidence is basically expert opinion, as described below. Not all treatments or interventions will always be studied under Level 1 conditions.

Level 1a evidence consists of systematic review with homogeneity of the randomized controlled trials.
Level 1b evidence includes individual randomized controlled trials with narrow confidence intervals of estimate
Level 1c evidence includes all or none trials

Level 2a evidence includes systematic review with homogeneity of the cohort studies included
Level 2b evidence includes individual cohort studies and low quality randomized controlled trials including those with poor followup.
Level 2c evidence includes outcomes research and ecological studies

Level 3a includes systematic reviews with homogeneity of the case control studies included
Level 3b includes individual case control studies

Level 4 includes case series and poor quality cohort and case control studies

Level 5 evidence is expert opinion without explicit critical appraisal or based on physiology, bench research or “first principles”.

From reviews of available evidence, medical experts are able to make recommendations surrounding the use of the procedures, treatments or medications under discussion.

These recommendations are listed under the following categories:

Grade A recommendations are made after the review of consistent Level 1 studies.

Grade B recommendations are made after review of consistent Level 2 or 3 studies or when experts extrapolate the results of level 1 studies to the situation under consideration (not the exact situation from the studies but a similar condition or situation)

Grade C recommendations are made after review of Level 4 studies or when the results from Level 2 or 3 studies are extrapolated to the situation under consideration.

Grade D recommendations are made when available studies are Level 5 or when the results from studies of any level are either inconclusive or inconsistent.

References for these levels of evidence and recommendations:

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