

Pre-hospital Systems Response to Major Trauma in Nova Scotia: A Case Review and Analysis

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Abstract: Pre-hospital or Emergency Medical Services (EMS) is an area of the health care system that many physicians have little or no exposure to through medical school or in post graduate training. Indeed EMS remains something of a paradox in the Canadian health care system since it is considered an "essential service" yet is not guaranteed within the parameters of the Canada Health Act. This article will use a case scenario to guide the reader through the personnel and services and other resources involved in a pre-hospital trauma case from injury to arrival at a tertiary care hospital emergency department, in the province of Nova Scotia.

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A 30 year old female has collided into a tree while downhill skiing on a ski hill in Nova Scotia. This ski hill is roughly three hours from the sole adult tertiary care center.ⁱ Despite wearing a helmet, she is found at the scene to be unconscious. Shortly thereafter, the patient has a transient generalized seizure. The ski hill personnel expeditiously assess and appropriately immobilize the patient and take her downhill by sled to a ski hut. At the same time they have placed a call to the province's 9-1-1 call center and are immediately connected to the communication and dispatch center, which handles all ambulances- air and ground- for the entire province. The patient is noted to have an abrasion on her right frontal-parietal area and her vital signs are as follows:

Pulse:	118bpm
Respiratory rate:	24/min (tachypneic)
O2 sat:	99%
BP:	120/Diastolic
Glasgow Coma Scale:	7 (E1/V1/M5)

This skier is critically ill with a Glasgow Coma Scale (GCS)ⁱⁱ of seven, indicating a major head injury and post-traumatic coma. By definition, this patient needs rapid transport to a tertiary care center with advanced life support and optimal airway management in the interim. As well, she may have significant secondary injuries (such as neck injury or intra-abdominal injury), which need to be addressed in a timely manner. Her optimal outcome is dependant upon decreased time to tertiary care and direct transport from scene to hospital.² Any episode of transient hypoxia will double her mortality rate.³ The 9-1-1 communication and dispatch personnel immediately confirm the critical nature of the patient's status through discussion with the ski hill personnel, and dispatch the provincial air medical transport

service (EHS LifeFlight).ⁱⁱⁱ On further discussion with the medical control physician,^{iv} the helicopter is dispatched directly to the ski hill. The following times have elapsed:

Incident:	1120 hrs
EHS LifeFlight on standby:	1131 hrs
Helicopter lift off:	1142 hrs
LifeFlight arrives at ski hill/patient:	1210 hrs
Definitive airway intervention at ski hill:	1220 hrs
Departure from ski hill by helicopter:	1232 hrs
Arrival at tertiary care hospital:	1315 hrs
Total elapsed time from injury:	115 min

The air medical crew that attends to the patient is composed of a critical care paramedic and ICU/Emergency medicine nurse; at the patient's side are several physicians who were skiing that day, including an anesthesiologist. On discussion with the air medical crew RSI^v (rapid sequence intubation) was performed with full cervical immobilization, using the following medications for pre-treatment, induction and paralysis: fentanyl 100µg, propofol 100mg, and succinylcholine 160mg. The initial attempt at intubation is difficult; a second attempt is successful with the use of a gum elastic bougie, which enables the intubator to successfully articulate the trachea with the endotracheal tube. Intubation is confirmed with qualitative end tidal CO₂, normal oxygen saturations, symmetrical chest movement, and auscultation of lung fields. After further assessing the patient, securing lines (two peripheral intravenous sites) and ensuring appropriate monitoring and immobilization, the crew moves the patient to the helicopter.

During the flight, the MCP is given an update on the patient's condition, and any needed interventions are performed. The MCP communicates with the tertiary care emergency department, who activate a trauma team in preparation for the arrival of the patient.

ⁱ Tertiary care hospitals treat patients that are >15yrs of age

ⁱⁱ GCS is a measurement of the severity of head injury and is used to predicate interventions and ultimate disposition of the patient in the pre-hospital phase. Post traumatic coma is defined as GCS < 9 and associated with airway compromise (see Appendix A & B). It is sub-categorized into best eye response (E), best motor response (M) and best verbal response (V) and is scored from 3 (poorest) to 15 (best).¹

ⁱⁱⁱEHS: Emergency Health Services is a government agency which oversees all pre-hospital services, including ground and air ambulances.

^{iv}MCP: Medical Control Physician is on call 24/7 to assist and provide medical support/decision making to the air medical crew in a "real-time" or "on-line" basis.

^v RSI is a process whereby a sedative hypnotic, combined with a paralytic, are rapidly administered to the patient in order to optimize the conditions for a successful intubation while minimizing the chance of aspiration for a successful intubation.⁴

The helicopter arrives on the rooftop helipad and delivers the patient to the emergency department team. The air ambulance personnel then return to their base, and are ready for their next mission. The “classical” in-hospital care of the patient then ensues.

DISCUSSION

Pre-hospital (also called out-of-hospital or EMS) is pervasive in Canada and predates the care of all patients in acute emergencies/urgencies who access this service prior to delivery to hospital based care. It is an aspect of health care that is unmentioned in the Canada Health Act, seldom referred to in the Romanow report and is poorly alluded to in most medical school and residency curricula, outside of certain disciplines such as emergency medicine. Yet, it is an essential service, which is present in some form or another, in every jurisdiction in Canada, and is a basic expectation of the general public with regard to emergency care outside of hospitals or clinics.

This case has illustrated the role of EMS in the identification, communication, care and transport of a major trauma patient. Decreased out of hospital time, timely access to tertiary care and advanced resuscitative interventions (rapid sequence intubation) were essential to optimal patient outcome.

Trauma is the fourth most expensive disease process to Canadian society; it contributes more to potential years of life lost than any other single disease, and it remains the commonest cause of death in those under the age of 45 years. Pre-hospital care is the initial link in trauma care systems and can be crucial in determining patient outcomes.⁵

In Nova Scotia, the pre-hospital system is administered by Emergency Health Services (EHS). This government agency has been responsible for EMS for the whole of Nova Scotia (population 940,000) since 1996. It ensures that the quality of care is uniform and consistent for all clients and that care is cost-efficient, evidenced-based and has close medical control and oversight.

It is important to note that prior to 1996 the EMS system in Nova Scotia was considerably different than the one currently in existence. The prior system consisted of 54 separate and independent ground ambulance operators. There were no performance standards, and the system was run as a fee for service. At that time the system was essentially a “transport service” with no medical oversight, no evidenced based protocols, no standards of care, and no centralized communications and dispatch.

In 1995, Dr. Ron Stewart, then Minister of Health for Nova Scotia, mandated Dr. Mike Murphy to re-organise and modernise the emergency medical system of Nova Scotia. The Murphy report was developed (see Appendix C for major highlights). The result is the high standard of quality care that we have come to expect of our EHS system.

Having one emergency service provider means that today there is province-wide 9-1-1 coverage, which has the capability of concise geographic location for callers. All

calls are managed through one central communication and dispatch center in Nova Scotia which directly facilitates the resources of all ambulance and ground vehicles and personnel using comprehensive computer-aided dispatch (CAD) and system status management (SSM). Nova Scotia is the first province or state in North America to completely integrate to one single site communications and dispatch center.

All call times are automatically captured (except those placed via cell phones). The call is displayed to both the call taker and ambulance dispatcher. The call taker is a fully trained paramedic, certified in medical communications and protocols, and asks a series of scripted questions that define the acuteness of any clinical scenario. The call taker determines whether an ambulance is to be sent, and the level of expertise needed from the responding paramedic team.

As the call taker is evaluating the need for an ambulance, the dispatcher is using CAD to geolocate the nearest ambulance and alerts the ambulance crew of an incoming call to their area. The National Academy of Emergency Medical Dispatch certifies emergency Medical Dispatchers and they require re-certification every 2 years. All 145 ambulances in Nova Scotia are owned by EHS; there are 131 type II vehicles (basic life support), 7 type III (advanced life support), 1 disaster support unit and 6 patient transfer units. All vehicles are replaced at 200,000 kms, or at 36 months (they are refurbished and sent offshore). The paramedics who staff the ambulances are registered with EHSNS, and they must re-register every 2 years. There are 520 P1s (60% of paramedic work force), 240 P2s (27%) and 120 P3s (13%) (see appendix B for paramedic level criteria). As well there are advanced critical care paramedics (CCP) who work mainly in the air medical program or in the tertiary care emergency departments. Each paramedic is given immediate feedback on their performance, and they are also given a yearly report card. The immediate administration of ground ambulance services in Nova Scotia is subcontracted through Emergency Medical Inc., a business which has a performance based contract with EHS Nova Scotia.

Nova Scotia has an air medical transport program (AMT) known as EHS LifeFlight. The primary purpose of this program is to provide specialized critical care transport for the most critically ill Nova Scotians who need expeditious transport to tertiary care and the advanced skills of the critical care crew. This program has been in existence since 1996 and works closely with ground services to ensure the best pre-hospital care. Their yearly mission patient profile is composed of an adult population greater than 15 years of age (57%), neonates (20%), pediatric (15%) and obstetrical cases (8%).⁵

The AMT crew consists of paramedic, an adult flight RN, a neonatal/pediatric RN and respiratory technologist. This team is on the base 24/7 and crew configuration depends upon mission type and the clinical needs of the patient. An obstetrical nurse is on call 24/7.

Case Resolution

The patient was closely assessed for secondary injuries in the emergency department and none were found. A CT of the patient's head showed evidence of diffuse axonal injury with evidence of scattered intraparenchymal hemorrhage and some blood in her lateral ventricle on the right side (Figure1).



Figure 1: Arrows showing intraparenchymal blood (thin arrow) and intraventricular blood

She was admitted to the neuro intensive care unit under the immediate care of the neurosurgery service. She remained intubated for six days and spent a further two weeks in hospital; she was discharged from hospital and has made excellent recovery.

CONCLUSION

This paper has illustrated the role and logistics of a pre-hospital, or EMS, response to the scene of a major trauma. It has attempted to illustrate those aspects of a trauma case which are seldom appreciated by practicing physicians, that is, the emergency medical services component and associated interventions. All Canadians rely upon EMS for rapid, professional pre-hospital interventions and care. Physicians would be well advised to learn more about their own local/regional or provincial EMS system and to participate within that system with regards to education, research and administration.

APPENDICES

Appendix A: Glasgow Coma Scale (GCS)

Eye Opening (E)

- 4 Spontaneously
- 3 To voice
- 2 To pain
- 1 Not at all

Verbal Response (V)

- 5 Converses, oriented
- 4 Converses, disoriented/confused
- 3 Inappropriate words
- 2 Incomprehensible sounds
- 1 No verbalization

Best Motor Response (M)

- 6 Obeys
 - Follows motor commands*
- 5 Localizes
 - Clearly pushes painful stimuli away*
- 4 Normal flexion(withdrawal)
 - Only withdraws arm or leg to painful stimuli*
- 3 Abnormal flexion (decorticate)
 - Flexion of arms with extension of legs to painful stimuli*
- 2 Abnormal extension (decorticate)
 - Extension of all extremities to painful stimuli*
- 1 Flaccid
 - No response to painful stimuli*

Appendix B: Head Injury Guidelines for Nova Scotia⁵

GCS 3-12: Major Head Trauma

1. Intubate (C-spine in neutral position) for GCS <8 or deteriorating GCS. Oxygen by mask for all others
2. Spine immobilization (C-spine collar and backboard)
3. 2 minute neurological assessment:
 - GCS
 - Pupil size and reaction to light
 - Biceps and knee jerk reflexes
 - Babinski responses
 - Gross motor function (equal movement in all four limbs)
4. Call air medical critical care and prepare for air transport

GCS 13-15: Minor Head Trauma

CT urgently needed if all 3 of the following:

1. History of blunt head trauma within the last 24 hours
2. History of loss of consciousness, amnesia or disorientation
3. One or more of the following:
 - GCS < 15, at 2 hours post-injury
 - Suspected open or depressed skull fracture
 - Sign of basal skull fracture (hemotympanum, "raccoon eyes", CSF fluid otorrhea/rhinorrhea, Battle's sign)
 - Vomiting = 2
 - Age > 65yrs

Abnormal CT- immediate air transport

Normal CT- observe, discharge and follow up with family physician

If GCS is deteriorating or there is a penetrating head injury – treat as major head injury

Appendix C: Paramedic Designation

Paramedic level 1 (PCP)

- 8 month course (in Nova Scotia)
- Automatic external defibrillation (AED)
- IV monitoring
- Symptomatic drug relief (ASA, N/G, ð-agonist, subcutaneous epinephrine, glucagons, and charcoal)

Paramedic level 2 (ICP)

- This paramedic level is being phased out
- Same capabilities of level 1, in addition to the following
- IV insertion
- ETI
- Specific drugs (epinephrine, atropine, lidocaine, bicarbonate. Diazepam, D50, morphine, gravol, narcan – by verbal order, and heparin by IV pump)

Paramedic level 3 (ACP)

- 18 month training program after P1 (in Nova Scotia)
- Same duties as level 2, in addition to the following
- Manual defibrillation, cardioversion, pacing
- Chest compression
- Extended pharmacology based on protocols

Critical Care Paramedic (CCP)

- 12 month training after level P3
- Same duties as level 3, with extensive pharmacologic capabilities (drug types and routes of administration)

Please refer to the EHS web site (www.gov.ns.ca/health/ehs) for specific details on qualifications of each paramedic level

Appendix D: Strategic and Structural Policy Initiatives of the Murphy Report⁵

1. Creation of an EHS agency responsible for system design, implementation and management for all of Nova Scotia
2. Development of expertise in EHS, drawing on experience in mature systems elsewhere
3. Standards for paramedic training, licensure, equipment and vehicles
4. Financial incentives and contracting for services that reward patient care, system performance and efficiency of operations, with deterrents for performance deficiencies
5. Appropriate use of information systems to support research, outcomes analysis, cost-benefit analysis and feedback to quality improvement initiatives

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