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THE EXPERIENCES, KNOWLEDGE, AND PREFERENCES OF EMERGENCY MEDICAL TECHNICIANS (EMT) FOR SPINE BOARDING TRANSFER TECHNIQUES

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ABSTRACT

THE EXPERIENCES, KNOWLEDGE, AND PREFERENCES OF EMERGENCY MEDICAL TECHNICIANS (EMT) FOR SPINE BOARDING TRANSFER TECHNIQUES

By

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Purpose: The purpose of this study is to examine the knowledge, experience and preference of EMT professionals on spine boarding transfer techniques

Participants: There are 53 certified EMTs from a variety of work settings with a variety of experience and amount of spine boarding used.

Methods: 500 currently certified EMTs were surveyed on the topic. The newly designed survey addressed demographics, initial and continuing education, preference of techniques, and experience. A random sample was obtained from the state of Michigan registry; 53 subjects returned the surveys (10.8% return rate).

Descriptive statistics were completed to analyze the questionnaire items.

Results: Subjects reported answers in accordance with literature and perceived greater control on the seated and prone positions, but not in the prone. Some trends were found in relation to the amount of literature read or professional conferences attended and their knowledge of literature.

Conclusion: More education (either initial or continuing) could lead to better initial care for possible spine injuries. By introducing everyone to all the possible techniques, it would benefit the EMTs by letting them be more prepared to handle each situation to the best of their ability.

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Chapter 1

Introduction

Overview of the Problem

Spinal cord injuries are a major medical issue that leaves up to 250,000 people injured and costs around $2 billion for treatment and rehabilitation annually (De Lorenzo, 1996). As these injuries are usually accidental and unexpected, it is a great inconvenience to patients, families, and the health care system. Automobile accidents are the cause for over half of all spinal injuries with falls, sports, and assaults accounting for the rest of the injuries (Hockberger & Kirshenbaum, 2002). If there is any suspicion of a spinal injury, there is a need for immediate immobilization of the head, trunk, and extremities (Burton, Dunn, Harmon, Hermanson, & Bradshaw, 2006), The Emergency Medical Technician (EMT) protocol for traumatic injuries is to immobilize all trauma patients, not differentiating between those that do need it and those that may not (Burton et al., 2006). The goals for initial treatment are to reduce shock, stabilize the patient, and determine the severity of the injuries (Fonseca, Ozer, Axelson, & Phillips, 1987). The correct management of spinal injuries may be the difference in complete recovery and complete disability (Campagnolo & Heary, 2002).

Considering spinal injuries can occur at any time or place, anyone is susceptible to these injuries. In the most serious cases, the correct care for an injured person may involve cervical immobilization and spine boarding for transportation to a hospital. Proper spine boarding is important anytime that a spine injury may be suspected (De Lorenzo, 1996). While it may seem sufficient

to simply immobilize the patient, the method for this immobilization is an important component of a successful patient transfer. There are different spine-boarding transfer techniques and significant research has investigated the difference between these techniques. The most common methods used are the log roll and the lift-and-slide. Literature shows that the lift-and-slide technique allows for greater control in a supine lift and the log roll is more efficient in a prone position (Kleiner et al., 2001).

The lift-and-slide technique optimally involves five people; one controlling the head, three straddling the patient, and one positioning the spine board. The people straddling the patient lift him or her straight up on the head rescuer's command and the fifth rescues slides the board under the lifted patient where he or she may be placed down onto the board (Del Rossi et al., 2008_a; Del Rossi et al., 2008_b). Another lifting method commonly associated with the lift-and-slide technique is the 6-plus person lift. In this technique, again you have the main rescuer at the head stabilizing the head and neck, but the other remaining rescuers are positioned at the sides of the patient to lift the patient as the spine board is slid in under the patient's feet (Del Rossi et al., 2008_a; Del Rossi et al., 2008_b). The log roll maneuver also uses five people when available; one controlling the head, one positioning the board, and three at the side of the patient. The people at the patient's side and the head rescuer together roll the patient onto his or her side on the head rescuer's command and the fifth person wedges the board against the patient at a 45 degree angle to allow the other

rescuers to roll the patient back down onto the board (Del Rossi et al., 2008_a; Del Rossi et al., 2008_b).

As a part of the prehospital care team, emergency medical technicians have a challenge to respond in an urgent manner with possible interruptions and environmental stresses. Furthermore, as medical professionals arrive on the scene of a possible spinal injury, one would assume EMT's are well educated and practiced in their skills so that the best care can be provided. Within the EMT education programs, there are different levels of EMT training, and in those levels there are different amounts of practice and performance of their acquired skills. The pressure put on these professionals is immense as "survival from the various acute illnesses and injuries are determined in that prehospital setting," (Myers et al., 2008, p. 141). These pressures along with EMTs having variable initial training and inconsistent continuing education, results in inconsistent practice in the field (Paris & O'Connor, 2008). As a medical professional, it is important to stay up to date with the most current literature and advances in procedures to provide the best possible medical care.

As EMTs usually work with a small group of rescuers when responding to an emergency, many people aren't available to assist in the spine boarding process. Because of this, the log roll can be performed easily with fewer people and from a multitude of positions, making it the main preference of EMTs (Caroline, 1995; Crosby & Lewallen, 1995).

Significance of the Problem

Lack of experience and knowledge may lead to mistakes during the spine-boarding process potentially worsening the patient's condition with the possibility of permanent disability. Correct spinal care is imperative in initial treatment of spinal injuries as up to 25% of injuries occur during management of the initial trauma (Del Rossi et al., 2004$_b$; Hadley, 2002; Ransone, Kersey, & Walsh, 2000). This statistic demonstrates that there is room for improvement in the prehospital care of spine-injured individuals. With better prehospital care, the amount of secondary injuries could be greatly reduced, decreasing the number of permanent injuries. The slightest deviation of even 1 mm in a spine injured patient can make the spinal cord more vulnerable to injury (Crosby & Lewallen, 1995), and if only 10% of axons in the spinal cord are saved in an adult, walking may be possible (Campagnolo & Heary, 2002). If permanent paralysis does occur, it not only affects the victim of a spinal cord injury, but also the family and friends of the patient.

The results of this study will be beneficial to the EMT community by learning the most effective and appropriate medical care and being able to implement that in the teaching of future EMTs. It is imperative that EMTs know which spine-boarding transfer technique allows less movement, so they can decrease the possibility of inflicting permanent damage to the patient. Globally everyone has the potential to benefit from the knowledge of the best spine-boarding transfer technique because anybody could get injured and require spine-boarding. We all want the best care possible and this research will help

identify what initial training and continuing education EMTs are receiving in the area of spine-boarding.

Statement of the Problem

The purpose of this study is to examine the knowledge, experience and preference of various EMT professionals on spine boarding transfer techniques. The main focus of the study is to see if EMTs keep up with current literature in their field and if those that do keep up with the literature know proper spine boarding techniques. This information will be gathered through a survey dispersed through mail to EMTs registered with the Michigan state EMT office.

Research Questions

1. Which spine boarding technique (log-roll, lift-and-slide, or KED) will currently certified EMTs believe is known to be best for managing cervical stability when assisting injured persons found in prone, supine, and seated positions?
2. Which spine boarding technique (log-roll, lift-and-slide, or KED) do currently certified EMTs feel the greatest amount of cervical stability is provided during moving injured persons found in prone, supine, and seated positions?
3. Does the extent to which currently certified EMTs (a) read the professional literature and/or (b) attend professional conferences affect their beliefs about or use of different spine-boarding techniques?

Operational Definitions

Lift-and-slide - refers to a maneuver where the person is lifted straight up 4 to 6 inches to allow the spine-board to slide beneath him or her (Del Rossi et al., 2008_a; Kleiner et al., 2001).

Log roll - refers to a maneuver where the person is rolled onto his side in the recumbent position and the spine-board is placed under him at a 30 to 45 degree angle and the person is rolled onto the spine-board (Del Rossi et al., 2008_a; Kleiner et al., 2001).

Manual stabilization - refers to in-line stabilization that is applied to limit motion of the head and neck (Thiboutot, Nicole, Delalaitue, Lessard, & Enfant-Jésus, 2006).

Clinical instability- refers to the inability of the spine to resist displacement to prevent neurological impairment or deformity when excess loads are applied (White & Panjabi, 1990).

Emergency Medical Technician (EMT), refers to a certified nationally registered health care professional in the emergency medicine field that provides prehospital care to patients.

Chapter 2

Review of Related Literature

The need for this research is immense and may help save lives and limit life-changing injuries from improper care. In spine-boarding, many aspects have been studied including the type of spine board, the spine-boarding transfer techniques, cervical immobilization, and EMT education.

There are numerous studies that have investigated various aspects of the spine-boarding process. Some have studied the difference in techniques such as log roll (Del Rossi, Heffernen, Horodyski, & Rechtine, 2004_a; Del Rossi et al., 2008_a; Del Rossi et al., 2008_b; Del Rossi, Horodyski, & Powers, 2003; DiPaola, 2008; Kleiner et al., 2001; Swartz, Nowak, Shirley, & Decoster, 2005), lift-and-slide (Del Rossi et al., 2004_a; Del Rossi et al., 2008_a; Del Rossi et al., 2008_b; Del Rossi, Horodyski, & Powers, 2003), the 6-person lift (Del Rossi et al., 2008_a; Del Rossi et al., 2008_b; Kleiner et al., 2001;), and the motorized spine-board (Swartz et al., 2005). Others have used a variety of measurement tools such as motion tracking devices (Del Rossi et al., 2008_a; Del Rossi et al., 2008_b; Swartz et al., 2005), electromagnetic tracking devices (Del Rossi et al., 2004_a; Del Rossi, Horodyski, & Powers, 2003; DiPaola, 2008), and electronic digital inclinometers (Hamilton & Pons, 1996). There have also been differences in the use of human subjects (Del Rossi, Horodyski, & Powers, 2003; Hamilton & Pons, 1996) and cadaver studies (Del Rossi et al., 2004_a; Del Rossi et al., 2008_a; Del Rossi et al., 2008_b; DiPaola, 2008). Lastly, researchers have focused on different areas of the spine, mainly cervical (Del Rossi et al., 2004_a; Del Rossi et al., 2008_a; Del Rossi,

Horodyski, & Powers, 2003; Hamilton & Pons, 1996; Swartz et al., 2005) and thoracolumbar (Del Rossi et al., 2008_b; DiPaola, 2008;). The utility of these research papers largely depends on the distribution of this information to the clinical setting and to those responsible for educating future EMTs.

Spinal Cord Injuries

Traumatic spinal cord injuries are one of the most common causes of disability and death (Bohlman, 1979). Spinal cord injury was defined by Golob, Claridge, Yowler, Como, and Peerless (2008) as "any neurologic deficits or radiographic evidence of spinal cord involvement including cord contusion or edema" (p. 312). Spinal cord injuries occur as a result of failure of the vertebral column, including vertebrae, ligaments, and musculature, around the spinal cord (Campagnolo & Heary, 2002). Spinal cord injuries are mostly the result of trauma to the vertebral column such as a fracture, dislocation, or sprain of the vertebral ligaments, leading to a compression of the spinal cord (DiLima & Schust, 1998). Although spinal cord injuries only account for 4.3% of trauma patients (Rhee et al., 2006), detection of these injuries is imperative to diminish the devastating consequences of the injury. The incidence of non-recognized spinal cord injuries varies from 8% to 30%, but 10% of patients without initial neurologic problems had their condition worsen after hospital admission (Poonnoose, Ravichandran, & McClelland, 2002). The response of the spinal cord to this traumatic event may lead to a condition called "spinal shock" where the body has no function below the lesion level (Fonseca et el., 1987). Spinal shock may be confused with a complete spinal cord injury, but spinal shock

usually resolves within 24 hours whereas the complete spinal cord injury doesn't (Hockberger & Kirshenbaum, 2002).

With a spinal cord injury, nerves superior to the level of injury retain their normal function, but the nerves below the injury level are impaired to some extent (DiLima & Schust, 1998). The higher the level of injury, the greater chance there will be more loss of function (DiLima & Schust, 1998; Fonseca et al., 1987). All nervous function, including sensory, motor, and autonomic function, below the level of injury may be impaired depending on the extent of injury (Fonseca et al., 1987).

Etiology. According to the National Spinal Cord Injury Statistical Center (NSCISC), new spinal cord injuries vary from 25 new cases per million per year in West Virginia to 59 new cases per million per year in Mississippi, with a national average at around 40 new cases per million, just over 10,000 cases, per year (DeVivo, 2002). The NSCISC also showed that injuries are least common in the pediatric age group (younger than 15) and most common in those ages 16-19 years old with a steadily decline in injury incidence after the age of 19 (DeVivo, 2002). The average age of acquiring a spinal cord injury is 31.8 ± 15.6 years with the median age being 26.4 years and the most common age of injury being 19 years old (DeVivo, 2002). According to the NSCISC, the average age of those currently with a spinal cord injury is 41 years old, 9 years older than the average age of initial injury (DeVivo, 2002). Men are four times more likely to report a spinal cord injury than women (Hockberger & Kirshenbaum, 2002).

Injuries to the cervical spine are shown to be the majority of all spine injuries (60-80%) in the pediatric age group, which is much higher than the general population which cervical spine injuries account for only 30-40% of spinal injuries (Platzer et al., 2007). Pediatric cervical spine injuries are of particular interest because the structure of a child's cervical spine may not fully develop into full adult maturity until around age 8 (Platzer et al., 2007). In the elderly, it is shown that falls are the most common mechanism for cervical spine fractures (Damadi, Saxe, Fath, & Apelgren, 2008) and have a lower threshold for an injury to occur than the younger populations (Golob et al., 2008). In the pediatric population, motor vehicle crashes (70 % of those under 8 years old) and sports-related injuries (77% of those between the ages of 9 and 16) were the most common causes of injury (Platzer et al., 2007). Fractures to C1 and C2 cervical vertebrae are more common in the elderly and lead to a high mortality rate of 21-30% (Damadi et al., 2008; Golob et al., 2008). Platzer et al. (2007) showed that seventy-seven percent of those ages 9 to 16 had lower cervical spine injuries and that they had a high rate of complete neurologic recovery (66%), but also had a high mortality rate of 75% for those with complete spinal cord injuries.

Eleven specific causes of spinal cord injuries are used to classify mechanisms of injury and account for 93.4% of all cases in the NSCISC. Those causes are: automobile crashes accounting for 34.3% of injuries, falls at 19%, gunshot wounds at 17%, diving mishaps at 7.3%, motorcycle crashes at 5.6%, being struck by falling object at 3.3%, medical or surgical complications at 2.1%,

pedestrians being struck by a motor vehicle at 1.8%, and stab wounds, bicycle mishaps, and violent personal contact each at 1% (DeVivo, 2002).

Of the injuries in the National Spinal Cord Injury Statistical Center, 50.7% of patients had cervical level injuries, 35.1% had thoracic, and 11% had lumbosacral injuries (DeVivo, 2002). In a study by Burton et al. (2006) that examined 31,885 trauma-related EMS encounters with 334 spinal fractures, they had slightly different distribution of injuries with 31% of spinal fractures occurred in the cervical spine, 28% in the thoracic spine, and 41% in the lumbar spine. Overall, the most common injury was to C5 (14.7%), followed by C4 (13.2%), C6 (11.3%), T12 (7.2%), C7 (5.7%), and L1 (5%) (DeVivo, 2002).

Spinal anatomy. The spinal cord is a part of the nervous system and is involved with function throughout the body because it sends and receives information between the brain and the body (Fonseca et al., 1987). The spinal cord, along with the brain and optic nerves, is part of the central nervous system; all other nerves in the body are classified into the peripheral nervous system (Fonseca et al., 1987). Neurons in the central nervous system are incapable of regeneration, making spinal cord injuries irreversible (Hockberger & Kirshenbaum, 2002). The spinal cord is surrounded and protected by bones called vertebrae that are stacked on top of each other to make up the vertebral column. The vertebral column provides both structure and support for the body and the spinal cord runs through the middle of the vertebrae (DiLima & Schust, 1998; Hockberger & Kirshenbaum, 2002). The general vertebra consists of a body and a vertebral or neural arch with the body being the load-transmission

point of 80-90% of forces placed on the spinal column. The neural arch protects the spinal cord by transmitting muscular and gravitational forces (Schneck, 2002).

The vertebral column is divided into two sections, the anterior column formed by the intervertebral discs and vertebral bodies and the posterior column consisting of the spinal cord, pedicals, transverse processes, articulating facets, laminae, and spinous processes (Hockberger & Kirshenbaum, 2002). The anterior column is supported by the anterior and posterior longitudinal ligaments while the posterior column is supported by the supraspinous, infraspinous, interspinous, and capsular ligaments as well as the ligamentum flavum (Hockberger & Kirshenbaum, 2002).

In order to keep the bony vertebrae in place to protect the spinal cord, there are many ligaments that add to the stability of the spinal column (Schneck, 2002). The anterior longitudinal ligament resists extension and supports the anterior portion of the intervertebral disks. It is most commonly injured through hyperextension injuries, but can be injured in relation to a fracture as well (Schneck, 2002). The posterior longitudinal ligament resists flexion and protects the posterior aspect of the intervertebral disks. This ligament is commonly injured in any injuries that result in an unstable spine (Schneck, 2002). The ligament flava resists flexion and is commonly inured in hyperflexion or injuries of forced flexion. Less commonly, the ligament flava can be injured in a hyperextension injury where it collapses into the spinal cord, causing a spinal cord contusion (Rogers, 1957; Schneck, 2002). There are both infraspinous and

supraspinous ligaments that connect the spinous process of two vertebrae. These ligaments resist flexion of the spine and are commonly torn in hyperflexion injuries from the posterior opening of the spinous processes (Schneck, 2002). The capsules of facet joints can also be ruptured in hyperflexion injuries, possibly leading to a subluxation or dislocation of the facet (Schneck, 2002).

There are four sections of the vertebral column—cervical, thoracic, lumbar, and sacral. The cervical area is the most superior area of the spine and contains seven vertebrae. The next section is the thoracic region which includes 12 vertebrae and makes up the chest region. Inferior to the thoracic region is the lumbar region in the low back which consists of five vertebrae. The bottom of the spine is the sacral area and is comprised of five fused sacral bones (DiLima & Schust, 1998). In the thoracic, lumbar, and sacral regions, the number of spinal nerves matches the number of spinal segments, but in the cervical region, there are seven vertebrae and eight spinal nerves (DiLima & Schust, 1998). This provides for a total of 31 nerve roots that branch from the spinal cord at their various levels (Fonseca et al., 1987). Spinal nerves exit the spinal cord through the intervertebral foramina below the vertebra of the same name except in the cervical spine where they exit the intervertebral foramina above their associated segment with the eighth spinal nerve root exiting between C7 and T1 (Sapru, 2002).

Mechanism of injury. One of the major mechanisms of injury for traumatic spinal cord injuries is for an axial load to be applied to the top of the head. One of the most common examples of this mechanism is a passenger impacting with

the windshield of an automobile. This mechanism is even more dangerous when the axial load when the neck is slightly flexed since the spine is no longer in its anatomical alignment, decreasing its ability to absorb such forces (Bailes, Petschauer, Guskiewicz, & Marano, 2007). Generally, spinal cord injuries result from one traumatic event to the spinal cord (Phillips & Axelson, 1987). In water sports-related cervical spine injuries, shallow water dives and wave-related accidents are common mechanisms of injury, usually with a hyperextension of the neck while the head hits the bottom of the ocean or pool (Chang, Tominaga, Wong, Weldon, & Kaan, 2006).

Neurologic impairment will result from an injury to the vertebral column where a fracture, dislocation or a part of the intervertebral disc protrudes into the spinal cord or where there is excessive hemorrhage at the injury site (Bailes et al., 2007). The impairment that is present or the risk of getting neural dysfunction is present until the injury has been reduced and/or stabilized and the spinal cord can be relieved of the encroachment (Rogers, 1957).

One of the most fatal subluxations or dislocations occurs at the atlantoaxial joint because the disruption may be associated with the medulla which controls cardiovascular and respiratory function (Schneck, 2002). Fracture to the odontiod process of the atlas, C2, is common in hyperflexion, hyperextension, or forced rotational injuries (Rogers, 1957) and is commonly unstable, leading to neurologic impairment (Schneck, 2002). A burst fracture is common from a vertical load being applied to the vertebral column, causing the nucleus pulposus of the intervertebral disc to increase pressure, causing the

vertebral body to explode (Schneck, 2002). The most common cervical burst fracture occurs at C5, and the most common lumbar burst fracture occurs at L1 (Campagnolo & Heary, 2002). This is a common injury seen in patients that fell from a height or dove into shallow water (Rogers 1057). The burst fracture can have a wide range of neurologic involvement from displaced fragments that could potentially interrupt the spinal cord (Schneck, 2002), usually with immediate symptoms from the spinal cord involvement (Rogers, 1957).

The direction of forces placed on the cervical spine will usually determine the type of injury that occurs. The most common types of forces to the spine are flexion, flexion-rotation, extension, and vertical compression (Hockberger & Kirshenbaum, 2002). Hyperflexion injuries tend to result in compression of the anterior spinal column and distraction to the posterior spinal column (Schneck, 2002). Flexion injuries most likely affect C1 and C2 (Hockberger & Kirshenbaum, 2002). Common injuries from this mechanism include anterior subluxation, wedge compression fractures, facet dislocations, teardrop fractures, and an avulsion fracture of the spinous process (Schneck, 2002). An anterior dislocation of the vertebrae is the most common type of cervical injury common in falls where the patient lands on the back of the head (Rogers, 1957). This injury can also be complicated into a fracture-dislocation if there is more force applied, especially longitudinal compression (Rogers, 1957). A wedge fracture is more common below C2 where the anterior portion of the vertebral body is compressed, increasing the body concavity (Hockberger & Kirshenbaum, 2002). The teardrop fracture is from a compression where a teardrop-shaped fragment

avulses from the anterior portion of the body which can cause neurologic impairment (Hockberger & Kirshenbaum, 2002).

If a hyperflexion mechanism is combined with rotation, then it is more likely that a unilateral facet dislocation will occur with possible fracture (Schneck, 2002). In a unilateral facet dislocation, there are commonly neurological symptoms arising from a secondary injury to the nerve root unilaterally (Campagnolo & Heary, 2002). In the cervical spine, a unilateral facet dislocation without fracture is common, but because of the shape of the thoracolumbar facets, a fracture is common with a unilateral facet dislocation (Hockberger & Kirshenbaum, 2002).

Hyperextension injuries commonly occur from an anteroposterior force applied to the face (Rogers, 1957), causing compression of the posterior spine and distraction of the anterior portion. These injuries usually injure the anterior longitudinal ligament, posterior longitudinal ligament, and intervertebral disk, and may displace the vertebral body into the spinal canal. Specific hyperextension injuries include dislocations, extension teardrop fracture, laminar fractures (Schneck, 2002), posterior neural arch fracture, and a hangman's fracture (Hockberger & Kirshenbaum, 2002). The extension teardrop fracture occurs when the anterior longitudinal ligament avulses a part of the anterior vertebral body away from the rest of the body and is common in C5-C7 (Hockberger & Kirshenbaum, 2002). The posterior neural arch fracture occurs from compression of the posterior aspect of the vertebrae, most commonly C1 compressed between the occiput and C2 spinous process (Hockberger &

Kirshenbaum, 2002). Hangman's fracture is a traumatic spondylolysis of C2 and usually occurs with fast deceleration forces (Hockberger & Kirshenbaum, 2002). With both hyperextension and hyperflexion injuries, impairment of the spinal cord is commonly seen (Rogers, 1957).

Vertical compression injuries occur from a force being applied to either the head or lower extremity which causes the vertebral body end plates to fracture, forcing the nucleus pulposis of the intervertebral disc into the body of the vertebrae; commonly called a burst fracture (Hockberger & Kirshenbaum, 2002). A Jefferson fracture is a specific burst fracture of the arches of the atlas, C1, and is a common injury in football from spearing or any axial load applied to the top of the head (Schneck, 2002). Any type of injury to C1 is commonly a fatal injury (Campagnolo & Heary, 2002).

Central cord syndrome. Central cord syndrome is the most common incomplete spinal cord syndrome (Hockberger & Kirshenbaum, 2002; Kirshblum & Donovan, 2002). It "is characterized by motor weakness in the upper extremities greater than the lower extremities, in association with sacral sparing" (Kirshblum & Donovan, 2002, p. 88). The patient with central cord syndrome may also experience bladder control problems and some sensory loss below the level of injury (Kirshblum & Donovan, 2002). Central cord syndrome most likely occurs from a compression of the anterior or posterior cord commonly from an inwardly bulging ligamentum flavum from hyperextension (Hockberger & Kirshenbaum, 2002; Kirshblum & Donovan, 2002) or as the result of hemorrhaging or ischemia to the corticospinal tracts (Bailes et al., 2007).

Recovery from this syndrome usually begins in the lower extremity then may progress to bowel and bladder function, proximal upper extremity function, and finally hand function ((Kirshblum & Donovan, 2002), and a good degree of recovery, if not a fully functional recovery, is usually experienced in this syndrome (Bailes et al., 2007).

Brown-Sequard syndrome. Brown-Sequard syndrome involves hemisection of the spinal cord (Hockberger & Kirchenbaum, 2002; Kirshblum & Donovan, 2002) and is usually from a penetrating injury (Hockberger & Kirchenbaum, 2002). Brown-Sequard syndrome typically shows ipsilateral sensory loss and contralateral loss of pain and temperature below the injury level (Bailes et al., 2007). It has also been shown to have ipsilateral flaccid paralysis, and loss of sense of position and vibration at the injury level, and ipsilateral motor loss below the injury level (Kirshblum & Donovan, 2002). This syndrome is not a very common SCI, only adding up to approximately 2-4% or all SCIs (Kirshblum & Donovan, 2002). This syndrome is rarely found alone and is commonly seen in association with central cord syndrome (Bailes et al., 2007). A related syndrome is Brown-Sequard plus syndrome where there is ipsilateral hemiplegia with contralateral hemianalgesia (Kirshblum & Donovan, 2002). This syndrome is commonly occurring from knife injuries, but may also be caused from multiple sclerosis or vertebral fractures (Kirshblum & Donovan, 2002). Recovery from Brown-Sequard syndrome is promising and most patients will regain ambulation by the time rehabilitation is completed, but with varying levels of functionality (Kirshblum & Donovan, 2002).

Anterior cord syndrome. Anterior cord syndrome effects the anterior two thirds of the spinal cord or the anterior spinal artery, leaving the posterior columns unharmed (Kirshblum & Donovan, 2002; Bailes et al., 2007). Mechanisms for anterior cord syndrome include disc pathologies, protrusion of bone fragments, a direct injury to the anterior spinal cord or anterior spinal artery (Kirshblum & Donovan, 2002), or cord contusion from a hyperflexion injury (Hockberger & Kirchenbaum, 2002). Patients with anterior cord syndrome usually have a loss of motor control, pain and temperature sensation (Bailes et al., 2007), and pinprick sensation, but still have sensation of light touch, proprioception, and deep-pressure sensation (Kirshblum & Donovan, 2002). There is usually limited recovery associated with anterior cord syndrome, especially in motor function and control (Kirshblum & Donovan, 2002).

Posterior cord syndrome. This is a very uncommon SCI syndrome where there is localized swelling from injury to the posterior spinal artery (Bailes et al., 2007). It involves having a sense of pain, temperature, and touch with different levels of motor function with an absence of all dorsal column function (Kirshblum & Donovan, 2002).

Conus medullaris/cauda equina injuries. Conus medullaris is the end of the adult spinal cord which occurs at around the L1 vertebra (Kirshblum & Donovan, 2002). The segment just above this, the epiconus, contains segments from L4 to S1 (Kirshblum & Donovan, 2002). Those nerve roots then travel inferiorly and form the cauda equina (Kirshblum & Donovan, 2002). An injury to the epiconus affects the lower lumbar nerve roots, but spares the sacral reflex

function (Kirshblum & Donovan, 2002). Conus medullaris lesions at the S2 level or lower affect bowel and bladder function (Kirshblum & Donovan, 2002). Motor function may continue if the lesion did not interfere with nerve rots L3 through S2 (Kirshblum & Donovan, 2002). Conus medullaris lesions are usually bilateral because the small structure can easily be injured, and there is a poor recovery from these injuries (Kirshblum & Donovan, 2002). Cauda equina injuries usually produce motor weakness, atrophy in the lower extremity, and bowel/bladder involvement if it affects S2-S4 (Kirshblum & Donovan, 2002). Cauda equina injuries can be asymmetric because of the mobile nerve roots in the area, and also have a better prognosis because of the difference in structure than a SCI and the ability to regenerate since they are peripheral nerves (Kirshblum & Donovan, 2002). Injury to the L1 vertebrae may lead to a conus medullaris injury, where anything at the L2 level or lower will only result in injury to the cauda equina (Kirshblum & Donovan, 2002).

Spinal stenosis. Spinal stenosis is defined as the narrowing of the spinal canal that may lead to impingement of the spinal cord (Prentice, 2006). The average cervical spinal canal has a sagittal diameter from 17.8 to 18.4 mm. A spinal canal with a diameter smaller than 14 mm is deemed spinal stenosis (Bailes et al., 2007). This can occur from congenital abnormalities or anatomic changes including bone spurs, osteophytes, or disc bulges (Bailes et al., 2007; Prentice, 2007). Those with spinal stenosis are thought to be at a higher risk of SCI and an increase in neurologic involvement in those injuries because there is less space for force transmission and accommodation (Bailes et al., 2007).

Classification of injuries. In all spinal cord injuries, the extent of injury is determined by evaluating the neurologic capacity of the patient (Hockberger & Kirshenbaum, 2002). This is completed by assessing motor activity, deep tendon reflex, and sensory function (Hockberger & Kirshenbaum, 2002). There are many ways to classify spinal cord injuries. One of the simplest ways is to differentiate the injury between paraplegia and tetraplegia. Paraplegia refers to loss of feeling and motor control in the lower extremity of the body and usually occurs from an injury from the thoracic, lumbar, or sacral levels (DiLima & Schust, 1998). Tetraplegia, or quadriplegia, has loss of sensation and motor function in both the upper and lower extremities and is caused by an injury in the cervical area (DiLima & Schust, 1998). More specifically, spinal cord injuries are assessed and classified using the American Spinal Injury Association (ASIA) Impairment Scale. The categories are ranked classes A-E: a) neurologically complete injury (48.6% of NSCISC patients), b) incomplete injury with sensory sparing (10.3%), c) incomplete injury with nonfunctional motor capabilities below the lesion level (11.2%), d) incomplete injury with functional motor capabilities below the lesion level (29.1%), and e) complete neurological recovery (0.8%) (DeVivo, 2002).

According to Kirshblum and Donovan (2002), there is an eight-step process for the classification of an individual with a spinal cord injury: 1) perform sensory examination in 28 dermatomes bilaterally for pinprick and light touch and test for anal sensation on rectal examination, 2) determine sensory level (for both right and left sides) and total sensory score, 3) perform motor examination in the

10 major muscle groups, including voluntary anal contraction on rectal examination, 4) determine motor level (for both right and left sides) and motor index score, 5) determine neurologic level of injury, 6) classify injury as complete or incomplete, 7) categorize ASIA Impairment Scale (A through E), and 8) determine zone of partial preservation if ASIA-A.

There are two factors commonly used to determine the extent of injury—the level of injury and completeness of injury (Fonseca et al., 1987). According to the National Spinal Cord Statistical Center (NSCISC), the neurologic level of injury is defined as the lowest level of the spinal cord with both sensory and motor function intact bilaterally (DeVivo, 2002). The completeness of the injury will determine how much function is retained below the level of injury (Fonseca et al., 1987). The incomplete lesion has partial preservation of sensation and/or motor function below the injury level, whereas the complete injury has no sensation or motor function below the level of injury (Bailes et al., 2007; DiLima & Schust, 1998; Fonseca et al., 1987). The NSCISC uses the level and extent of injury to classify injuries into the following for categories—complete tetraplegia, incomplete tetraplegia, complete paraplegia, and incomplete paraplegia (DeVivo, 2002). Complete tetraplegia involves the region between C1 and C8 with the ASIA-A classification. Incomplete tetraplegia also involves the region between C1 and C8, but with the ASIA classification B-D. Complete paraplegia involves an injury between T1 and S5 with the ASIA-A classification. Incomplete paraplegia involves injury to the spinal cord between T1 and S5 with an ASIA classification B-D (DeVivo, 2002).

Types of Spine Boards

Spine boards are only one of the important pieces of equipment needed to completely immobilize a patient with a suspected spinal injury. Based on the location of the patient, the position of the patient, and the resources available, different types of spine boards can be used for different needs.

Long backboard. The typical long spine board used for transferring patients with a suspected spinal injury is six to seven feet in length (Crosby & Lewallen, 1995). The most recent models of backboards are made of plastic so bodily fluids are not absorbed into the surface, which was a problem in the older wooden models (Crosby & Lewallen, 1995). The rigid backboard is the standard for immobilizing a patient found in the supine position (De Lorenzo, 1996). The only con to the use of a rigid backboard is that the patient may experience discomfort or pressure sores if left on the unpadded backboard for an extended period of time, and this discomfort has been associated with unnecessary radiographic films being ordered (Hamilton & Pons, 1996).

Short backboard/ Kendrick Extrication Device (KED). A short spine board is used for patients found in the seated position. The short spine board is usually around three to four feet in length and has been recently been used in a vest-type device for extraction from a vehicle (Crosby & Lewallen, 1995). Graziano, Scheidel, Cline, and Baer (1987) concluded in their research that use of the KED provides more stability than a cervical collar alone.

Scoop stretcher. The scoop stretcher consists of two aluminum pieces that can connect together and is mainly used to transfer those that are minimally

injured or those patients in tight areas (Krell, McCoy, Sparto, Fisher, Stoy, & Hostler, 2006). Scoop stretchers have begun to be used in place of or in conjunction with the long backboard (De Lorenzo, 1996). Krell and colleagues (2006) studied the difference in application and immobilization of the long backboard and the Ferno Scoop Stretcher. Their research showed that the Ferno Scoop Stretcher is as effective as the long backboard in spinal stabilization and there was less movement during application of the scoop stretcher when compared to the log roll technique for the long backboard (Krell et al., 2006). Patients also reported feeling more comfortable on the scoop stretcher and felt equally secure on both devices (Krell et al., 2006). The Inter-Association Task Force recommends using the scoop stretcher with the six-person lift to transfer a supine patient onto the long backboard (Kleiner et al., 2001).

Vacuum splints. The vacuum splint is an airtight device filled with polystyrene balls that when fully inflated is flexible and can be conformed around a patient, but when air is removed, the balls are compressed together, forming a rigid splint that keeps shape until air is reintroduced to the device (Hamilton & Pons, 1996). Full-body vacuum splints have mainly been used in Europe, but they are beginning to be used in the US as stabilization during surgery (Hamilton & Pons, 1996). One of the reasons full-body vacuum splints are beginning to be used is the relative increase in comfort for the patient when compared to the long backboard (Hamilton & Pons, 1996). Another possible advantage of the full-body vacuum splint is that it conforms to the curvature of the spine, possibly providing more stability, but this has not been thoroughly studied (Hamilton & Pons, 1996).

A study by Hamilton and Pons (1996) showed that the full-body vacuum splint along with the use of a cervical collar provided equal immobilization as the long backboard with cervical collar in flexion, lateral beginning, and rotation, and provided more stability for extension.

Another study by Ransone, Kersey and Walsh (2000) looked at the use of cervical vacuum immobilization for football players with helmet and shoulder pads in place. Because of the equipment the football player may have on when sustaining a neck injury, the application of a cervical collar may not be possible (Ransone, Kersey, & Walsh, 2000). Alternatives to the rigid cervical collar include the soft cervical collar, sand bags, and cervical vacuum immobilizer. The cervical vacuum immobilizer is easily applied and is designed to provide greater stability than the soft cervical collar (Ransone, Kersey, & Walsh, 2000). Ransone, Kersey, and Walsh (2000) found that the cervical vacuum immobilizer significantly increased cervical stability in flexion, extension, and lateral bending in fully equipped football players when compared to no cervical immobilization.

Motorized spine board. The motorized spine board is a wedge-shaped machine that is battery-operated to be able to "crawl" under a patient in the supine position (Swartz et al., 2005). This is a newer method for spine-boarding that was designed to minimize human movement from the spine-boarding process (Swartz, et al., 2005). Swartz and colleagues (2005) compared movement during the log roll to movement during use of the motorized spine board. They found that the motorized spine board demonstrated less movement in the transverse and frontal planes, but slightly more movement with flexion and

extension when compared to the long roll (Swartz et al., 2005). The motorized spine board had more consistent application than did the log roll as the standard deviation in all planes was less, but the necessary flexion of the neck to allow the motorized spine board to get under the patient is a limitation to its application (Swartz et al., 2005).

Spine-boarding Transfer Techniques

When there is a person with a suspected spinal cord injury, the first person on the scene is responsible for the manual inline stabilization of the head and neck until additional help can arrive (Del Rossi, Horodyski, & Powers, 2003). This person could range in experience and training from no experience to years of EMT experience. The first responsibility is to check primary survey of the patient to observe any potential life-threatening conditions including airway, breathing, circulation, and level of consciousness (Kleiner et al., 2001). The patient suspected of a spinal injury or one that is unconscious and it is unknown if a spinal injury has occurred must not be moved unless it is necessary in order to provide life-saving measures, for example CPR or rescue breathing (Kleiner et al., 2001). Next, it is necessary to fully immobilize people suspected of having a spinal injury to a spine-board with the correct stabilization through the use of a rigid backboard, a rigid cervical collar, lateral supports, and straps to properly secure the patient to the backboard (Hadley, 2002).

Many studies examined the accuracy of head and neck stabilization during transfer techniques, but recently, the correct procedure for securing the person to the spine board has been studied as loose straps can lead to as much damage

as poor immobilization during transfer techniques. The correct technique for applying straps is believed to be around the pelvis, shoulders, legs, and lastly, the head (Kleiner et al., 2001). One study investigated the correct use of straps found that out of 50 patients brought into the emergency room, 44 had at least one failing strap, and the average number of failing straps was 3.4 (Peery, Brice, & White, 2007). The correct immobilization of the entire body, especially the pelvis, helps limit total body movement when the head and neck are secure (De Lorenzo, 1996). It is thought that motion during transfer techniques will be reduced with training and experience, but with a five step training and testing experiment, which took place over one week, Del Rossi, Horodyske, and Powers (2003) found minimal to no improvements in both the log roll and lift-and-slide techniques.

Using the correct transfer technique onto the spine-board is crucial in minimizing secondary injury to the spine (Del Rossi, et al., 2004_b). In a study using cadaver models with an unstable cervical spine segment, researchers found that both the log roll maneuver and the lift-and-slide technique were effective transfer techniques (Del Rossi et al., 2004_b). The Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete recommends using the lift-and-slide technique for a supine patient and the log roll maneuver for a patient found in the prone position (Kleiner et al., 2001).

Lift-and-slide technique. This is also commonly know as the six-plus person lift and uses at least six people; one maintaining inline stabilization of the head and neck with their hands and forearms, one positioning the spine-board,

and the others surrounding the patient with one person on each side at the levels of the chest, pelvis, and legs. For smaller patients, it has been found to be effective with as few as four rescuers, but never fewer than four (Kleiner et al., 2001). If the patient is heavier, up to ten people may be used, being evenly positioned at the sides of the patient (Kleiner et al., 2001). These rescuers reach under the patient to get a secure hold to be able to lift him or her 4 to 6 inches. The spine-board is then slid in from the feet into position under the patient, and the patient can be gently lowered back down, onto the spine board (Kleiner et al., 2001). The lift-and-slide is only recommended to be used from the supine position to avoid having to roll and then lift the patient. Some of the advantages to the lift-and-slide technique are that it is better when bulky equipment is involved or if a heavier person needs to be spine-boarded (Kleiner et al., 2001).

Log roll maneuver. This transfer technique needs at least four people; one maintaining inline stabilization of the head and neck (R1), two positioned along the chest and thighs (R2 & R3), and one positioning the spine board (R4). The patient is rolled to the side of R1's top hand if found in the prone position, or rolled away from R2 and R3 if in the supine position. This is completed by R2 and R3 rolling the patient onto his or her arm, which is placed above the head before rolling the patient. R4 then wedges the spine board against the patient's back at a 30 to 45 degree angle so the patient can be rolled back onto the spine board (Kleiner et al., 2001). An advantage of the log roll is that it is easy to conduct and requires less strength and coordination of the rescuers conducting the roll than the lift-and slide (Del Rossi Horodyski, & Powers, 2003). Another

advantage is the log roll can be used when the patient is in any position, and is shown to be the safest means of immobilization for a patient found in the supine position (Campagnolo & Heary, 2002). Some disadvantages to the log roll is, it has been found to potentially have a greater degree of thoracolumbar movement than the lift-and slide technique and is advised to not be used in those suspected of having a lower spinal injury (Del Rossi, Horodyski, & Powers, 2003). A study using cadaver models with unstable spinal segments showed that both the log roll and the lift-and-slide techniques allowed movement at the injured spinal level, but the lift-and-slide limited movement more than the log roll (Del Rossi et al., 2004_b).

One of the earlier studies on the amount of cervical movement during spine-boarding looked at the flexion and extension movement during the log roll and lift-and-slide techniques on cadaver models. Del Rossi and colleagues (2004_b) studied these techniques on stable cadavers, cadavers with a posterior ligametous injury at C5-C6, and cadavers with a complete segmental injury at the C5-C6 level. They had 24 individuals (certified athletic trainers, athletic training students, and EMTs) in four groups of six to perform the techniques. Groups completed two trials of each technique on five cadavers in three different sessions after completing an instructional and familiarization session on the techniques being used. The first session was conducted with a stable spine, the second with the posterior ligamentous injury, and the third was testing the stability of the complete injury. Their results showed the log roll had a slightly greater amount of movement in the sagittal plane than the lift-and-slide did, but

this did not reach statistical significance. They also found that as the amount of instability increased, the amount of motion produced at the segment also increased in both techniques (Del Rossi et al., 2004_b).

Del Rossi and colleagues (2008_a) studied axial rotation, flexion and extension, lateral bending, anteroposterior displacement, distraction, and medial-lateral translation of the stable and unstable C5-C6 spinal segment during three transfer techniques—the 6-plus person lift, the lift-and-slide, and the log roll. They used eight allied health professionals (3 physicians, 2 certified athletic trainers, and 3 other hospital staff members) to perform the different techniques. The participants conducted the techniques on five cadavers, first with intact spinal segments, then again after a complete spinal lesion was made to make the C5-C6 segment unstable. During all testing trials, the cadavers were placed in the supine position with the head and neck in line with the body for a zeroed position to make all comparisons. Three trials of each technique were measured for each technique on each cadaver with a stable spine and without (18 total trials for each cadaver). In axial rotation, they found significantly more motion with the log roll in respect to the two lift techniques as well as the log roll having a significant difference between the stable and unstable spine motion. With lateral flexion and medial-lateral translation, there was also a significant increase in the motion produced during the log roll in comparison to the lift techniques, but all three techniques had a significant increase in post-stability testing. For flexion-extension movement, anteroposterior translation, and distraction motion, there was not a significant difference between techniques, but all techniques had

significantly more motion after the spinal lesion. The log roll, showing more motion than the lift techniques for axial rotation and lateral flexion, might require more coordination of the rescuers as it requires a more complex movement of the head than the linear movement in the lift techniques (Del Rossi et al., 2008_a).

Later in the year, Del Rossi and colleagues (2008_b) published another study focusing on thoracolumbar instability. They used the same three transfer techniques (the 6-plus person lift, the lift-ad-slide, and the log roll) while examining the motion occurring in the thoracolumbar spine. They performed the three techniques on five cadavers both with a stable spine and instable spine from T12-L2. They used the same protocols for testing trials of the transfer techniques in this study as their study examining cervical motion. Del Rossi et al. analyzed the axial rotation, flexion/extension, and lateral bending of both the stable and unstable thoracolumbar spine for three trials of each transfer technique. In axial rotation, they found that the log roll and lift-and-slide had a significant difference between motion produced in the stable and unstable spine and that the log roll produced significantly more motion in the unstable spine than the lift-and-slide did. In flexion/extension, they found no significant differences between the techniques, but all three techniques showed significant increase in motion in the unstable spine when compared to the stable spine. Movement of lateral flexion during the transfer techniques again increased in the unstable spine, but did not reach statistical significance; this is also true when the increase in motion during the log roll was compared to the two lifting techniques. The results of their study again show that the log roll allows for more movement

during spine-boarding than other techniques. For over two decades now, research has shown that the log roll is not the most effective technique, yet it continues to be used for its versatility and ease (Del Rossi et al., 2008_b).

EMT Education

The Emergency Medical Services System is composed of personnel of different training levels including first responders (FR), EMT-basic (EMT-B), EMT-intermediate (EMT-I), and EMT-paramedic (EMT-P). EMT-Ps can also go into a specialization such as critical care, public health, rural management of farm and agriculture, hazardous materials management, and law enforcement tactical operations (Blackwell, 2002).

The combination of initial and continuing education of EMTs is essential in providing adequate pre-hospital care to patients (Dawson, Brown, & Harwell, 2003). The education program for emergency medical technicians is based on criteria set forth by each state, which is governed by the National Registry of Emergency Medical Technicians (NREMT) (NREMT, 2008). The curriculum still being used today for paramedics was based on the U. S. Department of Transportation's EMT-Paramedic National Standard Curriculum of 1985 (Brown & Fowler, 1999; Pollock, Brown, & Dunn, 1997). Today, the curriculum used for all levels of training is developed by the National Highway Traffic Safety Administration (NHTSA) (Blackwell, 2002). The NREMT is also accredited through the National Commission for Certifying Agencies, making sure that the proper exam and certification procedures are being followed (EMT-Basic Certification web).

In an attempt to understand the effectiveness of education programs for EMTs, the National Registry of Emergency Medical Technicians conducted the Longitudinal Emergency Medical Technician Attributes Demographic Study Project (LEADS Project). The LEADS Project studies the characteristics of skills needed for EMTs and assesses specific issues for EMTs over a longitudinal period (Dawson, Brown & Harwell, 2003). Specific issues addressed in the survey were demographic information, health status, level and years of EMS practice, EMS employer information, and satisfaction with the profession. Specific questions to education included the last course they attended, rating of their instructor and course material, how often their course met, how long classes lasted, how long the course took to complete, how many hours of classroom, clinical, and field internship hours were required, and how they have received their continuing EMS education (Dawson, Brown & Harwell, 2003). The results of the study showed that most EMT-B's had completed a course that met twice a week for less than four hours at a time for four to six months. There was an array of hours required for the EMT-B course, ranging between 110 and 250 hours total. EMT-P's showed that most courses also met twice a week for less than four hours at a time, but that the program lasted between 7 and 12 months to complete. The largest percentage of respondents (29%) said that their training required 1000-1500 hours, but there were ranges of less than 250-greater than 1500 (Dawson, Brown & Harwell, 2003). When asked on how prepared they felt on specific tasks, less than fifty percent of both EMT basics and paramedics

were very well prepared in the categories of childbirth and pediatric patient assessment (Dawson, Brown & Harwell, 2003).

First responder. The first responder requires the lowest level of training. The Department of Transportation recommends approximately 40 hours of instruction with a refresher course between 16 and 36 hours (Blackwell, 2002). FRs are the first person to report to the scene and are responsible for performing initial lifesaving care which may include cardiopulmonary resuscitation (CPR), basic airway management, hemorrhage control, and initial spinal immobilization (Blackwell, 2002; Crosby & Lewallen, 1995). Their main responsibility is to begin care for the patient until more advanced personnel can arrive at the scene.

Emergency medical technician-basic. The EMT-basic is the minimum level of certification needed in a basic life support (BLS) ambulance for use in nonemergency situations or patient transport (Blackwell, 2002). They are trained in triage, a more detailed patient assessment and transportation, and early defibrillation on top of the FR skills (Blackwell, 2002). EMT-Bs go through an initial training of at lease 46 lessons with a minimum of 110 hours and need 48 hours of continuing education every year (Blackwell, 2002). On top of that, the DOT recommends a 24 hour refresher course with a BLS course every other year (Blackwell, 2002).

Emergency medical technician-intermediate. The EMT-intermediate has a more complete understanding of care for patients where paramedic services are unavailable in the advanced life support (ALS) ambulance (Blackwell, 2002). EMT-I training adds bag/mask ventilation, endotrachial intubation, intravenous

initiation, and defibrillation to the skills of the EMT-B through 300-400 hours of initial training in the classroom, hospital, and field experiences (Blackwell, 2002).

Emergency medical technician-paramedic. The EMT-paramedic is the prehospital care provider with the most advanced skills. In addition to the EMT-I skills, the EMT-P can recognize cardiac rhythm, administer pharmacologic treatment, perform advanced airway interventions, and perform some minimally invasive procedures (Blackwell, 2002). Their training requires 10000-12000 hours of training in the classroom, clinical and field settings that are sometimes completed as an associates or bachelor's degree program (Blackwell, 2002). Recertification requires a 48 hour refresher course, 24 hours of continuing education, and BLS/ALS pediatric and adult classes (Blackwell, 2002). Often, the paramedic program is part of an associate of applied science or baccalaureate degree program, but they can also be a certificate training program with no degree attached (Brown & Fowler, 1999). In a survey study completed by Brown and Fowler (1999), they found that paramedics that enrolled in a certificate program felt equally prepared for patient-care tasks, but lacked non-patient-care tasks that degree program paramedics felt prepared for. Degree paramedics were also more likely to have advantages in hiring, higher pay, and greater chance of promotion in their field (Brown & Fowler, 1999).

Topics in EMT training. EMT education is broken up into categories with subcategories within each category. The categories of their education include preparatory, airway, patient assessment, medical, trauma, special considerations, and operations (Michigan Department of Community Health,

2007). Depending on the level of training (basic, intermediate, or paramedic), different subcategories are covered and/or expanded upon under each main topic. The EMT-Basic examination includes spinal immobilization through the core topic of trauma which is a total of approximately 16.7% of the entire examination. In addition, skill areas on the practical examination for both seated and supine spinal immobilization are also tested (NREMT, 2008).

EMT spinal immobilization training. As a part of the trauma category, EMTs learn proper spinal immobilization techniques, including spine boarding transfer techniques. A report on the LEADS Project by Dawson, Brown, and Harwell (2003) showed that 76% of EMT-B and 78% of EMT-P felt they were very well prepared to perform the clinical skill of spinal immobilization while 1% in both training levels felt they were poorly prepared to complete the skill. The rescuer that is first on the scene is responsible for manual stabilization of the head and trunk after it is established that the airway is unobstructed (Crosby & Lewallen, 1995). To do this, the rescuer grasps the head of the patient with both hands, having index fingers along the jaw, and thumbs and palms on the occiput. They are to put the patient into the "eyes forward position," having the patient's eyes looking straight ahead, having the head in line with the torso, aligning the nose with the navel. This position allows for easier immobilization procedures, but excessive motion should be avoided (Crosby & Lewallen, 1995). If the patient has muscle spasm in the neck, has an increase of pain, has numbness, tingling, or weakness, or has a compromised airway, do not move the patient into the "eyes forward position" and immobilize in the position they were found

(Cosby & Lewallen, 1995). A second rescuer should then apply a rigid spinal immobilization cervical collar to increase stability to the cervical spine, but manual stabilization is still needed until the patient is fully secured on the backboard (Crosby & Lewallen, 1995).

If a patient is found in the supine position, EMTs are taught to utilize the four-person logroll technique to place the patient on a long backboard (Crosby & Lewallen, 1995). The rescuer that first applied manual stabilization is the rescuer in charge of the rest of the team. He or she commands the other rescuers what they are to do next. The three rescuers controlling the body movement are to roll the patient towards them with the backboard ready on the other side of the patient. When rolling the patient onto his or her side, it is important to concentrate on heavier portions of the body to help coordinate a smooth coordinated movement (Crosby & Lewallen, 1995). On the head rescuer's command, the patient is to be rolled back down onto the spine board, making sure to avoid twisting of the head, shoulders, or pelvis. From here, after the patient is centered on the board, straps need to be applied to secure the patient. Straps should be placed to secure the head (two straps), upper torso, pelvis, legs (above and below the knees), and arms (Crosby & Lewallen, 1995) to the rigid spine board.

If a patient is found in the seated position, the decision must be made if the patient is stable enough to take the time to apply the short spine board or if a quick extrication is needed (Caroline, 1995). If the patient is showing signs of shock, respiratory distress, or lowered levels of consciousness, it may benefit the

patient to have a quick removal as the chance of survival decreases about one percent every minute between initial injury and the beginning of surgery (Caroline, 1995). The use of a short spine board or short spinal extrication device (KED or Kendrick Extrication Device is commonly used) must be used for immobilization instead of the long spine board in these seated situations, namely automobile accidents (Caroline, 1995). Again, the first step is manual stabilization of the head and neck followed by the application of a rigid cervical collar (Crosby & Lewallen, 1995). Next, maneuver the short spine board between the patient's back and the seat, securing the side flaps around the patient's torso (Crosby & Lewallen, 1995). Secure the upper torso strap, followed by the mid torso strap then the groin loops, and finally the two head straps to secure the patient to the spine board. The next step is to get the patient onto the long spine board to completely immobilize him or her. Place the long spine board perpendicular to the patient's trunk, right against the buttocks. Next, rotate the patient and lower him or her onto the long spine board and secure both the long and short spine boards together (Crosby & Lewallen, 1995). If the quick extrication is needed, the EMTs are to follow the same procedure listed above, except instead of having the short spine board supporting the patient's head and neck during the process, the rescuer's hands provide the only support (Caroline, 1995).

Continuing medical education. Continuing education is another important part of the life-long learning process needed for health care professionals, including EMTs. The physical and cognitive skills of EMTs and other health care

professionals have been studied and show decline over time, demonstrating the need for continuing education (De Lorenzo & Abbott, 2007). Through the National Registry of EMTs, at the EMT-basic level, 48 hours of continuing medical education is needed every two years (De Lorenzo & Abbott, 2007). Most continuing education is completed in the classroom setting (Dawson, Brown, & Harwell, 2003), but other means of continuing education, such as web-based training (Jerin & Rea, 2005), conferences, cases/run reviews, interactive computer programs, journal articles, and videocassettes are methods for EMTs to meet their continuing education requirement (Dawson, Brown, & Harwell, 2003).

Review of Method Literature

Making sure that EMT's have the best training possible is important to everyone as all of us at one time or another might be in need of the emergency medical services. There have been studies in the emergency medicine field that have examined the knowledge and experience of many aspects of their training, such as dental injuries (Lin, Levin, Emodi, Fuss & Peled, 2006), strokes (Crocco, Kothari, Sayre, & Liu, 1999), and cardiopulmonary resuscitations (Brown et al., 2006). The studies looking at dental knowledge and strokes were survey-based approaches (Crocco et al., 1999; Lin et al., 2006) while the CPR study looked both at a quantitative skill measure and a questionnaire to measure their knowledge of guidelines (Brown et al., 2006).

Many other aspects of the EMT educational process have also been studied, such as initial training levels, continuing education, and practical

experience. A study done by Pollock, Brown, and Dunn (1997) investigated the emphasis of various skills that EMT-Paramedics perceived through their initial training, continuing education, and the importance of each skill. They used a survey of 21 skills that they evaluated on three likert scales—emphasis on the skill in initial training, emphasis placed on continuing education, and the importance of each skill in providing prehospital emergency care. Their results showed that the perceived importance outranked the emphasis placed on the skills in both initial and continuing education in most of the skills. In reference to immobilization in the study, it was ranked as the ninth most important skill, and emphasis of the skill in both initial and continuing education were ranked less than the perceived importance.

The survey-based study has been used widely in the field to assess knowledge, attitude, experiences, and views on an array of subjects. Survey studies used on EMTs have been distributed in a variety of ways, including calling agency directors directly and asking them to have their station participate in the study with a 44% return rate (Pollock, Brown & Dunn, 1997); handing surveys out at a conference with an 87% return rate (Vilke, Fisher & Chan, 2002) and a 77% return rate (Hennes, Kim & Pirrallo, 2005); attaching surveys to re-registration packets for the National Registry of EMTs with a 71% return rate (Studnek & Ferketich, 2007); mailing surveys got a 36% return rate (Crocco et al., 1999), a 62% return rate (Sherbino, Guru, Verbeek, & Morrison, 2000), and a 28% return rate from EMT-B and 36% return rate from EMT-P (Dawson, Brown, & Harwell, 2003); and a convenience sample of EMTs working out of certain

hospitals was used to hand out surveys in person with a 100% return rate (Compton, Madgy, Goldstein, Sandhu, Dunne, & Swor, 2006).

The number of subjects used in EMT survey distributions has varied among researchers: Vilke, Fisher, and Chan (2002) had a return of 580 surveys to study latex allergies in a select community, Stadnek and Ferketich (2007) had a return of 30000 surveys in a national study on EMT seat belt use, Sherbino et al. (2000) had a survey return of 221 while studying a community sample of do-not-resuscitate orders, Pollock, Brown, and Dunn (1997) had 600 surveys returned while studying paramedic skills in North Carolina, Lin and colleagues (2006) had 68 surveys while testing a small sample on dental trauma, Hennes, Kim, and Pirrallo (2005) had 155 surveys studying a county on pain management, Crocco et al. (1999) had 355 responses in a national survey on stroke management, Compton et al. (2006) had 128 respondents in a community sample on CPR administration, and Brown and colleagues (2006) had 60 participants in a community study of CPR guidelines.

Summary

Spinal cord injuries are traumatic at any degree of severity. Managing initial injuries may reduce the possibility of worsening the severity of the injury and potential recovery for the patient. Current literature has studied many aspects of spine boarding to try and identify the safest way to transport patients suspects of a head of neck injury, but it is unknown if the results of these studies are known to personnel involved in the spine-boarding process or if it is changing their views on proper techniques.

To investigate these questions, a survey-based study will be completed. The survey-based approach has been used in a variety of ways within the EMT setting with acceptable return rates from mailings. There have been good results and a gain of knowledge through these studies, and it has been proved as a useful tool.

Chapter 3

Method

As medical professionals, it is important for EMTs to continue learning throughout their careers. Keeping up with changing technology and practicing techniques that aren't used as often is imperative so EMTs are as prepared as possible to handle any situation. By surveying EMTs on their initial and continuing education on the subject of spine boarding, the thoroughness of their knowledge of the topic will be examined. In addition to their knowledge, their experience and preference will also be studied in a survey being distributed to EMTs in the state of Michigan.

Participants

People participating in this study were Michigan certified EMTs who have completed at least the EMT-Basic 1 training level and kept up with their continuing education and registration. EMTs at all levels were used in this study to permit comparisons based upon experience and continuing education. Those EMTs no longer practicing were excluded from the study as they may not have been as likely to maintain their continuing education. EMTs were randomly selected from a listing obtained from the Michigan Emergency Medical Technician office. Each selected person was mailed a survey to participate in the study.

Instrumentation

The survey (see Appendix A) was created specifically for this study. The survey included 25 items that fell into the following categories: demographic

information, initial knowledge, continuing education, preference of spine boarding techniques, and experience. Demographic information included age, sex, highest degree completed, highest EMT training completed, and duration of EMT certification. Initial knowledge addressed what techniques were originally taught and if certain techniques were recommended for use in different scenarios. Continuing education was touched on by asking what literature they read, how often they read literature, and how often they attend conferences. In the survey, participants were asked their preference of techniques they have used in certain scenarios (seated, supine, and prone). Experience was judged by how long they have been an EMT and how often they used spine boarding transfer techniques. Crocco et al. (1999) had similar categories while surveying EMTs about stroke knowledge—quality of training, general stroke knowledge, stroke management, signs and symptoms, and demographic information.

*The d*ata were collected based on ordinal scale categories. The survey is formatted in a multiple choice manner and allowed computation by assigning each selection a number. There was no set distance between the choices, so it was not integer data. The maximal number of choices for a question was nine.

Psychometric properties. The survey being used in this study had not previously been tested or studied since it was developed specifically for this study. It does have face validity as overseen by professionals in the EMT and athletic training fields (personal communication with 6 EMTs and 4 ATCs knowledgeable in the spine-boarding process).

Data-Collection Procedures

The researcher obtained approval for the study from the Michigan State University Institutional Review Board (exempt status). A letter explaining the survey procedures and the purpose of the study was sent with the survey and stated that by submitting the survey, they are agreeing to participate in the study (see Appendix B). Participants were recruited by mail from mailing labels acquired from the Michigan EMT. The initial mailing to 500 EMTs contained a brief overview of the purpose of the study, inclusion and exclusion criteria, time the survey took to complete, instructions, and the actual survey. The survey was mailed out in March, 2009. Responses were accepted for two months after the initial mailing.

Participants completed the survey on their own time in an unknown location. Since the surveys were mailed to the participants' home addresses, the exact location and time of the survey completion was unknown. The survey was estimated to take no longer than 10 minutes to complete.

Data management. All survey results were collected by return mail and entered into SPSS (SPSS, Inc, Chicago , IL) for data computation. The original survey responses were kept in a locked file cabinet in a locked office. No other personal information or data were collected, so there was no threat to personal identity.

Data Analyses

Data analysis was completed using SPSS 16.0 software. To analyze if EMTs have a preference of technique, if they know what technique literature

shows to be most effective, and which technique EMTs perceive greater control with, a frequency count was completed on those survey items. Cross-classification analysis models were completed to compare the research questions regarding the EMTs who read more literature or attend more conferences and their knowledge of the techniques that provide more stability.

CHAPTER 4

Results

The results section will report findings related to each research question, other analyses completed from the data, and demographic information of the participants. There were three major research questions:

- Which spine boarding technique (log-roll, lift-and-slide, or KED) will currently certified EMTs believe is known to be best for managing cervical stability when assisting injured persons found in prone, supine, and seated positions?
- Which spine boarding technique (log-roll, lift-and-slide, or KED) do currently certified EMTs feel the greatest amount of cervical stability is provided during moving injured persons found in prone, supine, and seated positions?
- Does the extent to which currently certified EMTs (a) read the professional literature and/or (b) attend professional conferences affect their beliefs about or use of different spine-boarding techniques?

Participant Demographics

A prospective sample of 500 EMTs was contacted to participate in this study. After two months of data collection, a response of 53 subjects was received, for a response rate of 10.6%. Of the 53 that responded, some participants did not completely fill out the questionnaire, so the *n*-values in each table will reflect the number of responses for each item.

The age of participants ranged from 30 to 66 years with the mean age being 46.1 ± 8.8 years. Subjects reported working an average of 38.5 ± 22.8 hours per week, with a range of 0 to 90 hours. The majority of participants are males, have an Associate's Degree, work in a fire department in a small town, and use spine boarding on a weekly basis. Additional details are provided in Table 1.

Table 1

Demographic Characteristics of Participants

Variable	Frequency	Percent[1]
Gender		
Female	16	30%
Male	36	68%
Did not report	1	2%
Highest level of education completed		
High School diploma/GED	15	28%
Associates	23	43%
Bachelor's	9	17%
Master's	4	8%
Doctorate	2	4%
Work Setting		
Fire department	18	34%
Hospital	5	9%
Private ambulance company	10	19%
Police department	2	4%
Private industry	1	2%
Multiple work settings	10	19%
Other	6	11%
Did not answer	1	2%
Work Town		
Rural area	7	13%
Small town	14	32%
Medium town	10	19%
Large town	8	15%
Mid-sized city	4	8%
Suburb/fringe of mid-sized city	0	0%
Large city	5	9%
Suburb/fringe of large city	3	6%
Did not report	2	4%
Frequency of spine boarding use		
Multiple times a day	5	9%
Daily	9	17%
Weekly	19	36%
Monthly	14	32%
2-3 times a year	4	8%
Less than once a year	1	2%
Did not report	1	2%

Note-Graph based on a sample size of 53 subjects

[1]Because of rounding to whole numbers, percentages within a data category may not add up to 100%

Research Question 1: Spine-Boarding Technique thought to be the Best

For a patient found in the prone or supine position, subjects believed the log roll was the best technique and for a patient found in the seated position, the use of the Kendrick Extrication Device is thought to be best. Almost all respondents (96%) believed using the KED or short spine board was the best method for a patient found in the seated position. Most respondents (79%) believed the log roll was the best technique if the patient was found in the prone position. The majority of respondents (60%) indicated that the log roll was the best technique for a patient found in the supine position although the responses were more variable with respect to this position (see Table 2). Nonetheless, it was surprising to learn that a noteworthy percentage of practicing EMTs were not aware of which technique was recommended for persons found in the supine position.

Table 2

What do Participants Think Literature Reports Providing the Most Cervical Stability during Spine Boarding?

	Patient Position		
Technique	Prone $n = 52$	Supine $n = 52$	Seated $n = 52$
Lift-and-slide/6-plus person lift	4 (8%)	12 (23%)	0 (0%)
Log roll	41 (79%)	31 (60%)	0 (0%)
KED/short spine board	1 (2%)	3 (6%)	50 (96%)
Only used one technique	0 (0%)	0 (0%)	0 (0%)
Don't know	6 (12%)	5 (10%)	2 (4%)
Other	0 (0%)	1 (2%)	0 (0%)

Research Question 2: Spine-Boarding Technique Perceived to Have Most Stability

Subjects reported they perceived the greatest control using a KED for a seated patient and the log roll for an injured person found in the prone and supine positions. The response pattern for this question is the same as RQ1 where almost all respondents (94%) chose the KED or short board for the seated position, most (86%) chose the log roll for the prone position, and the majority (56%) also chose the log roll for the supine position. Once again the responses were more variable for the question related to persons found in the prone position than those found in the supine and seated position (see Table 3).

Table 3

Which Technique do Participants Perceive the Greatest Amount of Control while Performing Spine Boarding Techniques in Various Positions?

	Patient Position		
Technique	Prone *n* = 51	Supine *n* = 52	Seated *n* = 51
Lift-and-slide/6-plus person lift	4 (8%)	15 (29%)	1 (2%)
Log roll	44 (86%)	29 (56%)	1 (2%)
KED/short spine board	1 (2%)	7 (14%)	48 (94%)
Only used one technique	1 (2%)	1 (2%)	0 (0%)
Don't know	0 (0%)	0 (0%)	0 (0%)
Other	1 (2%)	0 (0%)	1 (2%)

Research Question 3: Effects of Continuing Education on Spine-Boarding Knowledge

According to the results from the data, most EMTs don't read literature or attend conferences on a consistent basis. The highest percentage of subjects (40%) reported that they read professional literature less than once a month.

EMTs reported highest frequency of responses for attending an average of one or two conferences a year (both representing 18% of total responses), although their answers ranged from never attending a conference to attending more then five a year. As Table 4 indicates, subjects tended to answer questions according to literature in the seated and prone patient position, but not the supine position.

Table 4

Did Subjects Answer Positional Questions Same as Literature Reports?

	Patient Position		
	Prone	Supine	Seated
Response match?	*n* = 52	*n* = 52	*n* = 52
Yes	41 (79%)	12 (23%)	50 (96%)
No	11 (21%)	40 (77%)	2 (4%)

Effects of literature. The analysis of the amount of literature read and how respondents answered the questions related to technique recommended for use by patient position was conducted. A cross-classification analysis was conducted to analyze if the amount of literature read correlated with what literature reports. Some trends were found that showed that those who answered the prone and seated questions differently from what the EMT literature reported also tended to read literature on a less frequent basis (see Table 5). A frequency analysis on which journals the EMTs read on a regular basis was also conducted (see Table 6).

Table 5

Does Amount of Literature Read Have an Effect on Literature Knowledge?

	Matched answer with literature[1]		
Amount of literature read	Prone *n* = 52	Supine *n* = 52	Seated *n* = 52
Daily	4 (100%)	0 (0%)	4 (100%)
Weekly	16 (94%)	4 (24%)	17 (100%)
Monthly	6 (60%)	2 (20%)	10 (100%)
Less than once a month	15 (71%)	6 (29%)	19 (90%)

[1] The literature recommended log roll for prone, lift-and-slide for supine, and KED for seated.

Table 6

Journals EMTs Read on a Regular Basis

Journal	Frequency	Percentage[1]
Journal of Emergency Medicine	23	43%
Emergency Medical Services	19	36%
Prehospital Emergency Care	4	8%
The Spine Journal	0	0%
American Journal of Sports Medicine	0	0%
Journal of Athletic Training	0	0%
Doesn't currently read literature	14	26%
Other	12	23%
Did not report	2	4%

[1]Percentage represents the percentage of all respondents that read that journal on a regular basis

Effects of professional conferences attended. The analysis of the number of professional conferences attended and if the respondents answered the questions in agreement with the literature was conducted. A cross-classification analysis was completed to analyze if the number of professional conferences attended had an effect on if the subjects' spine boarding technique answers tended to agree with what literature reported. Again, trends were found in the

prone and seated positions showed those subjects who did not answer questions the same as literature reports tended to attend fewer conferences (see Table 7).

Table 7

Does the Number of Professional Conferences Attended Have an Effect on Spine Boarding Knowledge?

	Matched answer with literature[1]		
Number of conferences	Prone *n* = 51	Supine *n* = 51	Seated *n* = 51
>3 per year	11 (100%)	4 (36%)	11 (100%)
1-2 per year	13 (72%)	4 (22%)	17 (94%)
Less than once a year	16 (73%)	4 (18%)	21 (95%)

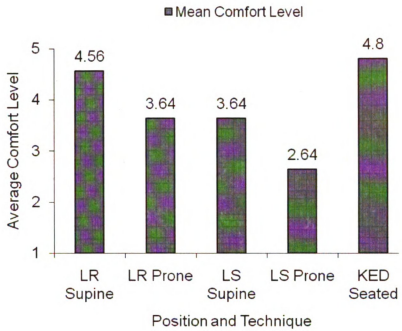
[1] The literature recommended log roll for prone, lift-and-slide for supine, and KED for seated.

Amount of EMT Control by Spine Boarding Technique and Patient Position

EMT's perceive the greatest cervical stability while providing manual stabilization during each of the following scenarios. The respondents answers were reported on a Likert scale for spine boarding technique and patient position. The low score of 1 represented little control and the highest score of 5 represented the most control. An average of all subjects' answers was taken to show the average rating for each scenario. The EMTs reported the highest level of comfort using the KED on a patient found in the seated position (4.8/5) and least comfortable using the lift-and-slide on a patient found in the prone position (2.64/5). More control is perceived by EMTs in both the prone and supine positions while using the log roll than the lift-and-slide or the 6-plus person lift (see Figure 1).

Figure 1

EMT's Perception of Control by Position and Technique



Effects of Frequency of Spine Boarding Use and Perceived Control

A comparison of the frequency of spine boarding used by subjects and the level of comfort they reported was conducted. Of the subjects that reported having a high comfort level, a higher percentage also reported having to use spine boarding at least weekly for all situations except for the lift-and-slide in the prone position (see Tables 8-12). The largest difference was found in the seated position where 60% of those reporting high comfort in performing spine boarding techniques reported using spine boarding weekly and 32% reported using it monthly or less. The next two differences were performing the log roll from a prone position (32% used spine boarding at least weekly; 18% used it monthly or

less) and the lift-and-slide from a supine position (36% used spine boarding at least weekly; 18% used it monthly or less).

Table 8

Frequency of Spine Boarding Use and Control Performing the Log Roll for a Patient in the Supine Position

	Level of Control		
Frequency of Spine Boarding Use	Low	Medium	High
At Least Weekly	1 (2%)	8 (16%)	23 (46%)
Monthly of Less	0 (0%)	1 (2%)	17 (34%)

Note: Percentages are calculated from only the 50 subjects that responded to both questions being analyzed from the questionnaire.

Table 9

Frequency of Spine Boarding Use and Control Performing the Log Roll for a Patient in the Prone Position

	Level of Control		
Frequency of Spine Boarding Use	Low	Medium	High
At Least Weekly	7 (14%)	9 (18%)	16 (32%)
Monthly of Less	2 (4%)	7 (14%)	9 (18%)

Note: Percentages are calculated from only the 50 subjects that responded to both questions being analyzed from the questionnaire.

Table 10

Frequency of Spine Boarding Use and Control Performing the Lift-and Slide for a Patient in the Supine Position

	Level of Control		
Frequency of Spine Boarding Use	Low	Medium	High
At Least Weekly	5 (10%)	9 (18%)	18 (36%)
Monthly of Less	6 (12%)	3 (6%)	9 (18%)

Note: Percentages are calculated from only the 50 subjects that responded to both questions being analyzed from the questionnaire.

Table 11

Frequency of Spine Boarding Use and Control Performing the Lift-and-Slide for a Patient in the Prone Position

	Level of Control		
Frequency of Spine Boarding Use	Low	Medium	High
At Least Weekly	16 (32%)	10 (20%)	6 (12%)
Monthly of Less	6 (12%)	6 (12%)	6 (12%)

Note: Percentages are calculated from only the 50 subjects that responded to both questions being analyzed from the questionnaire.

Table 12

Frequency of Spine Boarding Use and Control Using the KED for a Patient in the Seated Position

	Level of Control		
Frequency of Spine Boarding Use	Low	Medium	High
At Least Weekly	0 (0%)	2 (4%)	30 (60%)
Monthly of Less	1 (2%)	1 (2%)	16 (32%)

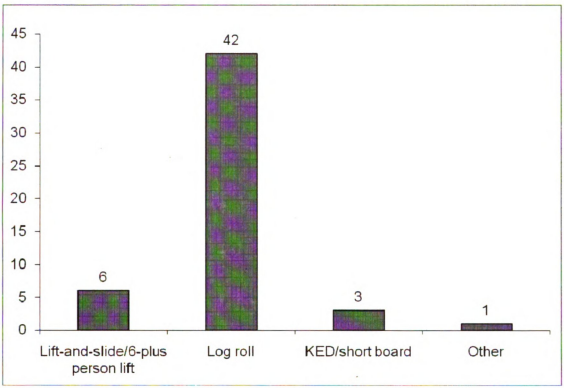
Note: Percentages are calculated from only the 50 subjects that responded to both questions being analyzed from the questionnaire.

Comfort of Using Techniques

To analyze which technique EMTs reported as having the most ease to perform, a frequency count of one of the questionnaire items was conducted. By far, the technique they are most comfortable using is the log roll (42 responses, 81%) followed by the lift-and-slide and 6-plus person lift (6 responses, 12%) and lastly, the KED or short board(3 responses, 6%) (see Figure 2).

Figure 2

EMT's Reported Most Comfortable Technique to Perform



Chapter 5

Discussion

The purpose of this study was to determine the knowledge, preference, and experience of EMTs on different spine boarding techniques. The discussion section will address each of the research questions and the relationship of the study findings to current literature, limitations of the study, future directions for study and practice, and major conclusions from the study.

Belief of Superior Spine Boarding Method According to Literature

This survey addressed the beliefs of EMTs on what literature states as the preferred techniques for spine boarding in differing positions. For a patient found in the supine position, literature mostly recommends that the rescuer use the lift-and-slide technique to move the patient (Del Rossi et al., 2008_a; Del Rossi et al., 2008_b; Kleiner et al., 2001). The majority of EMTs in the current study selected log roll (incorrect according to the literature) rather than the lift-and-slide (preferred method according to literature). A possible explanation could be related to the fact that EMTs rarely have enough people to use the lift-and-slide method, therefore, they might not think of it as the preferred method. Also, most EMT education programs focus on the log roll and use of the KED, so not all EMTs are taught the lift-and-slide initially. If they did learn the technique, it would be through continuing education, recertification training, on-the-job training, or learning from other coworkers. There is an inconsistency among the teaching of the lift-and-slide that could have influenced the survey results when lift-and-slide was an option.

When addressing how to care for a patient found in the prone position, both the literature (Kleiner et al., 2001) and the survey responses overwhelming show the log roll should be used. It is believed that most of the respondents answered this question in accordance with literature because it is known that the patient will have to be rolled from the prone position to the supine position at some point. The log roll is the most commonly chosen technique to use in this situation because it avoids rolling and lifting the patient if another technique was used. The log roll is also a consistently taught technique in the initial education throughout the state. This could be a major factor into why most EMTs knew the technique that was preferred for this position.

The last literature question addressed how to attend to a patient found in a seated position. Again, literature (Caroline, 1995; Crosby & Lewallen, 1995) and the subjects in this study are in agreement that the use of a KED or short board is the preferred method to provide the most stability for the patient. They are both small enough to get into a car (where most seated patients are found) and support the head, neck, and back until the patient can be laid flat on the long backboard better than extraction alone. Again, like the log roll, the KED is consistently taught in the initial education programs and is widely used by EMTs.

Initial education may have a major role in the ability of EMTs to know the proper techniques to use in various situations. EMTs were able to identify the positions to use the two techniques that are regularly taught in the initial education programs, but not as many were able to identify the use of the lift-and-slide in the supine position. Of those that did not choose the lift-and-slide, most

of them resorted to the use of the log roll (the technique taught to them and used by them).

Belief of Superior Control of Patients by Position

Similar to the previous discussion, questions were asked about which technique EMTs felt provided them the greatest amount of control while caring for patients found in the seated, supine, and prone positions. No current literature has ranked EMTs' perception of control while performing spine boarding techniques. The head and neck movement of people being spine boarded has been studied to show which methods actually provide the most stability. If rescuers perform the technique that has been shown to produce the least amount of movement but they are not comfortable performing that technique, the use of that technique might not be as beneficial as literature reports. Again, the perception of control matched the actual control provided for the patients in the seated position (using the KED) and the prone position (using the log roll). Contrary to perceived control in the supine position, the lift-and-slide is shown to provide the most cervical stability, yet the majority of EMTs perceived greater control with the log roll technique. EMTs may perceive less control with the lift-and-slide when compare to the log roll and the KED because they use the later two techniques on a regular basis. They are taught the log roll and the KED initially and they tend to use these two techniques in the field. Also, the lift-and-slide, if taught at all, is used less because it is not as versatile as the log roll in the situations it can be performed and the amount of people necessary to execute the technique properly.

Effects of Continuing Education

EMTs are medical professionals. As with any medical professional, continuing education is imperative in order to stay up to date with the newest technology and techniques in the field and to prevent skills and knowledge from being forgotten from lack of use. Continuing education has been shown to maintain and in some cases improve skills (De Lorenzo, 2007). EMTs have the option to obtain their required continuing education in many ways. In this study, an analysis of the amount of literature read and if they knew what the literature identified as being the technique that offered the most support was conducted. No associations were found between the two variables, but there was a trend noticed in relation to the prone and seated positions. Those that reported reading the literature less than monthly ended up not answering the positional questions the same as what literature reported. When reporting which journals subjects read regularly out of a list provided, none indicated they read the journals that had most of the articles on spine boarding techniques (*The Spine Journal, Spine, and Journal of Athletic Training*). Again, the influence of the initial education may have a major role in their responses as indicated previously.

Another analysis was conducted examining the number of professional conferences attended. Again, respondents that reported attending the highest number of conferences a year answered the prone and seated positional questions contrary to what literature reports, and the fewer the number of conferences attended annually, the more incorrect responses occurred. For both reading literature and attending conferences, the effect on answering the supine

boarding question did not follow any trends, showing that there was no influence of these two types of continuing education on the knowledge of caring for a patient in the supine position. As EMTs, this could be due to the fact that the lift-and-slide technique is not addressed in their literature or conferences since it is not widely used in the field. Looking at the results in the LEADS project by Dawson, Brown, and Harwell (2003), they reported that 30% of EMT-Basics went to state conferences but only 5% went to national conferences. EMT-Paramedics reported higher attendance rates with 54% at state conferences and 21% at state conferences (Dawson, Brown, & Harwell, 2003). Although the measures of attending conferences were slightly different, both reported the lack of consistency in conference attendance throughout the profession.

Another factor to address is the effect of continuing education on spine-boarding techniques. Most of the initial education books used in Michigan only address the use of the log roll and the KED or short backboard for a possible spine injury (Caroline, 1995; Crosby & Lewalle, 1995). Many subjects reported not initially learning the lift-and-slide or 6-plus person lift, showing that they either have never learned the technique, learned it from continuing education, or had to learn it as on-the-job-training. If a more consistent initial education on the spine boarding techniques was available, EMTs could learn the pros and cons for each method and which techniques are preferred in each scenario. This could be greatly beneficial for the care of victims suffering from possible spine injuries, ensuring that they receive the most appropriate care possible. The results from the LEADS project showed that almost a quarter of EMT-B and EMT-P did not

feel very prepared in the task of spinal immobilization (Dawson, Brown, & Harwell, 2003). With a 25% chance that the EMT providing care for someone I know is not prepared to complete the task, it seems that there is room for improvement in the education process.

If the use of spine boarding techniques was originally taught, the continuing education relating to these skills can improve the performance in that skill area. De Lorenzo and Abbott (2007) showed similar results when studying performance in four skills (IV insertion, airway management, patient assessment, and bleeding control) pre and post continuing education units. They found improvement in all four skills of up to a 30% between the two assessments (De Lorenzo & Abbott, 2007). Continuing education can have a profound influence on the ability to perform skills if the necessary skills are addresses in the continuing education experiences.

Limitations

One limitation to the current study is the sample size. Only having 53 subjects respond to the survey made trying to reach statistical significance almost impossible. Chi square analyses could not be conducted as there were not enough data distributed for the analysis to be valid. The original mailing of 500 surveys was conducted hoping for a 30% return rate since other mailed surveys in the field have had response rates of at least 30 percent (Crocco et al., 1999; Sherbino et al., 2000; Dawson, Brown, & Harwell, 2003). With the expected response of 150 participants, the analyses might have shown different results and a more thorough analysis could have been conduced.

The method of distribution for the survey is another limitation. The original preferred method would have been an online distribution using e-mail addresses. This was not possible because the State of Michigan EMT office only had e-mail addresses for those who were certified in the past two years, which if used would have skewed the results to newly certified EMTs, not EMTs of different experience levels. Another limitation to distribution was funding for mailing. Due to the cost of postage, follow-up mailings could not be sent out to those who had not returned the survey in the first two weeks, limiting the number of responses.

Another possible limitation to the study is that it was conducted using a survey that was newly designed for this study. Although pilot testing and revisions were completed multiple times, the validity and reliability of the instrument might not be as strong as other instruments that have been tested and used to a greater extent. This was evident in one subject responding to multiple choice questions one way and the open-ended question another. It is believed that the terms "prone" and "supine" were confused as they were not defined in the survey since it was believed most EMT professionals used the terms commonly.

Threats to internal validity. Reverse causation could be a threat as in a survey all variables are being measured at the same time. In this study, this threat is minimized by variables not relating to each other in and cause and effect relationship. As variables in this study are not being measured over time, time threats are not a problem. Group threats are also not a concern because there are not multiple groups in this study. Mortality is a possible threat to internal

validity, but it is controlled by having a short survey that will not deter people from finishing it and not participating in the study. Having people not participate in the study might be a problem as mail surveys don't have the best return rate, but by including a letter with the survey explaining the purpose of the study and the anticipated use for the information gathered from the study, participants will hopefully be motivated to take part in the research process. Expectancy is not a threat as there is no intervention in this study. The "on-stage" effect might be a possible variable to consider. Participants taking the study might try to answer with the response that is desired instead of what they think so they do "better, " but this is minimized by having questions that are not leading or indicating of the desired response from the researcher.

Threats to external validity. There is no threat of reactive or interactive effects of testing as there is no pretest/posttest in this study. There is also no interaction of selection bias and treatment because we have one population of randomly selected individuals and there is no treatment involved in this study. Since participants get to complete the survey where they choose, the threat of a reaction to the experimental setting is minimized in this study. Lastly, the threat of multiple treatment interference is not a threat because there are no treatments in this study.

History is another possible threat to validity in this study. As reported earlier, not all EMTs were taught the lift-and-slide initially as it is not a part of the common initial education curriculum. This could the ability of those not taught the lift-and-slide initially to answer questions that included it as one of the

options. Also, with the lift-and-slide not being taught consistently, the quality of learning the technique may be variable as well. As some EMTs may learn it as they are responding to a call that needs to use the lift-and-slide due to space issues, they might not learn the technique as well as someone who was instructed in an educational setting.

Future Directions

A suggestion for future research is to conduct the study to a broader population and on a bigger scale. Using an online distribution should increase return rates if e-mail addresses are compiled of all currently certified EMTs. With a follow-up survey study, a few changes to the survey instrument or use of another instrument may be used to clarify a couple items that seemed problematic for some subjects. Another possibility is to change the mode of data collection to an interview method to get more thorough answers and allow for follow-up questions to be asked, possibly conducting it before or after a recertification session (or both to see if the recertification session had any influence on their answers).

Another possibility for advancing future care in the field is to implement mandatory practice of all techniques with recertification; therefore, the techniques not used as frequently can still be practiced so the rescuers are more comfortable using the technique should they come to a situation where it would be applicable to use it. In talking with EMTs, most said they wouldn't use the lift-and-slide because they are rarely in a scenario that they have enough people to conduct it and when there are enough people, they do the log roll because that is

the method they are most comfortable with. By practicing all techniques on a regular basis, the best method could be selected for each scenario they respond to.

Conclusions

Although none of the analyses reached statistical significance, a few trends in the results demonstrated that EMTs are knowledgeable in performing the log roll and using the KED or short backboard, but are not as knowledgeable in the use of the lift-and-slide technique. The lift-and-slide technique is not used as much by the EMTs and they are less comfortable using the technique. This could be a concern considering the use of the lift-and-slide is recommended in some situations. A more thorough continuing education and initial education on all spine boarding techniques would be beneficial to the EMTs providing care to patients so the best care can be provided.

APPENDIX A

EMT Spine-Boarding Knowledge and Preference

Instructions: Please answer each question to the best of your ability and mark your choices clearly with a ball point pen.

DEMOGRAPHIC CHARACTERISTICS

1. Age ____ years

2. Sex: [ ] Male [ ] Female

3. Highest degree you currently hold

   [ ] High school diploma/GED

   [ ] Associates degree

   [ ] Bachelor's degree

   [ ] Master's degree

   [ ] Doctoral degree

   [ ] Post-doctoral study

4. For each level of certification, enter the number of years (e.g., 12 years) for which you have been certified.

   EMT First Responder ____ years

   EMT Basic ____ years

   EMT Intermediate ____ years

   Paramedic ____ years

5. If you know the dates, enter the year (e.g., 2003) in which you were most recently certified for each level of certification.

   ____ EMT First Responder

   ____ EMT Basic

   ____ EMT Intermediate

   ____ Paramedic

6. Are you currently up-to-date with the continuing medical education credits needed for maintaining your certification as an EMT?

   [ ] Yes

   [ ] No

7. Which related certifications do you currently hold (**check all that apply**)?

   [ ] Medical physician (MD)

   [ ] Orthopedic physician (DO)

   [ ] Doctor of physical therapy (DPT)

   [ ] Certified athletic trainer (ATC)

   [ ] Certified strength and conditioning specialist (CSCS)

   [ ] Other, describe _____

8. How many hours do you usually work in the EMT setting in a typical week (e.g., 13 hours per week)?

____ hours per week

9. Please indicate your work telephone area code (please circle).

231	248	269	313
517	586	616	734
810	906	947	989

Other _____

10. Where do you currently work as an EMT (check all that apply)?

[ ] Fire department

[ ] Hospital

[ ] Private ambulance company

[ ] Police department

[ ] Private industry

[ ] Military

[ ] Other, describe _____

11. What is the type of community where you do most of your work as an EMT (check the one best answer)?

[ ] Rural area (less than 2,500 people)

[ ] Small town (2,500-24,999 people)

[ ] Medium town (25,000-74,900 people)

[ ] Large town (75,000-149,000 people)

[ ] Mid-sized city (less than 500,000 people)

[ ] Suburb/fringe of mid-sized city

[ ] Large city (500,000 or more people

[ ] Suburb/fringe of a large city

USE OF SPINE-BOARDING TECHNIQUES

12. How frequently do you use spine-boarding transfer techniques in your work setting (check the one best answer)?

[ ] Multiple times a day

[ ] Daily

[ ] Weekly

[ ] Monthly

[ ] 2-3 times a year

[ ] Less than once a year

[ ] I have never performed a spine-boarding transfer technique

13. Please check the spine-boarding transfer techniques that were taught during your initial EMT education (check all that apply)?

[ ] Lift-and slide/6 person lift

[ ] Log roll

[ ] Short spine board/KED

[ ] Other, describe _____

14, During your initial EMT education, in what situations were you instructed to use different spine-boarding transfer techniques (e.g., using KED for an injured person seated in a car)?

Lift-and-slide/6 person lift _____

_____

Log roll _____

_____

Short spine board/KED _____

_____

Other _____

_____

15. Which spine-boarding transfer technique are you most comfortable using (choose the one best answer)?

[ ] Lift-and slide/6 person lift

[ ] Log roll

[ ] Short spine board/KED

[ ] Other, describe _____

16. Which spine-boarding transfer technique does literature show head and neck movement in controlled most if the patient is found in the supine position (choose the one best answer)?

[ ] Lift-and slide/6 person lift

[ ] Log roll

[ ] Short spine board/KED

[ ] Don't know

[ ] Other, describe _____

17. Which spine-boarding transfer technique does literature show head and neck movement in controlled most if the patient is found in the prone position (choose the one best answer)?

[ ] Lift-and slide/6 person lift

[ ] Log roll

[ ] Short spine board/KED

[ ] Don't know

[ ] Other, describe _____

18. Which spine-boarding transfer technique does literature show head and neck movement in controlled most if the patient is found in the seated position (choose the one best answer)?

[ ] Lift-and slide/6 person lift

[ ] Log roll

[ ] Short spine board/KED

[ ] Don't know

[ ] Other, describe _____

19. Through experience, which spine boarding transfer technique has provided you with greater control of a supine patient's head and neck movement during the transfer if you are the person in control of the head stabilization (choose the one best answer)?

[ ] Lift-and-Slide/6 person lift

[ ] Log Roll

[ ] Short Spine Board/KED

[ ] I haven't been the person at the head

[ ] I have only done it one way (please specify): _____

[ ] Other, describe _____

20. Through experience, which spine boarding transfer technique has provided you with greater control of a prone patient's head and neck movement during the transfer if you are the person in control of the head stabilization (choose the one best answer)?

[ ] Lift-and-Slide/6 person lift

[ ] Log Roll

[ ] Short Spine Board/KED

[ ] I haven't been the person at the head

[ ] I have only done it one way (please specify): _____

[ ] Other, describe _____

21. Through experience, which spine boarding transfer technique has provided you with greater control of a seated patient's head and neck movement during the transfer if you are the person in control of the head stabilization (choose the one best answer)?

[ ] Lift-and-Slide/6 person lift

[ ] Log Roll

[ ] Short Spine Board/KED

[ ] I haven't been the person at the head

[ ] I have only done it one way (please specify): _____

[ ] Other, describe _____

22. How often do you read current literature related to emergency medicine or related fields in health care (choose the one best answer)?

[ ] Daily

[ ] Weekly

[ ] Monthly

[ ] Less than once a month

[ ] Never

23. On average, how often have you attended conferences related to emergency medicine or other health care fields (choose the one best answer)?

[ ] More than 5 a year

[ ] 5 a year

[ ] 4 a year

[ ] 3 a year

[ ] 2 a year

[ ] 1 a year

[ ] 1 every other year

[ ] Less than every other year

[ ] I've never been to a conference

24. What journals are you subscribed to or do you read on a regular basis (check all that apply)?

[ ] Journal of Emergency Medicine

[ ] Emergency Medical Services

[ ] Prehospital Emergency Care

[ ] The Spine Journal

[ ] American Journal of Sports Medicine

[ ] Journal of Athletic Training

[ ] I don't read current literature regularly

[ ] Other, describe _____

For each of the following, please indicate **how much cervical stabilization you perceive you can perform** when spine boarding a patient in the following scenarios; 1 being no/little control (you didn't feel that you could correctly keep manual stabilization), 5 being the most control (no movement allowed)

Performing the LOG Roll on a patient in the SUPINE position

Little 1 2 3 4 5 Most

Performing the LOG Roll on a patient in the PRONE position

Little 1 2 3 4 5 Most

Performing the LIFT-AND-SLIDE on a patient in the SUPINE position

Little 1 2 3 4 5 Most

Performing the LIFT-AND-SLIDE on a patient in the PRONE position

Little 1 2 3 4 5 Most

Using the KED on a patient in the SEATED position

Little 1 2 3 4 5 Most

APPENDIX B

Participant Information and Consent Form
EMT Experience, Knowledge and Preference on Spine Boarding Transfer Techniques

Questions regarding this study, please contact the main investigator:

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Questions regarding your rights as a research participant, please contact:

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You are being invited to participate in a research study to examine spine boarding use in the EMT setting and the initial and continuing education programs. The main focus of the study is to see if EMTs keep up with current literature in their field and if those that do keep up with the literature know proper spine boarding techniques. Participants in this study must be Michigan registered EMTs that are currently practicing in the field. The following questionnaire asks a variety of questions about this topic. It should take you no more than 10 minutes to complete.

The results of this project will be used to assess the effectiveness of EMT education programs in education EMTs on the spine boarding techniques that provide the most support for patients. The results of the survey will hopefully be useful for determining whether EMTs are taught all spine boarding methods to use in different scenarios. The results of this survey will be used for my Mater's thesis and hope to be presented to the EMT community through a conference presentation or journal article.

There are no known risks to you if you decide to participate in this survey and your responses do not provide identifiable personal information. Surveys will be coded to allow for tracking of return rates, but all identifying information is kept confidential to the main researchers. You will not benefit directly from your participation in this study; however, your participation in this study may contribute to the EMT community and education process. Surveys will be analyzed and kept in IM Sports Circle on the campus of Michigan State University. Your confidentiality will be protected to the maximum extent allowable by law. Your participation is completely voluntary and completion/return of the survey implies consent to participate. You are free to terminate your participation at any time and without prejudice. If you have any questions about this study, such as scientific issues, how to do any part of it, or to report any injury, please contact the main investigator.

Again, the survey should take you no more than 10 minutes to complete. We hope you will take the time to complete this questionnaire. **By completing and returning the included survey, YOU indicate your voluntary agreement to participate and have my answers included in the dataset for this research project.**

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