

REVIEW ARTICLE

# Techniques and tools used in trauma patients transfer: a review

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## ABSTRACT

Secondary spinal cord injury is a major concern for trauma patients. Thereby, proposing the necessity for the development and application of spinal immobilization techniques to guarantee minimal motion during transfer of the patients from the trauma scene to the trauma care center. Thus, this review aimed to provide an updated summary of the different techniques and tools used for the transfer of trauma patients with suspected spine injury. A retrospective PubMed search was conducted to collect the data for the most common methods used and effective tools and techniques for spinal immobilization. The log roll technique is commonly used in trauma settings and is recommended for prone patients. However, the hard board is still preferable transferring tool, and the scoop stretcher is recommended to aid a more successful lift and slide. The trauma care providers should be aware of different transfer techniques to provide the appropriate care.

**Keywords:** Patient transfer, trauma patient, log roll, tools, techniques.

## Introduction

Since the 1960s, spinal immobilization using cervical collar and backboard has been the standard of care in clinical practice [1]. Today, spinal cord injuries are considered one of the major causes of death and permanent disability [2]. Transporting patients with suspected spinal injury is a concerning issue, that needs to be carefully handled due to the fear of secondary spine injury. It is estimated that 3%-25% of the patients might experience permanent neurological deficit during the initial management phase, during trauma patient transfer [3,4]. According to the American Academy of Orthopedic Surgeons [5], unstable bony fragments produced because of the trauma to the cervical spine could jeopardize the spinal cord with even the slightest movement (1-2 mm). This proposes a necessity for developing several maneuvers, strategies, and tools to avoid further spine damage. The current guidelines dictated that a trauma patient with suspected spinal cord injury should be transferred with care using spine immobilization techniques [6,7]. The most used techniques are the log-roll technique, the straddle lift and slide (LS), and the six plus lift (6+ lift). With each technique having advantages and disadvantages, their use is recommended in different trauma scenarios guided by research regarding their stability, patient weight and position, and how easy it is to perform adequately. For the application of these techniques, the use of a transfer tool is required, most commonly the rigid hard board. Emerging tools recommended to be used in concordance

with immobilization techniques included the scoop stretcher and the vacuum mattress splint (VMS).

As the different trauma scenes and trauma patients require different immobilization techniques, the trauma care provider and primary care professionals should be familiar of the techniques and tools appropriate for the trauma patient and should be able to perform each technique properly. Thus, this review aimed to provides an updated summary of the different techniques and tools used for the transfer of trauma patients with suspected spine injury. The review covers the uses, advantages, and disadvantages of the most studied techniques and tools that were used by the paramedics and primary care providers daily in the trauma scene and emergency settings, which would serve as a guide for healthcare providers in choosing the appropriate technique for each situation.

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## Materials and Methods

A retrospective PubMed search was conducted to collect the data of the most common methods used and the effective tools and techniques for the spinal immobilization. The intent was to focus the literature review towards the published papers in PubMed, English language, pre-hospital settings. In this paper, the main focus was on the trauma patients in a pre-hospital setting and to compare between the most commonly used techniques and tools.

## Discussion

### *Spine immobilization techniques*

#### *The log-roll technique*

The log roll technique is the most studied and widely used technique for transferring patients from the trauma scene to a health care facility. Despite the ongoing debate on its effectiveness and the spine stability [8,9], especially during the rotation needed to slide the spinal hardboard underneath the patient, the log roll technique is still practiced widely amongst paramedics and is one of the recommended by Advanced Trauma and Life Support (ATLS).

#### Technique

In the trauma scene, the log-roll maneuver is done by four health care providers at least. The rescuer 1 is positioned in front of the patient's head. His role as a team leader is to restrict the motion of the head and the C-spine during the procedure and to give clear instructions about the movement of the patient on their side, 90 degrees on the count of three. The rescuer 2 and rescuer 3 position themselves on one side of the hard board to turn the patient. Rescuer 2 needs to stand at the level of the patient's shoulders and upper chest and apply both arms across the patient, placing one hand at the level of the scapula, and the other on the hip. Rescuer 3 needs to stand at the level of the patient's hip and his hand at the level of the iliac crest while crossing hands with rescuer 2, placing the other hand underneath distal thigh; with the forearm resting on the other thigh of the patient. And rescuer 4 pushes the hard board underneath the patient and inspect and palpate the spine for any deformity.

#### Advantages

The log roll technique is one of the most studied techniques for the spine immobilization [3,4,8,10]. The log roll technique could be adequately performed with only four rescuers. Compared to other techniques, where six or more rescuers are required, with fewer number, the leader of the team could give clear instructions and could also communicate with the rest of the group in a closed loop fashion. Each of the four rescuers has a clear role which leads to minimal motion of the spine. The log-roll technique involves inspection and palpation of the patient's back, allowing the identification of bruises, burns, open wounds, and foreign bodies [11], allowing for a more comprehensive examination of the patient's status

for early management. When finding a prone victim in a trauma scene, the only technique that allows for flipping the patient on their back is the log roll technique, allowing for better assessment and management of the patient per the ATLS protocol.

#### Disadvantages

Many studies have compared the log roll to other techniques and showed unacceptable motion produced. In an experiment by McGuire [12], it was found that the logroll technique have unintended motion on the lateral and antero-posterior aspects. A study by Suter et al. [13] replicated the same results, when radiographing healthy volunteers while being log rolled, and showed that placing the patient on the lateral aspects (as with the log-roll) would generate more motion. This explained the fact that the arc plane of motion in the log roll is undesirable due to the disproportionate shoulder to hip ratio in humans. In a review, conducted on the use of log roll technique on trauma patients with a pelvic fracture, showed increased volume of blood in the pelvic cavity [14]. Moreover, palpation of the back followed by the log roll inspection showed a low sensitivity to detect fractures in the vertebral column in the unconscious patients by a 27.5% [11].

#### Indication and contraindication

The log roll is still considered standard practice per ATLS protocols. It is still performed by majority of paramedics in the trauma scene. One indication of the log roll technique is found when the victim is prone, as there is no other way to flip the patient supine other than rolling them on their back.

#### The 6-plus person lift technique (6+ lift)

In sports injuries, victims are often heavy, wore large gadgets and protective equipment. Rolling those patients could introduce further displacement to the spine as suggested by Suter et al. [13]. The straddle LS could be difficult to execute with heavy victims. A stabilization method that does not involve rolling the patient and does not depend on the strength of rescuers is ideal in the setting of an athletic arena, where a large number of qualified rescuers are available. Thus, when dealing with heavy persons, like athletes, the 6+ lift is an efficient way to transfer the patient safely when a spine injury is suspected. The Inter-Association Task Force [15] recommended that the 6+ lift technique could be used along with a scoop stretcher whenever possible.

#### Technique

The 6+ lift requires eight rescuers. The rescuer 1 immobilizes the neck by placing both hands on the patient's shoulders with the thumbs pointed away from the patient's face. The other six rescuers position themselves along the patient's sides: one on each side of the chest, pelvis, and legs. The hands are slid under the patient to provide a firm, coordinated lift, while only touching hands under the patient. The patient needs to be lifted 4-6 inches from the ground. As the

team coordinator, rescuer 1 gave the command “prepare to lift, lift.” The eighth rescuer could then slide the board into place from the foot end. After the board is in place, while positions are maintained, rescuer 1 gives the command “prepare to lower, lower” where the patient is lowered onto the spinal board. The number of participants lifting the patient could be adjusted based on the patient weight and size. Up to 10 individuals might participate in the technique to achieve spine immobilization.

### **Advantages**

The 6+ lift technique provides a better motion control than other spine immobilization techniques [3]. When compared to the 4-person log-roll recommended by the ATLS [16], log rolling requires the head and the body to follow an arc of motion simultaneously that translates to a curvilinear path along a horizontal plane. However, the 6+ lift technique requires the head and torso to move in a simple linear fashion. Del Rossi et al. [9] studied the effectiveness of the 6+ lift for limiting spinal motion compared with the 4-person log-roll and the LS (straddle) techniques. It was found that a significantly decreased spinal motion was produced when performing the 6+ lift as compared to the log roll and the LS techniques in lateral flexion, anteroposterior translation, distraction motion, and medial-lateral translation in the stable and unstable spine. Axial rotation in the globally unstable spine was noted less in the LS technique, with no significant differences noted in flexion–extension degrees in all three techniques.

In another study by Conrad et al. [3] compared the range of motion produced by logroll with other spine transfer technique, the 6-plus-person produced less motion than the log-roll and the straddle LS in almost all directions of motion. The study recommended performing the 6-plus-person lift when transferring the supine patient to a spinal board, and when removing a patient from the spinal board.

### **Disadvantages**

Although a simple concept of the 6+ lift that relies heavily on the strength and coordination of the rescuers, compared to other transferring techniques, the 6+ lift requires the greatest number of rescuers. Further, the Inter-Association Task Force recommended that the six-plus-person lift should be used along with a scoop stretcher whenever possible. However, the scoop stretcher has only been investigated when performing the log-roll technique, and even then, it produced extra 6-8 degrees of motion during the transfer [17]. In an investigation by Conrad et al. [10], sliding the scoop stretcher by four rescuers without rotating the patient produced significantly less motion when compared to the log roll.

Although the 6-plus-person lift does not include rolling or rotating the patient, further studies need to investigate the safety of using a scoop stretcher alongside the 6-person-plus lift to secure minimal spine motion. In the initial transfer, the patient usually needs to be inspected to make sure that the patient is managed properly, with no missed injuries. When administering the 6+ lift, the

patient lifted from the ground without rolling, eliminates any complex rotational motion. But does not allow for proper inspection of the spine for spinal fractures or bruising.

### **Indications and contraindications**

The Inter-Association Task Force recommended that the 6+ lift technique should be used along with a scoop stretcher whenever possible. However, the 6+ lift could only be administered for patients in the supine position. When the patient is prone, it is not recommended to use the 6+ lift technique. It is safer to perform the log-roll technique to roll the patient on their back.

#### *Straddle LS technique*

The straddle LS is another lifting technique, usually executed in sports injuries. It is gradually growing to be standard practice for first responders replacing the three-dimensional rolling motion in the log roll. The LS technique slowly introduced itself as a simple and efficient way of transferring victims. Straddling a patient using three rescuers besides the team leader is easier to coordinate. It is quickly performed with no complex training needed to perform the technique.

### **Technique**

The LS technique requires a minimum of five rescuers. The first rescuer should maintain the head and neck in a neutral position using manual traction and coordinate the rest of the rescuers to ensure team synchrony. The three other rescuers straddle the patient, and prepare the patient for lifting, at different levels: chest, pelvis, and lower extremities. Once the patient is lifted 10-20 cm off the ground, a fifth rescuer is responsible for sliding of the spinal hard board under the patient. Finally, the patient movement should be restricted by securing the straps on the spinal hard board.

### **Advantages**

The LS was originally introduced to solve the problem of transporting casualties in confined space from the trauma scene to the health care facility. It requires five rescuers in a space efficient manner to quickly move the victim while maintaining an aligned spine. When used in sports injuries, the LS is convenient to avoid rolling the patient over bulky clothing and equipment. With the emerging literature, the LS technique showed better motion control in all planes of motion for both stable and unstable cervical spine [3,10,18]. It is a straightforward technique that is easy to learn and perform, with better coordination between the team leader and the rest of the group members.

### **Disadvantages**

The effectiveness of LS is not as thoroughly studied as the log-roll maneuver. The LS required at least five rescuers to perform an efficient lift. Although a relatively manageable number compared to the 6+ lift, this number might not be sufficient when dealing with a heavy athlete. With the large number of qualified rescuers in the athletic

arena, the 6+ lift is usually advocated in sports setting over the LS technique.

### Indications and contraindications

The LS technique is usually the best technique to transfer a patient in a confined space. Requiring a few rescuers who can fit in a small space, and no rolling needed, front line care providers can assess and manage the patient using the LS efficiently. However, when facing a trauma with prone victims, the LS is not the optimal choice and rolling the patient could not be avoided (Table 1).

### Spine immobilization equipment

#### *The spinal hardboard (spinal board)*

In a patient with a suspected spinal injury, the stabilization of the head and spine during the transportation would play a major role in patient outcome. Therefore, patient immobilization has become the standard of care especially during a pre-hospital management. Many tools and techniques are used in the clinical field to preserve the neurological tissues from further damage. The spinal hardboard is used to aid transfer along with immobilization techniques. The spinal hardboard is the most conventional and convenient tool that has been used for a long time in trauma practices and is still recommended by the ATLS guidelines [16].

### Tool description and utilization

The spinal hardboard is a basic tool that is essential to aid any transfer technique. In 1967, Farrington first described the clinical use of the spinal board during transportation in pre-hospital management. It was designed to support the patient's spine and maintain a neutral alignment. It is usually made of light weight rigid plastic material that is completely translucent, so it does not interfere with the imaging assessments needed to manage the patient. It is used in conjunction with the rigid spine collar, ice packs, towels, or commercial padding [3] at least two straps are needed to secure the torso and the pelvis and legs to the board. The board is only recommended to be used for transfer, and not to immobilize the patient for long periods.

### Advantages and disadvantages

The simple design and application instructions make the use of the conventional spine board convenient. Despite many studies had encouraged the development of transfer

tools, the use of spine board in trauma centers and first responders training persists. This could be contributed to the simple design of the board with low maintenance needed to reserve the condition of the board. In a randomized clinical trial conducted by Mahshidfar et al. [19], the spinal hardboard compared with VMS was more effective in many aspects like the speed of application, and the quality of the spinal immobilization.

However, using the spine board is not without the side effects. Pain and discomfort are prominent side effects. Pain is not only limited to areas of contact with the spine board but could also be present in areas that were not painful prior to the application of the board, mostly caused by anatomically incorrect positioning of the patient on a flat board [20]. Pain might improve or resolve for some patients once they are removed from the backboard. Both lower back pain and cervical pain were reported to persist 24 hours after being on the board for only 1 hour in previously healthy volunteers [18]. In 1995, an experiment by Cordell et al. [21] was conducted on 20 healthy volunteer to study the pain on a visual subjective scale and the amount of the tissue-interface pressures on the three anatomical levels (occipital, sacral, and heel) by using a pressure measuring device. The volunteers had the average weight of 165.7 pounds and height 66.2 inches. Pain was reported by the volunteers within the first 20 minutes of board placement.

This pain solely generated by the board could be caused by unnecessary radiological testing, as clinicians are unable to differentiate whether the pain was caused by the trauma or the board placement. This causes unnecessary exposure to radiation and prolongs emergency department stay [22].

One of the major concerns described in literature regarding the spine board are pressure ulcers [23]. Pressure ulcers form on areas of dependency on a supine position, where the skin between bony prominence and the rigid board starts to pressure necrotize. Occipital and sacral contact pressures are higher for a patient on a rigid backboard compared to a padded backboard or a vacuum mattress and are significantly above the pressures at which tissue necrosis and pressure ulcers could develop [22].

Tissue interphase pressure was significantly increased using the rigid spine board for the occiput, sacrum, scapula, and heels, thereby increasing the likelihood of developing pressure ulcers [24]; therefore, the American college of surgeons recommended to remove the spinal backboard whenever the patient reaches to the

**Table 1.** Advantages and disadvantages of spine immobilization techniques.

Notes	Disadvantage	Advantage	No. of rescuers	Maneuver
the obvious unstable pelvic fracture it will increase the volume of the blood in the pelvic cavity. Needs well trained rescuers.	Poor motion control. Palpation of the spine is inaccurate.	Better exposure to patients back. Recommended technique when the patient is prone.	Minimum of four rescuers	Log-roll
-	Requires large number of rescuers.	More control over movement.	Minimum of eight rescuers	6+ lift
Cannot be used in prone patients.	Needs trained rescuers.	Can be performed in confined places.	five rescuers	Straddle LS

hospital and use it for the transportation purpose only with a margin of up to 2 hours only in favor to avoid the complications [19]. For instance, when a newly developed soft layered long spine board was used, volunteers experienced significantly less discomfort and decreased tissue interphase pressures when compared to the standard rigid board and vacuum stretchers [25].

### *The scoop stretcher*

With improved trauma care practices, many tools that ease the process of assessment and transfer of patients from the trauma scene were introduced. One practical example is the scoop stretcher. Recent researches compared the scoop stretcher with the spine board being a transfer tool that aids immobilization. As well as a transfer technique on its own that does not include lifting or rolling.

### **Tool description and utilization**

The scoop stretcher was not originally developed to transfer spine injured patients. It is made of two longitudinal pieces that separate and latch to a mechanical hinge on both ends of the board. It is usually made of aluminum, but some models are made with other materials such as plastic. Stronger models have been tested for their ability to immobilize the spine during transfer of a potentially spine injured patients. The scoop stretcher proved to be more stable than the log roll technique, and as safe as the LS technique [18].

To utilize the scoop stretcher, one rescuer stabilizes the head and neck of the patient. The two longitudinal halves of the device are separated and positioned on either side of the patient. Three rescuers carefully wedge the two pieces under the patient at the same time until the two hinges latch together and are properly locked. Two of the three rescuers are positioned at the shoulders of the patient, while the third rescuer is located at the foot end of the patient to ensure locking the two halves correctly [3,15,18].

The scoop stretcher is also recommended to be used to aid the 6+ lift to ease the transfer of a heavy athletic patient [1]. The scoop stretcher is a flexible device that could be adjusted to fit the patients' body dimensions. It splits into two segments vertically and unite again via two hinges interlocking pieces, after adjusting it to fit the patient body. Each piece is a wedge shape which enables it to slide beneath the patient, to avoid any undesired movement. However, newer models have been redesigned to accomplish such tasks safely.

### **Advantages and disadvantages**

When used without a lifting or a rolling technique, wedging of both longitudinal pieces of the scoop stretcher produced less motion compared to the log roll in both intact spine and artificially injured spines of cadavers [18]. In addition to reduce the likelihood of pressure ulcers. Compared to the rigid spine board, the scoop stretcher produced approximately 6-8 degrees less motion in the sagittal, lateral, and axial planes [17]. The design of the adjustable halves of the stretcher makes it practically useable for heavier and taller than average patients.

The scoop stretcher is not as commonly used as the rigid spine board by first responders. This could be due to the higher level of maintenance it requires. The hinges might be difficult to latch and unlatch, it needs periodic oiling and proper maintenance. When first introduced, the material used for the scoop stretcher was not able to support the heavy weight of the patients. The new models used today are made with better material that is steadier and supports the weight of the patient. The device could only be used on hard floors. When used on grass, like in most athletic arenas, the hinges might be difficult to align and latch [23]. The aluminum scoop stretchers might obscure imaging, due to its translucent material and the patient might be mis-positioned [23].

### *Vacuum mattress splint (VMS)*

Although in standard practice, the use of the spinal hardboard and its advantages fade considering the research on the probability of pressure ulcer formation in contact points. This has led to the development of the VMS as an alternative, to aid the immobilization transfer technique. The VMS is a flexible device that could be accurately fitted to the patient's body regardless of their position. VMS is widely used in trauma settings in the United Kingdom and is becoming more and more popular around the world as it proved to be both comfortable and stable to handle such situations.

### **Tool description and utilization**

The VMS is a portable device that could be folded into a small package. It is made up of polystyrene beads, with one valve that when connected to an external pump allows the air to be vacuumed out of the bag to seal the VMS tightly on the patient's body firmly. This device could accommodate patient's body contour. Along either side of the device there are several straps: a head strap, a pelvic strap, two criss-cross torso straps, and two criss-cross leg straps. The straps are often color coded to help secure the straps in the correct order.

Four rescuers are needed for applying the VMS. After unfolding the VMS on a flat floor besides the patient, one rescuer secures the head and neck. The patient is then moved into the mattress using the log roll or a lifting technique. After making sure the forehead is horizontal to the forehead straps, rescuer one tightly straps the forehead. The second and third rescuers strap the pelvic straps and then the leg straps and finally the torso straps. The external air pump is controlled by rescuer four who vacuums the air out of the mattress through the valve, until it is firmly fitted on the patient's body. All handles must be used to carry the patient out of the trauma scene steadily.

### **Advantages and disadvantages**

The VMS stability and comfort has been tested against the standard rigid spine board.

Several studies testing the stability and comfort of the VMS found that the amount of movement in longitudinal and lateral tilts is significantly reduced by the vacuum mattress. Volunteers kept on the VMS found

**Table 2.** Advantages and disadvantages of tools used in spine immobilization.

Disadvantage	Advantage	No. of rescuers	Tool
Creates more segmental motion than the scoop stretcher. Can cause pressure ulcer.	Can be used with any surface. Safely exposed to radiation. Has better motion control.	Depends on the technique.	Rigid spine board
Requires regular maintenance. Requires a full crew.	Properly fitted to the body contour. More stability and comfort.	Four to six rescuers	Vacuum mattress board
Cannot be used in prone position. Only used on soft surfaces.	Safely exposed to radiation. Has better motion control. Decreases the incidence of pressure ulcers.	Minimum of four rescuers	Scoop stretcher

it significantly more comfortable and tolerable than the rigid spine board [26].

The VMS is also x-ray and Magnetic resonance imaging compatible, as it is made of all translucent material [27]. Comparing the probability of pressure ulcer formation, Pernik et al. [24] immobilized 21 healthy volunteers using pressure sensing cells distributed all over the pressure points in the body (occipital-scapula-sacrum-heels). Pressure was significantly higher when using the rigid spine board in all the pressure points, thereby, increasing the likelihood of pressure ulcer formation.

It must be noted that when transporting the patient in the VMS, all handles must be carrying the patient, or else it could lead to catastrophic events. This fact might limit the use of the VMS on a full paramedic crew of approximately six rescuers.

Although the time needed to apply the VMS is equal to that of the rigid spine board, there are many technical issues that might arise to make the application of the VMS poorer [26]. Compared to the soft straight surface of the spinal hardboard, the VMS is larger when spread, and is made of the high friction material, which makes sliding the patient on the device more difficult. It could only be used on flat surfaces and has limited use on grass and rocky surfaces. The VMS also requires regular maintenance, the integrity of the valve and fabric must be checked regularly (Table 2).

This review article serves as a quick guide to healthcare professionals in their busy everyday practice. However, it has some limitations, which included the selection of only most popular and useful tools and maneuvers, some less common trauma patient transfer techniques were not included due to the lack of sufficient publications.

## Conclusion

Spine immobilization in trauma scenes is now standard of care. Many techniques and devices were developed to achieve the goal of spinal immobilization until a spinal injury is ruled out, with high levels of stability, comfort, and the least side effects possible. The log roll technique is commonly used in trauma settings and is recommended for prone patients. However, the hard board is still preferable transferring tool, and the scoop stretcher is recommended to aid a more successful LS. The trauma care providers should be aware of different transfer techniques to provide the appropriate care. Due to the dynamic nature of trauma care, it is essential for training programs in trauma and emergency settings to include techniques and devices that show promising efficacy.

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