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The Relevance of the Occult Cervical Spine Controversy and Mechanism of Injury to Prehospital Protocols: A Review of the Issues and Literature

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Introduction

Prehospital guidelines that define the clinical indications for spine trauma also serve as the criteria for selective spinal immobilization in the field. Therefore, these criteria are important for avoiding further spinal cord damage. Because some spine injuries may occur without neurological deficits or other clinical signs, the recommended field guidelines extend beyond the signs and symptoms and include mechanisms of injury or other injuries commonly associated with a high risk of spine injury.

Recent scientific evidence suggests that criteria beyond positive signs and symptoms may result in the immobilization of an excessive number of patients and result in doing unnecessary harm. However, before reaching such a conclusion, one must review the current scientific literature to determine which data and conclusions have relevance to prehospital care.

The current prehospital guidelines for which patients should be immobilized are based on the indications recommended by the American College of Emergency Physicians (as detailed in the Basic Trauma Life Support Course), the Committee on Trauma of the American College of Surgeons (as detailed in the Prehospital Trauma Life Support Course), and the National Standard Curricula promulgated by the National Highway Transportation Safety Administration. In general, these guidelines agree that 1) prehospital spinal immobilization is recommended and indicated in any patient with: a) a mechanism of injury suggesting that violent or sudden forces were applied to the spine regardless of the absence of any other signs and symptoms, or b) other injuries that suggest that violent forces acted upon the spine; or 2) the presence of any signs and symptoms of spine injury.1 The signs and symptoms associated with spine injury are: a) the presence of neck or back pain; b) pain, guarding, or splinting against movement of the head, neck, or back; c) pain on palpation of the posterior aspect of the neck or midline of the back; d) observable or palpable deformity of the spinal column; e) paraplegia, paresis, paresthesia in either the arms, torso, or legs at any time after trauma; f) signs of neurogenic shock; and g) in male patients, priapism.

Although paradoxical breathing commonly is associated with quadriplegia and may be a key sign suggesting spine injury when examining an unresponsive patient, it was not included as a sign specific to spine injury.

These guidelines have been reviewed during the past 15 months and remain unchanged in the latest Prehospital Trauma Life Support Course2 and Basic Trauma Life Support3 text revisions, and in the current (1994) revision of the Basic EMT Curriculum.6

Five types of patients can be excluded from the discussion, because there essentially is universal agreement that after trauma from a mechanism producing significant blunt force, or sudden movement, or rapid changes in the direction of movement, or extreme unnatural positioning of the head, neck, torso, or pelvis, the following patients should be immobilized until the radiological study has been read and spinal injury has been ruled out: 1) patients who have neurological deficits or other signs and symptoms associated with spine injury; 2) patients...
with any significant distracting pain; 3) patients who have a lowered or altered level of consciousness, or by other cause are not reliable reporters of present pain or pain resulting from physical examination; 4) patients with such injuries or conditions that they are categorized as having substantial multiple systems trauma; and 5) patients who have sustained any significant head trauma, regardless of current level of consciousness or absence of other multiple systems trauma.

Methods
In a search of the literature, nearly 100 studies were identified that focused and reported on some aspect of spine trauma and that also related to the immediate emergent care of the patient (both prehospital and in the preoperative hospital setting). Abstracts of each were reviewed and, in each case that appeared to be relevant to this discussion, the full published text of the study was reviewed.

Results
Several general observations and practices are worthy of mention, because they provide a necessary context for the discussion of specific studies that follow.

Until the exact nature of the patient's specific spinal injury is identified from the radiographs, which and how much movement can result in further injury cannot be determined. Therefore, in the United States, the accepted standard of care is to support the head manually and, unless specifically contraindicated, move it into neutral alignment. After applying a cervical collar, an interim device or manual method is used to immobilize the spine while moving the patient onto a rigid longboard in the neutral supine position. Once placed on the longboard, the patient is secured to it so that he or she is immobilized mechanically to maintain this position with the minimum of (unavoidable) movement allowed during transport.

Nothing in the literature challenges this practice for those patients with suspected spinal injury. The studies that address spinal immobilization solely raise the issues of which factors should be considered as indications for suspected spine injury. These issues include: 1) which radiographic studies are indicated for whom? and 2) whether and how certain practices promote or defeat proper immobilization in those for whom it is indicated.

It must be noted that all of the present studies that surround the topic of the probability of spine injury—regardless of the existence of asymptomatic unstable spine injuries and the cause and clinical course of missed or delayed identification of spine injury—are directed to a discussion of the national ordering of cervical spine radiographs in the hospital setting. They only address which patients require which spine studies, and on what basis the physician can safely rule out the possibility of an unstable spine. The current escalation in this debate understandably comes as a result of cost-containment pressures on physicians, and opposing pressure founded in the diagnostic, ethical, and medico-legal concerns against any abridgment in the indications for radiographic studies.

None of the studies surrounding the identification of patients with an unstable spine included scientific data or otherwise directly addressed the indications for prehospital immobilization or whether the field immobilization that was being done was sufficient or was excessively high. Similarly, they did not address whether a difference should exist between field and hospital indications for establishing proper spinal precautions.

With the more limited assessment capability and poor examining environment generally found at a trauma scene, the potential that less severe or nonspecific pain may be masked immediately after insult, and the devastating effects of avoidable cord damage, a conservative approach dictates that field immobilization should include all patients in whom there is a reasonable suspicion of spine injury. Therefore, spinal immobilization in the field should be indicated for a larger population than those who have positive signs or the 6% to 7% reported in the trauma studies actually have a spine injury. However, no historical guidelines suggesting the percentage needed to avoid missed spine trauma and iatrogenic cord injuries in the field are found in the current literature.

Although no data exist specific to the frequency of iatrogenic cord injury (or other significant spine damage) resulting from prehospital care, a variety of studies estimate that between 3% and 10% of cord injuries occur after arrival of the patient at the hospital. One must assume that if a less conservative approach is taken in the field, the number of secondary cord injuries occurring between the initial insult and the initiation of proper spine precautions in the hospital could increase.

Before addressing whether occult spine injuries exist, three other questions need to be raised and discussed. First, can one document that the present criteria for selection and that spinal precautions taken in the field provide a demonstrable benefit by improving outcome? Second, do these criteria generally result in the proper identification of patients for whom it is reasonable to suspect spine injury and prudent to initiate immobilization in the field, or are too many being needlessly immobilized? Finally, if too many are being immobilized, what (if any) harmful secondary effects result from the immobilization of patients for whom it may be unnecessary?

Review of the Issues and Literature
Historically, the frequency of omitted or inadequate spinal precautions by ambulance personnel and fire-based squads was identified as one of the major problems in prehospital care of the majority of trauma studies and position papers which, in the 1960s, argued for the establishment of a national emergency medical services system. It should be noted that the current indications for spinal immobilization have remained, in substance, the same as those introduced with the inception of formal national standards for the training and delivery of prehospital care in the early 1970s.

In a retrospective study published in 1988, the Northwestern University Spinal Cord Injury Center in Chicago reported a progressive decline in the proportion of trauma victims with neurological damage seen at that
institutions between 1972 and 1986. The frequency declined from 70% in 1972 to 33% by 1986. Although undoubtedly other advances in spine care between 1972 and 1986 also contributed to the 50% reduction in neurological deficits reported in this study, Meyer concluded that well-trained EMTs are "very evident in the body of personnel who are responsible for this dramatic change."

Determining whether the number of trauma victims being immobilized in the field is necessary or too large presents a much more difficult issue. Not only is this an area currently lacking scientific data, but because field immobilization is indicated for patients in whom a spine injury should be suspected as well as those in whom it is present, it is difficult to imagine a study design that would provide a scientific, rather than subjective, measure. Even if the design accepted the parameters of reproducible consensus by independent observers, the difference implicit between the hospital and field settings would still cause the evaluation of risk and data to be anecdotal.

It is the anecdotal experience in many areas throughout the country that the number of patients who arrive immobilized generally appears to be in keeping with the number in whom a reasonable suspicion of spine injury should have been raised. Furthermore, when there is a problem, investigation often identifies it to be with individual EMTs or services who use spinal boards for anyone with an injury (or limit use of spinal boards only to patients with a neurological deficit or those with severe trauma), rather than in reasonable keeping with the currently recommended guidelines.

This appears to have some scientific support in the absence of published studies to the contrary. A search failed to locate any current studies that examined the correlations between the number (or types) of immobilized patients who arrived at the emergency department and the number in whom a reasonable suspicion was determined to be present by the examining physician—or even the number in whom an ultimate diagnosis of spinal injury was made. If a significant problem was being observed, it is likely that a number of studies supporting this belief would have been reported.

Although many recent and ongoing studies of hospital/physician spinal injury diagnosis may be believed to contain implications for prehospital immobilization, this abstraction remains unfounded. Additional studies that include field data or studies which, exclusive of the occult spine injury issue, correlate the clinical impressions in the field with those of the receiving physician, are necessary before such an extension can be demonstrated to have a scientific basis. The impact and high frequency of such potential injuries signify the importance of additional study.

The next logical question is what (if any) are the deleterious effects of immobilizing a patient for whom this is not necessary? The current literature suggests several possibilities. A study at the University of Southern California Medical Center concluded that standard spinal immobilization (on a rigid long spine board, with a cervical collar, head immobilization, and a form of standard strap

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mended. Also, although more than 20% of the pediatric subjects included were 8 years of age or younger, no padding to elevate the thorax to maintain neutral cervical alignment was reported.

In the study by Herzenberg et al in 1989, they found that, because of the larger ratio of the head to the torso compared with adults, children who are 8 years of age or younger are pushed into flexion when placed supine on a rigid board. To avoid this effect, which can be injurious to patients with an unstable spine and can cause airway restriction by folding of the immature trachea and resulting reduced ventilation, they recommended that the torso be elevated to allow the maintenance of the neutral inline position of the head and neck. The same observation and conclusions were reported by Nepaver and Treloran in 1994.

Although these studies point out that it is possible to produce ventilatory inhibition when immobilizing adults or children, they fail to provide scientific support for the premise that, with proper technique, immobilization on a longboard (or other rigid device) results in reduced air exchange and oxygenation. Even though these studies warn that ventilation is more sensitive to specific immobilization techniques than is generally believed, they neither recommended nor concluded that the indications for suspected spine trauma or number of patient immobilizations should be changed.

Some observers deduce that the most insidious result of immobilization may be an associated additional field delay. The abundant scientific data supporting the "golden hour," the "golden 10 minutes in the field," and the factored increase in morbidity and mortality that results when victims of significant trauma are additionally delayed in the field, are irrefutable. The premise that spinal immobilization inherently causes such delay, however, is unfounded. If EMTs are properly trained and follow the rapid extrication methods recommended for patients with multiple-system trauma, the transfer of the patient onto a longboard and immobilization requires only three to four minutes and should not increase the elapsed time in the field beyond the recommended parameters. None of the literature reports either implied or concluded that the need to reduce the time until the patient can receive definitive care at an appropriate facility justified the omission of proper spinal precautions in patients with suspected spine injury, or suggested a change in the indications for such injury.

Although the studies of whether occult spine injuries exist in alert and reliable patients fail to include data or discussion of prehospital care, and provide no scientific data or basis to relate findings by physicians in the hospital setting to the indications and practices of responders in the field, a discussion of indication for field spine precautions would not be complete without some review of this body of literature.

Although similar findings and conclusions were reported by Fischer et al in 1984, the current debate appears to have been initiated by a Portland, Oregon, study reported in May 1987. In this retrospective study of 1,823 victims of blunt trauma, Buchulis et al found 94 patients (5%) with significant unstable cervical spine injury. Of the 65 who were alert and reliable reporters, 61 had neck pain and four had tenderness on palpation. In a review of a large number of patients, they concluded they could find no cases of cervical spine injury without identifiable signs and symptoms in reliable respondents. Therefore, they recommended selective (rather than routine) use of cervical spine radiography in victims of blunt trauma, and concluded that the use of such radiography is not recommended (or justified) in the assessment of alert, sober victims without neck pain, neck tenderness, or without other signs or symptoms of cervical spine injury or other (disturbing) painful injuries. These were also the general conclusions of the 1988 study by Ringenberg et al, Sadisson et al in 1991, and Hoffman et al in 1992.

The debate was rapidly joined by numerous individuals who offered case studies to repudiate these findings. Many of these clouded the issue rather than aiding in its resolution, because they described patients who were unreliable respondents to physical examination and therefore unimportant to the discussion of occult injuries. As late as May 1993, Robarge wrote to the Editor of the Annals of Emergency Medicine that no acute blunt traumatic cervical spine injury had been documented in any alert asymptomatic patient without neurological deficits or the presence of distracting pain.

During the same period, others reported contrary findings. In 1984, Walter et al reported that in a retrospective review of 67 patients with acute cervical fractures or dislocations, 18% had normal motor, sensory, and circulatory findings in all extremities (MS x 4), and no documented neck pain, muscle spasm, or guarding. They concluded that this finding suggests that "painless" cervical fractures may exist. In 1986, Jacobs et al and Ross et al in 1987 reported patients in whom cervical spinal injury was missed on initial examination because of the absence of any impressive signs or symptoms found on examination by the physician. Laham et al reported that one of the children with cervical spine injuries included in their 1994 study was a 3-year-old with normal results on physical examination who was simply "inexplicably inconsolable." Probably the case study and review of the literature presented by McKeen et al in 1990 best exemplifies and summarizes the case for the existence of asymptomatic occult cervical spine fractures in alert reliable patients without distracting pain. These authors conclude (on the basis of the case that they report and their review of the literature) that asymptomatic cervical spine injuries do exist. Repeated search of the literature shows that additional studies supporting each side of the controversy continue to be published from time to time. In reviewing these studies, one finds that although each new entry provides some new data and insight, the scientific evidence that supports or denies the existence of occult cervical spine injury has not changed materially or successfully resolved the controversy.

A broader investigation of the scientific literature identifies several studies that offer strong evidence that discussion of cervical injuries is not the singular paramount.
issue that should be considered in resolving whether occult spine injuries exist. In 1988, Pal et al reported findings indicating that in the patients with multiple trauma whom they studied, the majority of fractures of the spine occurred in the thoracic and lumbar regions rather than the cervical area. In 1990, Kcen et al reported that 6.4% of the patients found to have a cervical fracture also had other noncontiguous spine fractures. Because of the anatomical differences between the cervical and other vertebrae, and differences in the tissues and organs that surround each, findings from one region of the spine cannot be scientifically projected to the others. These studies point out that articles that exclusively report on occult cervical spine injuries cannot provide scientific evidence to deny the possibility that asymptomatic spine injuries exist in other regions.

This point is supported further by the 1994 report by Frankel et al listing criteria that provide high reliability for selecting patients with blunt trauma who have thoracic or lumbar spine injury. In this study from the Washington Hospital Center and the Uniformed Services University of the Health Sciences, the indicators used for obtaining surveillance thoracolumbar radiographs resulted in all of the 9% of the patients with fractures being identified. Of those with fractures, 48% had no pain or tenderness, and 35% required surgical spinal fixation. It is interesting to note that, included in the criteria that resulted in selective radiography without any missed or delayed diagnosis of thoracolumbar fractures, were some that exclusively reflected the mechanism of injury. This supports the position that some mechanisms, such as ejection from a speeding vehicle or falls from a considerable height, produce such a sufficiently increased potential that a resulting spine injury must be assumed until proved otherwise.

Davis et al, in reporting on the cause of missed cervical injuries in 1993, concluded that missed or delayed diagnosis of cervical spine injuries may lead to extension of those injuries and subsequent preventable mortality and morbidity. They further stated that in patients at risk for cervical spine injuries, cervical precautions should be maintained (particularly in high-risk patients) until appropriate and expert review of the roentgenograms can be obtained. Other recent studies similarly noted that with significant trauma, spine precautions should be maintained until unstable spine injury is definitely excluded.

Ruling out the presence of a spine fracture or other spinal column instability in the field in patients with a mechanism or other injuries associated with a high risk of spine injury, should remain beyond the diagnostic expectation and responsibility placed on the EMT even if the individual is highly experienced. Therefore, in cases with a mechanism associated with a high risk of spine injury, the patient should be immobilized in the field, and ruling out spinal injury should be deferred to the physician in the more definitive hospital setting.

Unless the prevailing professional consensus supports a clear distinction between the indications for immobilization in the field and those for spinal precautions and radiography at the hospital, the physician’s prerogatives and defense of cases in which he or she judged that radiography was not necessary to clear the spine will become greatly weakened. The promotion of this distinction also is essential to avoid deterioration in future spine care in the field. Without a widespread appreciation at present, EMTs often project that the physician’s decision to forego continued spinal precautions and radiography implies that immobilization of similar patients is unnecessary in the field—either because in such patients it is not indicated or because it seems precipitously removed at the hospital.

The current prehospital spine guidelines prepared for the state of Maine by Peter Goth, MD, FACEP, provide additional support for many of the positions found in the preceding discussion. In 1994, Maine became the first state to adopt statewide EMS spinal immobilization guidelines and protocols. The new monograph, which is the designated text for the Maine EMS training program in spine injury management, clearly identified certain “positive” mechanisms, that, by the potential violent forces that can come to bear on the spine, require immobilization of the patient regardless of the lack of other positive findings. Dr. Goth suggests that as a result of pain masking caused by the sympathetic acute stress reaction, patients may appear asymptomatic for as long as two hours after the injury, causing them to be “unreliable” respondents to early physical examination in the field.

Conclusions

Regardless of the large number of studies that deny or support the existence of asymptomatic cervical spine injuries in reliable respondents, the scientific literature is inconclusive and the issue of occult spine injury remains an unresolved debate. The present studies of occult spine injury focus primarily on the cervical region and are limited exclusively to data and discussion of in-hospital considerations.

The difference between the diagnostic capability in the hospital and that found at the commonly confused trauma scene, and the possibility that the patient may be an unreliable respondent for a transient period immediately after the injury, must be considered. Although some reporters maintain that occult spine injuries remain undocumented in the hospital setting, there is no scientific evidence that unstable cervical, thoracic, or lumbar spine injuries may not be asymptomatic (or so subtle as to be essentially asymptomatic) in the field.

There is compelling evidence that the current recommended prehospital indications for spinal immobilization, which have been altered little over the years, have contributed significantly to the progressive substantial reduction in the number of patients with neurological damage on arrival at the hospital. This logically suggests that these criteria effectively include those patients with spine injuries, but does not preclude the possibility that it also results in the immobilization of a significant number for whom this is not a reasonable precaution.

Repeated search of the literature failed to identify any reported data which, by adding the number of patients...
who have spine injury with the number in whom such an injury should be suspected, provide a historical guideline for the approximate percentage of trauma victims who should be immobilized in the field. Until studies can provide such a guideline, there is no quantified measure from which to conclude that immobilization of unnecessarily many patients is commonplace.

Even if local case reviews repeatedly identify a significant number of patients for whom immobilization seemed unwarranted, one cannot generalize that this results from the immobilization criteria. Commonly, on further investigation, these are found to reflect poor judgment on the part of some individual EMTs or squads or the lack of proper documentation explaining why the patient was immobilized. Such findings recommend the need for individual remediation rather than alteration of the field criteria.

The studies of the deleterious side effects of immobilization on a longboard provide a clear consensus that proper short-term immobilization produces only transient, moderate pain and discomfort without any mat-

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