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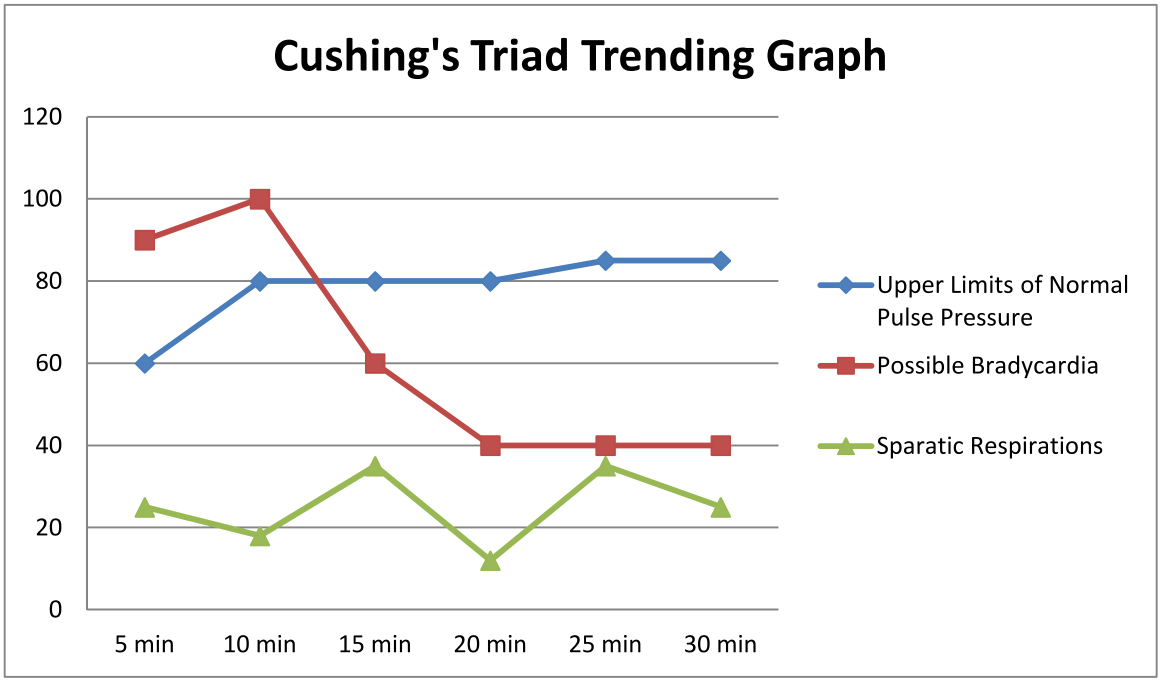
Appendix A

Sports Medicine Concepts' 12 Cranial Nerve Assessment Survey

Nerve	Name	Function	Test for	Result	
				Normal	Abnormal
I	Olfactory	Smell	Have the athlete identify odors w/ each nostril(sports cream, antiseptic, etc)		
II	Optic	Visual acuity	Have the athlete identify number of fingers		
		Visual field	Approach the athlete's eyes from the side using your finger or light pen		
III	Oculomotor	Pupilary reaction	Shine pen light in each eye and note pupilary reaction		
IV	Trochlear	Eye movements	Have the athlete follow your pen light without moving his/her head		
V	Trigeminal	Facial sensation	Have the athlete identify areas of face being touched		
		Motor	Have the athlete hold mouth open against resistance		
VI	Abducens	Motor	Check athlete's lateral eye movements		
VII	Facial	Motor	Have the athlete smile, wrinkle forehead, frown, puff cheeks, and wink each eye		
		Sensory	Have the athlete identify familiar tastes (Gatorade)		
VIII	Acoustic	Hearing	Have athlete identify sounds in both ears (tuning fork)		
		Balance	Check athlete's balance (Romberg sign)		
IX	Glossopharyngeal	Swallowing	Have the athlete say "ah" and swallow hard		
X	Vagus	Gag reflex	Test the gag reflex (tongue depressor)		
XI	Spinal	Neck strength	Have athlete complete full AROM, shoulder shrugs against resistance		
XII	Hypoglossal	Tongue movement and strength	Have the athlete stick out his/her tongue and move it around. Apply resistance with tongue depressor.		

absence does not rule out the possibility that an intracranial hematoma exists. Additionally, the trending graph results presented here represent only one example of sign and symptom patterns that result in a graphic form that may indicate the presence of an intracranial hematoma. Other trending patterns may produce other graphic forms also indicative of an intracranial hematoma. Therefore, sports health care professionals should consider this sideline evaluation protocol only as part of a comprehensive head injury management plan that includes a multi-disciplined emergency action plan. Future research efforts should focus on the validity and reliability of the ICP Trending Graphs as predictors of hematoma resulting from head trauma in sports.

Table 1. Cushing's Triad indicating elevated pulse pressure, bradycardia, and erratic respirations.



Conclusion

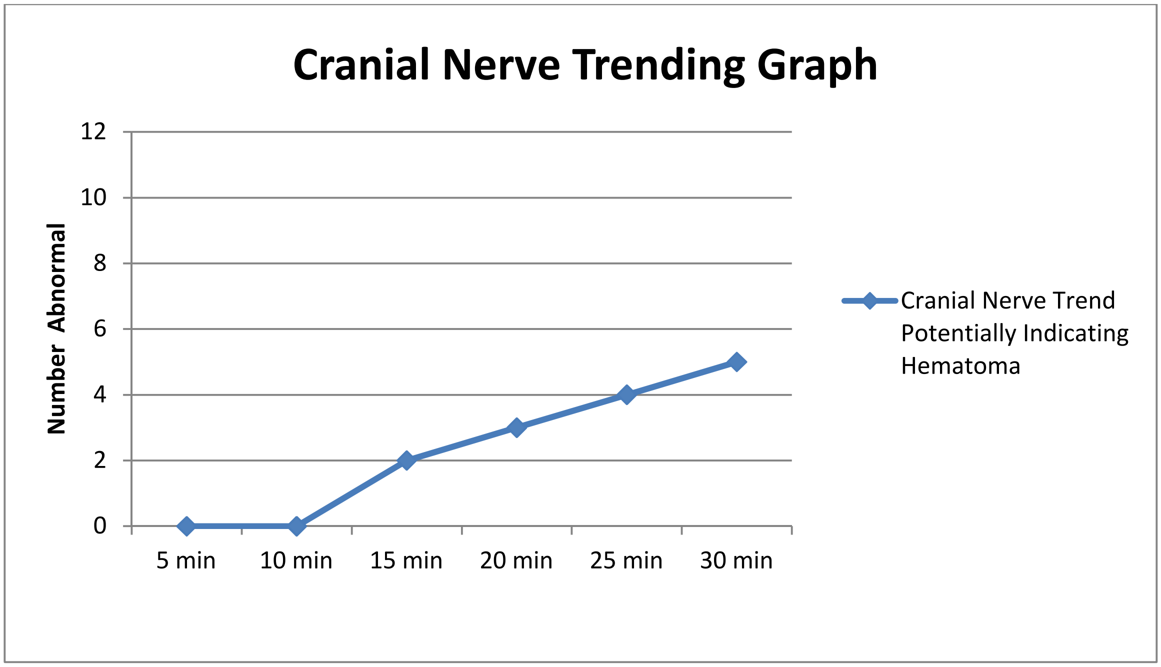
Assessing pulse pressure, heart rate, respirations, abnormal cranial nerve finding, and signs and symptoms of concussion at 5 minutes intervals for a period of 30 minutes may provide sports health care professionals with a mechanism for sideline identification of head injuries that are more likely to involve rising ICP due to intracranial hematoma and the need to immediately transport the injured athlete to an appropriate medical facility. An appropriate medical facility is one that is equipped to manage acute neurological injuries. Transport to a medical facility that is not equipped to handle acute neurological injuries will only result in loss of valuable time as the athlete will need to be transferred to a medical facility that is equipped to properly care for the athlete's injury. It is important to note that vital signs trending as a sideline assessment tool is not without significant limitations. The presence of any of the signs and symptom patterns discussed in this article may suggest an increased potential for intracranial hematoma, but their

Therefore, an injured athlete presenting with an elevated pulse pressure, heart rate, or respiration rate should be trending towards normal within 10 minutes, and should certainly demonstrate a normal pulse pressure, heart rate, and respirations following a 30 minute trending period.

To assess Cushing's Triad, use a blood pressure monitor to measure blood pressure and heart rate. Additionally, assess the athlete's respirations and respiration rate. Calculate pulse pressure and place the pulse pressure, heart rate, and respiration rate values on the Cushing's Triad Trending Graph shown in Tables 4. Blood pressure of a normal healthy individual should trend toward 120mmHg (systolic) / 80mmHg (diastolic) resulting in a normal pulse pressure of 40-80mmHg. Respiration rates should trend toward 10-12 breaths per minute. A general trend indicating an elevated pulse pressure combined with bradycardia and irregular respirations might indicate the presence of intracranial hemorrhage or edema and the need for immediate transport of the injured athlete. Incidentally, a low pulse pressure may also be problematic in and of itself, indicating the presence of shock or significant blood loss. A pulse pressure is considered low if it is less than 25% of the systolic value (11).

specific conditions may present themselves upon assessment of the Optic (II), Oculomotor (III), Trochlear (IV), and Abducens (VI) nerves.

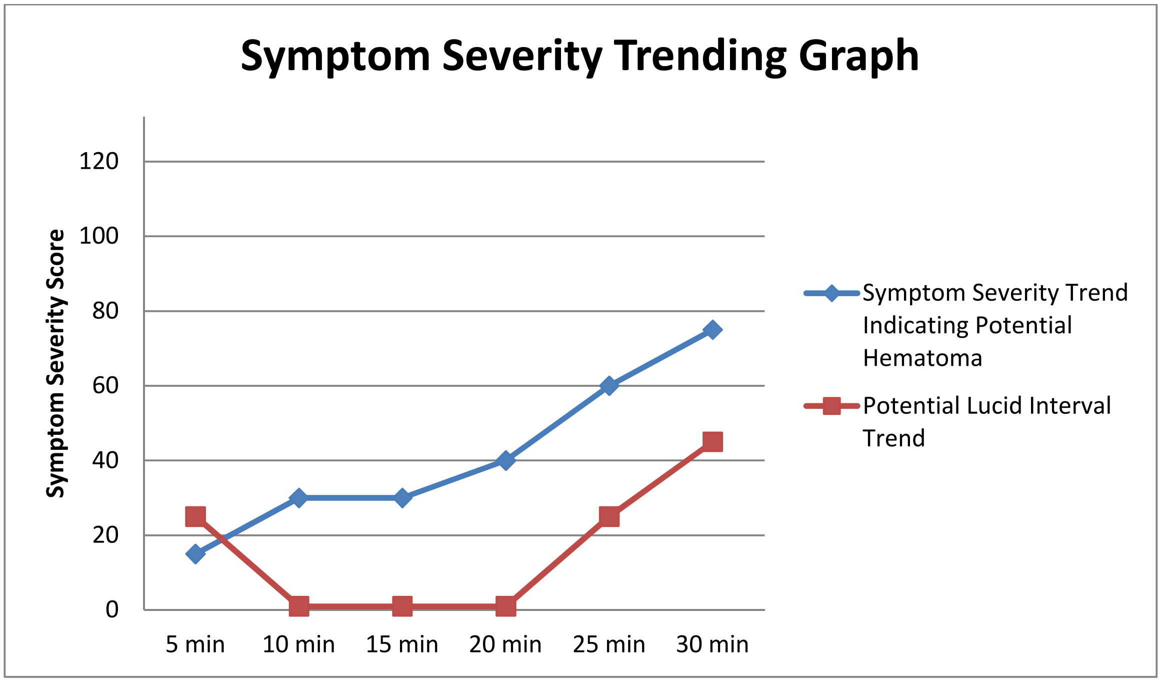
Figure 3. Cranial Nerve Trending Graph indicating a potential hematoma



Cushing's Triad

Cushing's Triad is an assessment battery that compares pulse pressure, heart rate, and breathing patterns to indicate the presence of intracranial hemorrhage or edema. Pulse pressure, or the amount of pressure required to create the feeling of a pulse, is the mathematical difference between the systolic and diastolic pressure. For example, normal blood pressure is 120mmHg (systolic) / 80mmHg (diastolic), resulting in an normal healthy pulse pressure of P (systolic) - P (diastolic) = 40 mmHg. The normal resting pulse pressure of a healthy individual, sitting position, is about 60-80 mmHg(11). Pulse pressure, heart rate, and respiration rate will increase with exercise, but have all shown to trend towards normal within 10 minutes following the cessation of exercise.

Figure 2. Symptom severity score trend indicating a potential hematoma

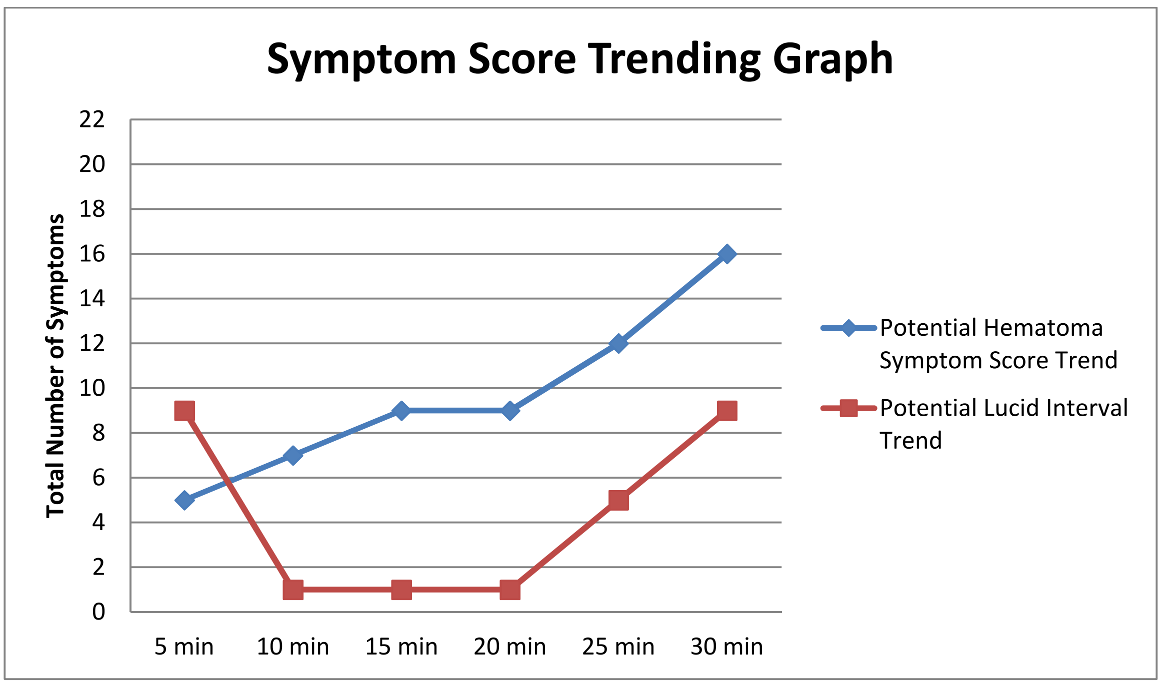


Cranial Nerve Assessment Graph

Although there is some overlap in the cranial nerve assessment survey with the SCAT2 Symptom Evaluation Form, specific assessment of all 12 cranial nerves is warranted because any rise in ICP could have immediate impact on any of the cranial nerves due to their anatomical location at the base of the brain within the cranial compartment. Therefore, assess both motor and sensory function for all 12 cranial nerves using the cranial nerve assessment survey provided in Figure 3. Calculate the total number of abnormal findings out of a possible 12 and place this number on the Cranial Nerve Trending Graph shown in Figure 3. Repeat this assessment at 5 minute intervals for a total of 30 minutes. A general trend in the number of abnormal findings may indicate the presence of rising ICP due to intracranial hematoma, and the need for immediate transport of the injured athlete. More specifically, rising ICP has been shown to result in ocular palsies, papilledema, pupillary dilatation, and abducens palsies. These intracranial hematoma.

Another significant sign of intracranial hematoma that may be observed using the Symptom Score and Symptom Severity Trending Graphs is a lucid interval. A lucid interval is a period of time during which an athlete reports improvement in signs and symptoms followed by worsening signs and symptoms, including variations in level of consciousness. Figures 1 and 2 depict potential graphic representations of a lucid interval by illustrating a general trend of improvement followed by worsening severity scores.

Figure 1. Symptom Score indicating a possible hematoma



Many of the signs and symptoms that present themselves in the sideline environment that are the result of an intracranial hematoma, rising ICP, or mid-line shift may be readily observed by trending three specific assessment batteries; the Sport Concussion Assessment Tool 2 (SCAT2) Symptoms Severity Score(10), the Sports Medicine Concepts' Cranial Nerve Assessment Survey (See Appendix A), and Cushing's Triad, which compares heart rate, respiration, and pulse pressure.

Symptom Severity Graph

Using the SCAT2 symptom evaluation form, ask an injured athlete to provide a current symptom severity rating for the 22 signs and symptoms listed on the form. Athletes are instructed to rate their symptom severity at the time of evaluation between 0 points, indicating they are not experiencing the sign or symptom at all, and 6 points, indicating the symptom is most severe. Place the total number of signs and symptoms out of a possible 22 on the ICP Symptom Score Trending Graph (See Figure 1). Next, calculate the symptom severity score by adding up the severity rating numbers and place this number on the Symptom Severity Trending Graph (See Table 2). Repeat this process at 5 minute intervals for a total of 30 minutes. Generally, athletes who may have sustained a head injury resulting in intracranial hematoma may present with an increasing number of signs and symptoms or an increasing symptom severity rating. A rapid rise in symptoms or symptom severity scores during the trending period may be indicative of rising ICP and the need to transport an athlete prior to the completion of the 30 minute trending period, particularly if the signs and symptoms involved include headache, nausea, or vomiting in the absence of nausea. Figures 1 and 2 illustrate general trends in the number and severity of signs and symptoms that might be indicative rising ICP due to set, a resulting mid-line shift will ultimately lead to brain herniation or brain stem compression resulting in brain infarction and decrease respiratory drive (8).

Sideline Assessment

An injury resulting in rapid increases in ICP or mid-line shift will present with immediately life-threatening outward signs and symptoms indicating the need for immediate transport. Injury to the brain resulting in more gradual rises in ICP may initially mimic a SRC. However, observation of certain sign and symptom trends should alert sports health care professionals to the possibility of elevated ICP secondary to intracranial hematoma, and thus the need for immediate transport. Vital signs trending is an assessment strategy that has been used to observe serial measures of heart rate (HR), respirations (R), blood pressure (BP), and temperature (T) at 10min intervals over a 30 minute period when upon initial evaluation HR is >100bpm, systolic BP is <100mmHg and/or body temperature is >100°F. Vital signs that do not normalize within the 30 minute trending period warrant immediate medical follow-up (9). In the following section the vital signs trending philosophy is modified and used to observe for the development of specific signs and symptoms indicative of rising ICP secondary to intracranial hematoma, and thus, the need for immediate transport of an injured athlete. Specifically, the vital signs trending protocol was changed from 10 minute to 5 minute serial measures of certain signs and symptoms over a 30 minute period of time. The protocol modification is believed to be more sensitive to changes in signs and symptoms. It is best to remove the athlete from the sideline to perform these observations as the sideline environment may have a direct impact on the measures being assessed.

signs and symptoms. Signs and symptoms indicative of rising ICP may include headache, nausea, vomiting without nausea, ocular palsies, altered levels of consciousness, back pain, papilledema, and widened pulse pressure. In children, bradycardia may be particularly suggestive of high ICP (6). Specific signs and symptoms indicating the presence of an intracranial hematoma include bradycardia, hypotension, hypertension, respiratory depression, systemic vasoconstriction, decreased or varying levels of consciousness (i.e., lucid interval), hyperventilation, sluggish dilated pupils, and widened pulse pressure. Early recognition of these signs and symptoms is paramount to ensure that injured athletes receive medical treatment before ICP reaches 40-50 mmHg, at which point catastrophic outcomes secondary to brain infarction and brain death become more likely (7).

Catastrophic outcomes may also result secondary to a mid-line shift of the brain within the cranial compartment. A mid-line shift may result over a period of time as intracranial hematoma results in a growing mass of blood that eventually pushes the brain from mid-line. If the mid-line shift results secondary to an intracranial hematoma, the on-set of signs and symptoms may develop over a period of time, depending on how long it takes for enough blood to collect in the cranial compartment to result in pushing the brain from mid-line. Signs and symptoms of a growing mass effect intracranial hematoma may include pupillary dilatation, abducens palsies, increased systemic blood pressure, bradycardia, irregular respiratory patterns, and a widen pulse pressure. Trauma, itself, may result in a mid-line shift. If the mid-line shift is a direct result of trauma, dire signs and symptoms may present immediately. Regardless of a gradual or immediate on-compensatory decrease in volume of another. For example, an intracranial hematoma resulting in an increase blood volume within the cranial compartment is compensated for by displacement of CSF into the ventricles and spinal canal, and some elasticity properties of the brain. This compensatory mechanism allows for small increases in cranial volume that do not immediately result in elevated ICP (4), (3).

Signs and Symptoms of Rising ICP

Normal adult ICP is 7-15 mmHg (3). Rising ICP is most commonly caused by head injury resulting in intracranial hematoma. The body's compensatory mechanism for controlling small increases in cranial compartment volume will accommodate pressures up to 25 mmHg. Therefore, initial increases in ICP may not result in any outward signs and symptoms that can be readily observed during acute sideline management. Although children have slightly higher tolerance for elevated ICP for longer periods, very high ICP can have devastating consequences and is usually fatal. As rising ICP begins to exceed the upper limits of normal, ICP begins to reach mean arterial pressure (MAP). As ICP reaches MAP, cerebral perfusion pressure (CPP) falls resulting in decreased blood flow to the brain. As a result of declining CPP the body's autoregulatory processes increase systemic blood pressure in an attempt to maintain adequate blood flow to the brain. In the case of an intracranial hematoma, an increase in systemic blood pressure will facilitate bleeding into the cranial compartment, initiating an ICP/CPP vicious cycle that will ultimately result in an elevated ICP that leads to ischemia and brain infarction secondary to inadequate blood flow to the brain (1), (2), (5).

As ICP exceeds the body's compensatory mechanisms and approaches 25-40 mmHg, the athlete is likely to begin exhibiting an increase in number and severity of

Distinguishing between a sports-related concussion and an intracranial hematoma has long been a challenge for sports health care professionals during sideline management of athletes having suffered head trauma. Both conditions can present with very similar signs and symptoms, but each requires very difference acute management. While proper management of both conditions is critical to prevent a catastrophic outcome, failure to identify an acute intracranial hematoma could result in rapid deterioration of the athlete's health due to life-threatening elevations in intracranial pressure (ICP) (1), (2). Rising ICP secondary to an intracranial hematoma has been shown to result in specific signs and symptom patterns.. These patterns that may be useful in helping sports health care professionals in identification intracranial hematoma and in making appropriate acute care management decisions. Therefore, this paper will: 1) explain how the body responds to rising ICP, 2) discuss specific signs and symptoms that evolve as ICP rises, 3) explain how serial monitoring of specific signs and symptoms following head trauma can be helpful in identifying intracranial hematoma, and 4) demonstrate a possible sideline assessment protocol using the ICP Trending Graph Series.

Body's Response to Rising ICP

The cranial compartment, vertebral canal, and dura form a rigid inelastic container that houses the brain, blood, and cerebral spinal fluid (CSF). ICP is the pressure inside the cranial compartment. Under normal conditions autoregulatory processes maintain pressure within the cranial compartment to within 1 mmHg (3). Rising ICP results from volume changes in the brain, CSF, or blood. In order to maintain ICP an increase in the volume of one of the cranial constituents must be offset by a

A Sideline Assessment Strategy That Uses Vital Signs Trending As a Mechanism for Identification of Intracranial Hematoma Resulting From Head Trauma in Sports

By

Michael J. Cendoma, MS, ATC
Curriculum Director, Sports Medicine Concepts, Inc
Clinical Coordinator, Concussion Management Specialists, PLLC
30 Commercial St., Ste 4
Livonia, NY 14487
Ph. 585-346-0240
Email: mjc@SportsMedicineConcepts.com

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