SPORT-RELATED CONCUSSION:
The Arkansas Pediatric Concussion Profile, Clinics, and Interventions

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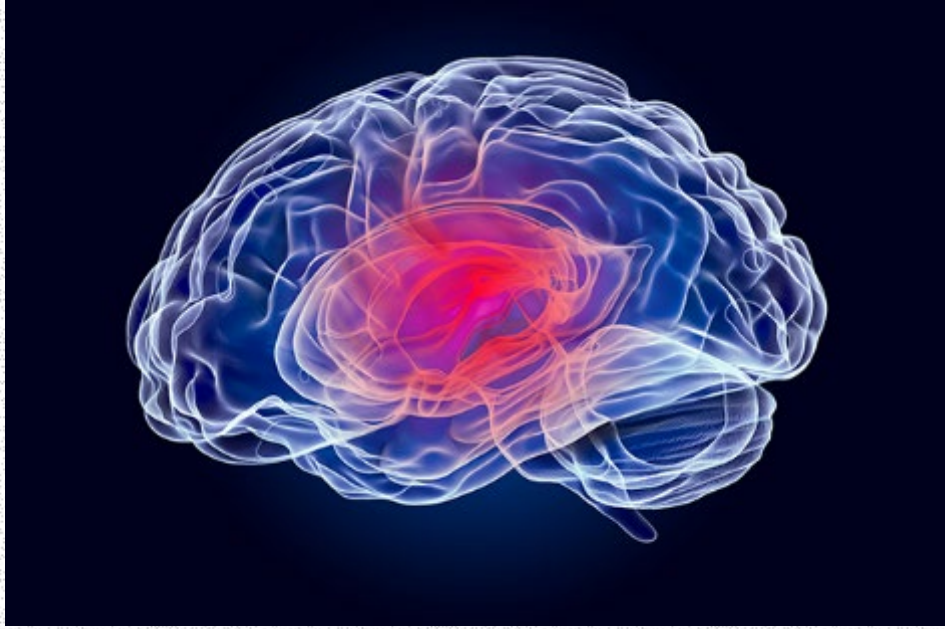
Agenda



Concussion Morbidity

Identifying the Problem

Defining Concussion

Concussion Assessment & Intervention

Existing Systems of Care

Change the EMS Culture at Student Athlete Sporting Events? – Let's hear from you

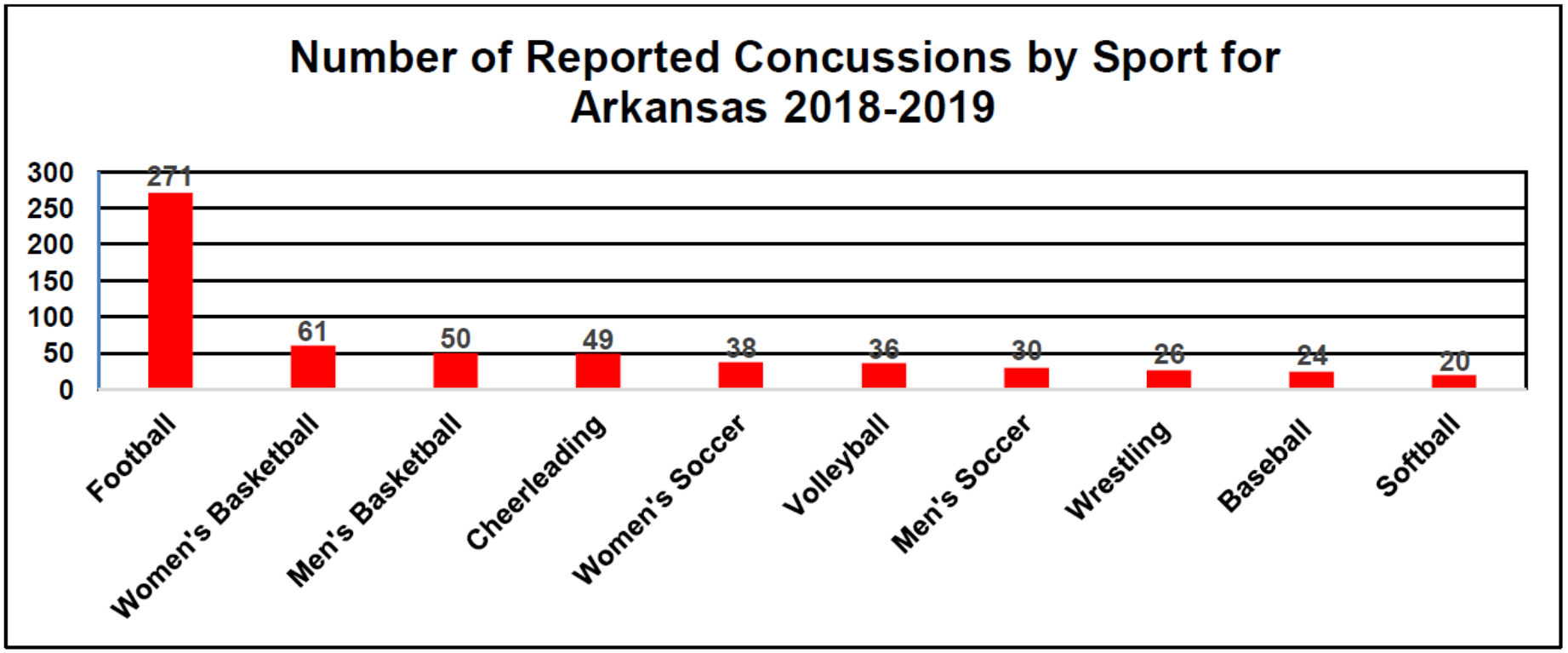
Concussion/mild TBI

- 58-88% of all TBIs
  - Bruns & Hauser, 2003
- 3.8 million sports-related injuries
  - Steenerson, K., & Starling, A. J. , 2017

U of A Office of Sport Concussion Research

- 2018-2019 Athletic Season
- Data were gathered for 176 high schools out of the 293 high schools affiliated with the AAA yielding a **60% response rate**.
- **605** concussions were reported for the 2018-2019 athletic season
- The highest number of concussions was reported for **Football** followed by **Women's' Basketball** and **Men's Basketball** (see Figure 1).
- **95%** of HS (**168/176)** require a doctor's medical release when returning an athlete to play after concussion.

Sports-Related Concussions



The Problem:

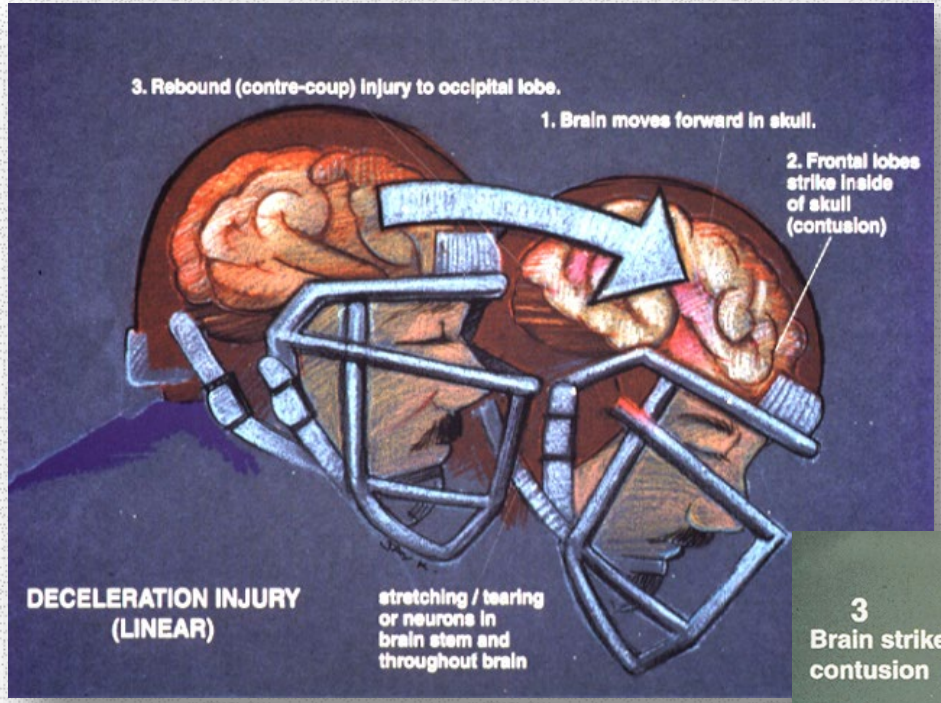
WHAT IS A CONCUSSION?

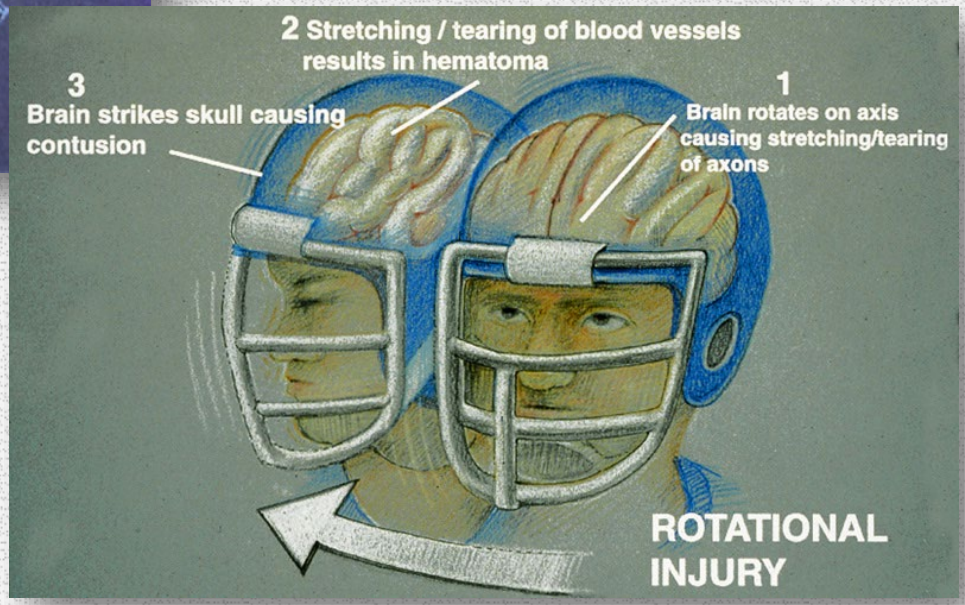
An Evolving Definition of Concussion

- Concussion involves:
  - Direct or indirect forces to the head
  - Functional injury, rather than a structural brain injury (**normal** CT, MRI)
- May or may NOT involve a loss of consciousness
- Recovery varies from days to months or longer

Patricios et al. (2023). Brit J Sports Med

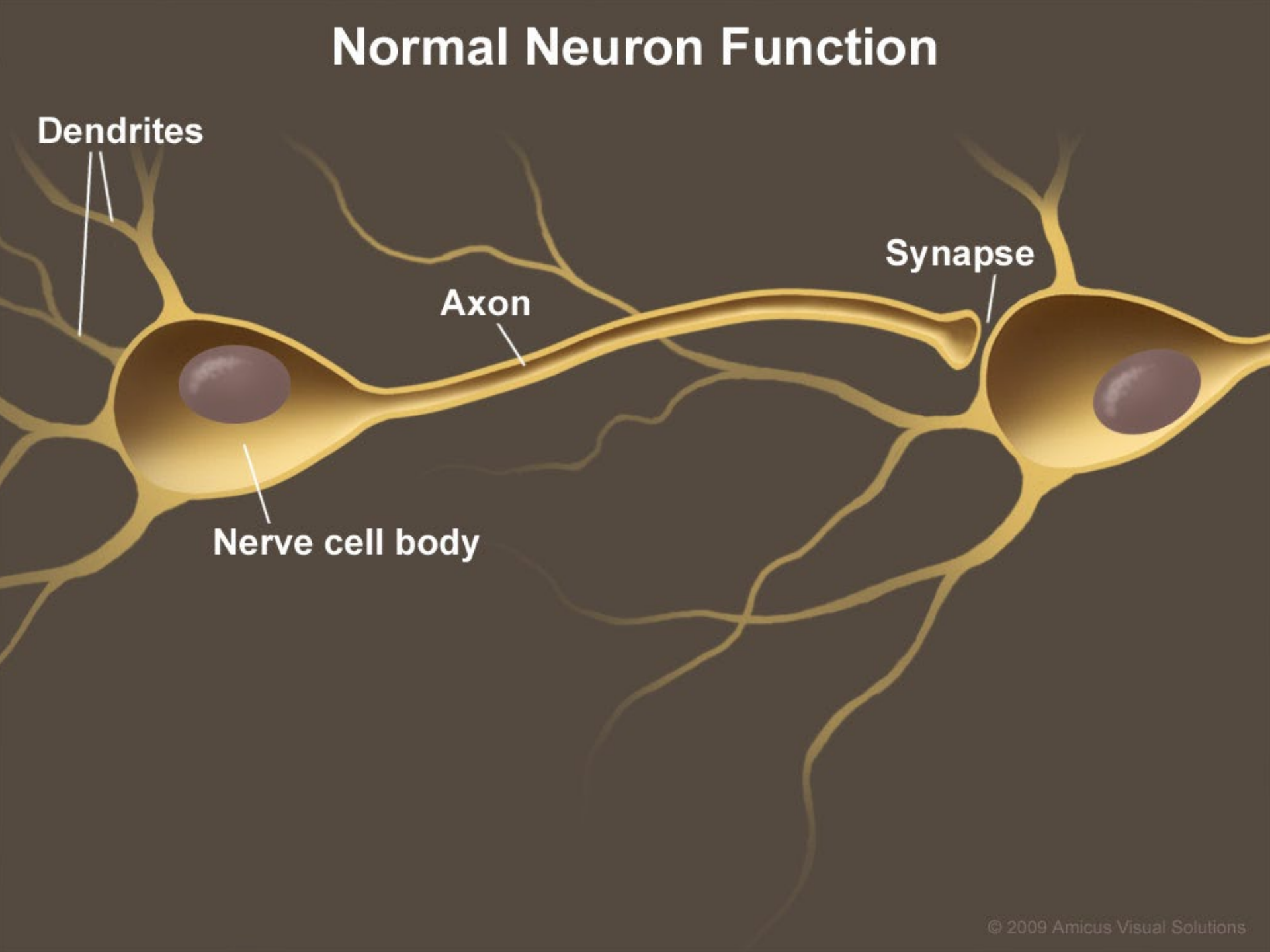
What Causes a Concussion?



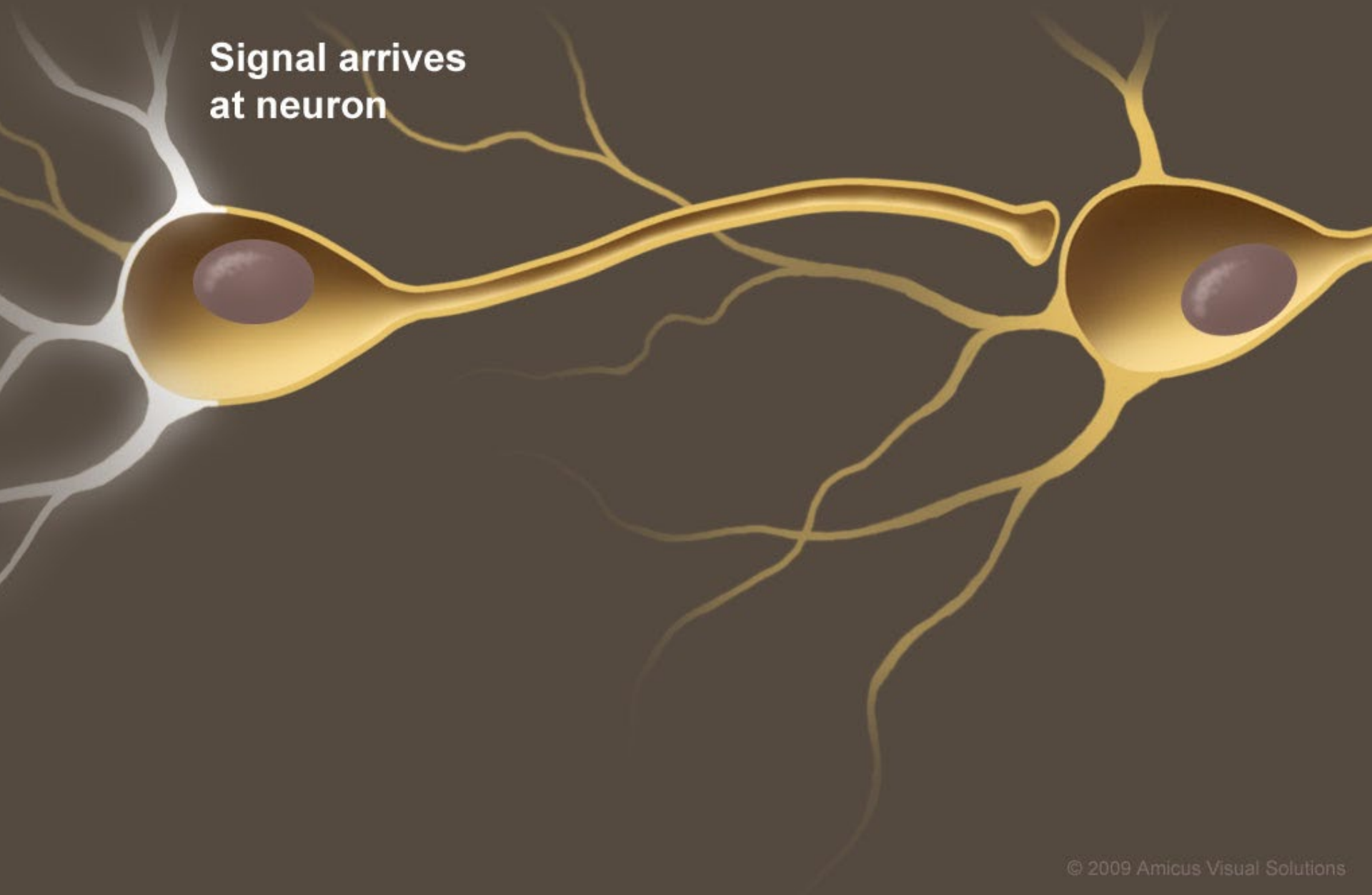


How Does Concussion Affect The Brain?

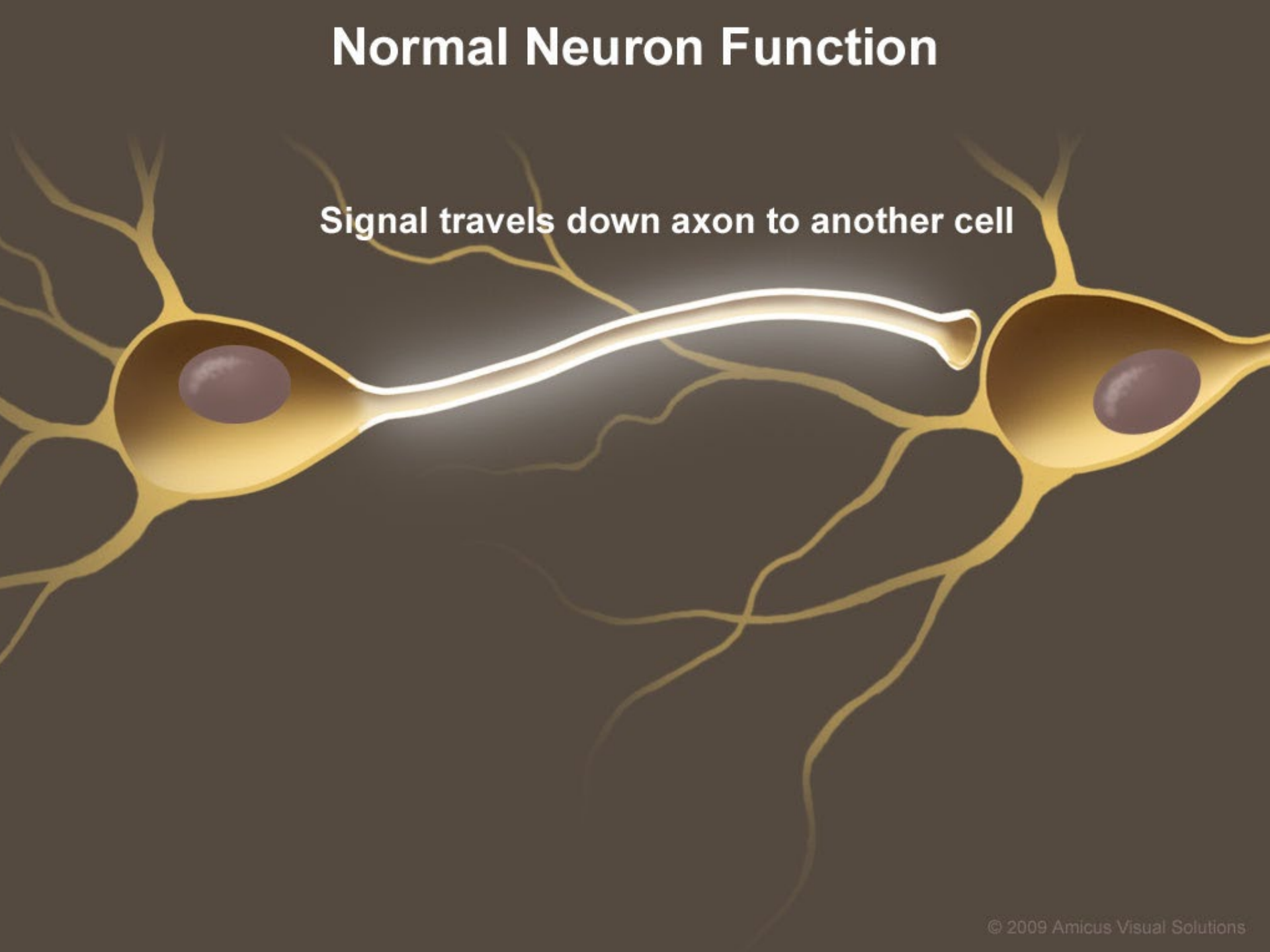
Normal Neuron Function



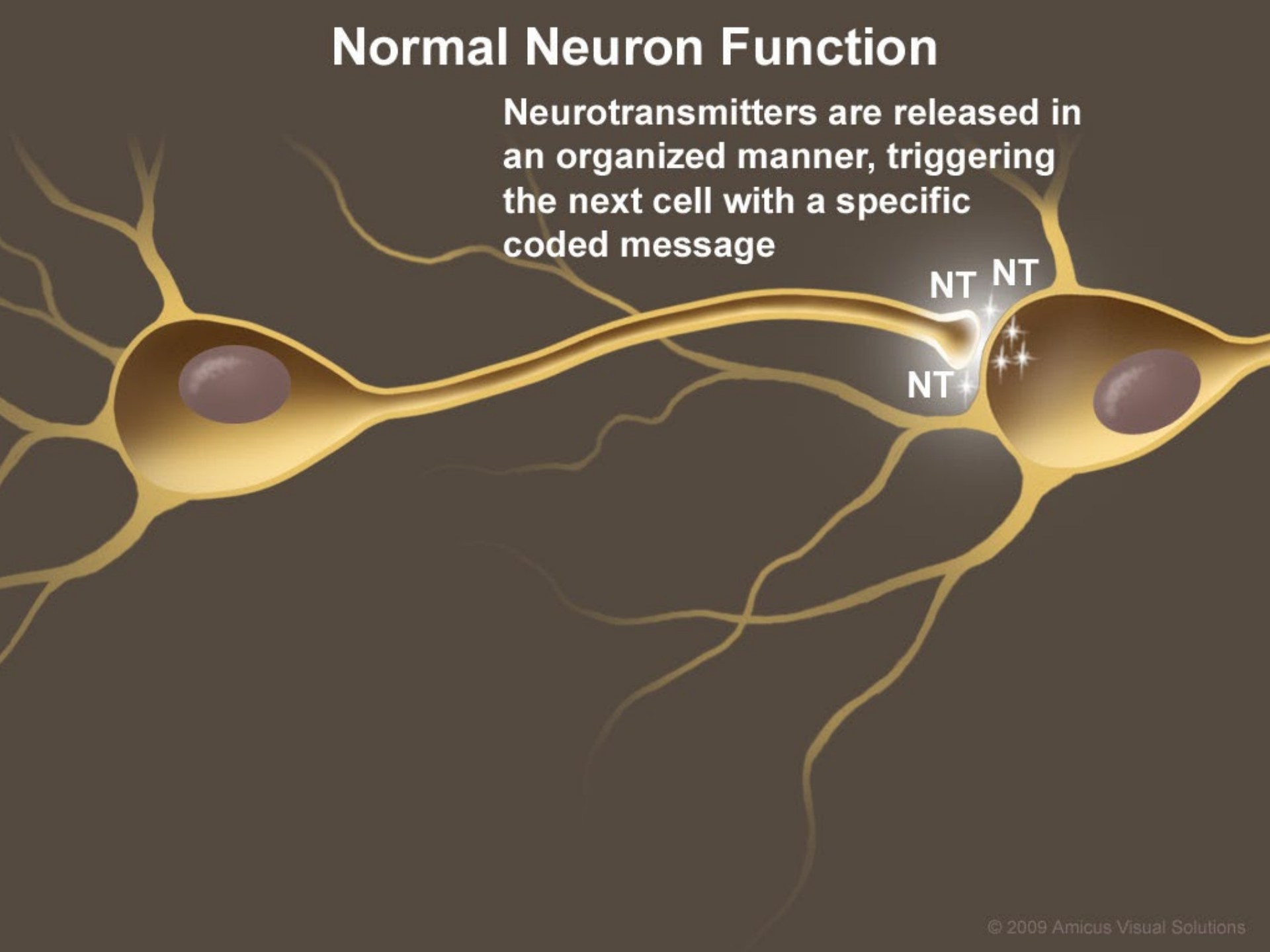
Normal Neuron Function



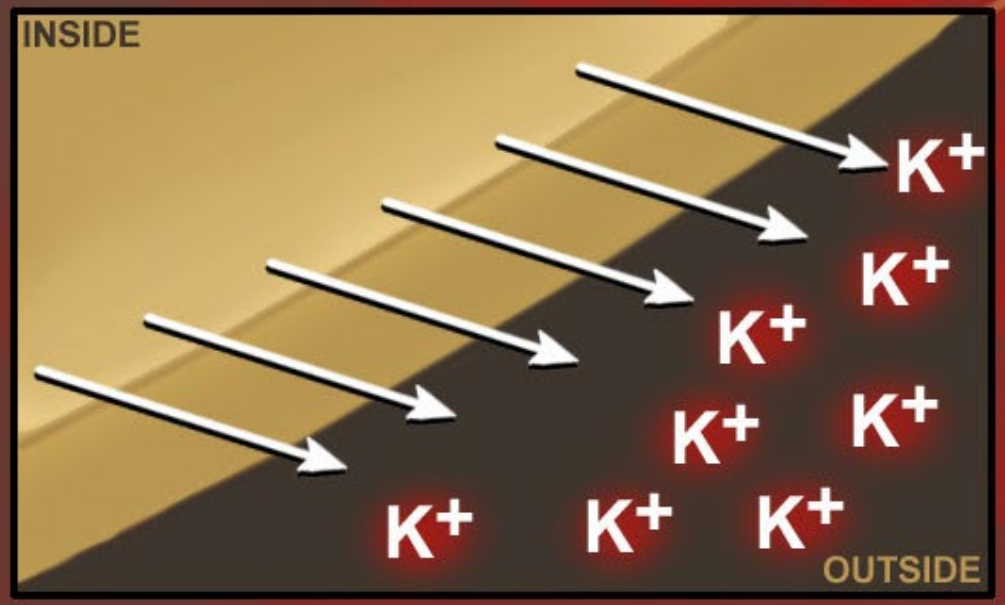
Normal Neuron Function



Normal Neuron Function

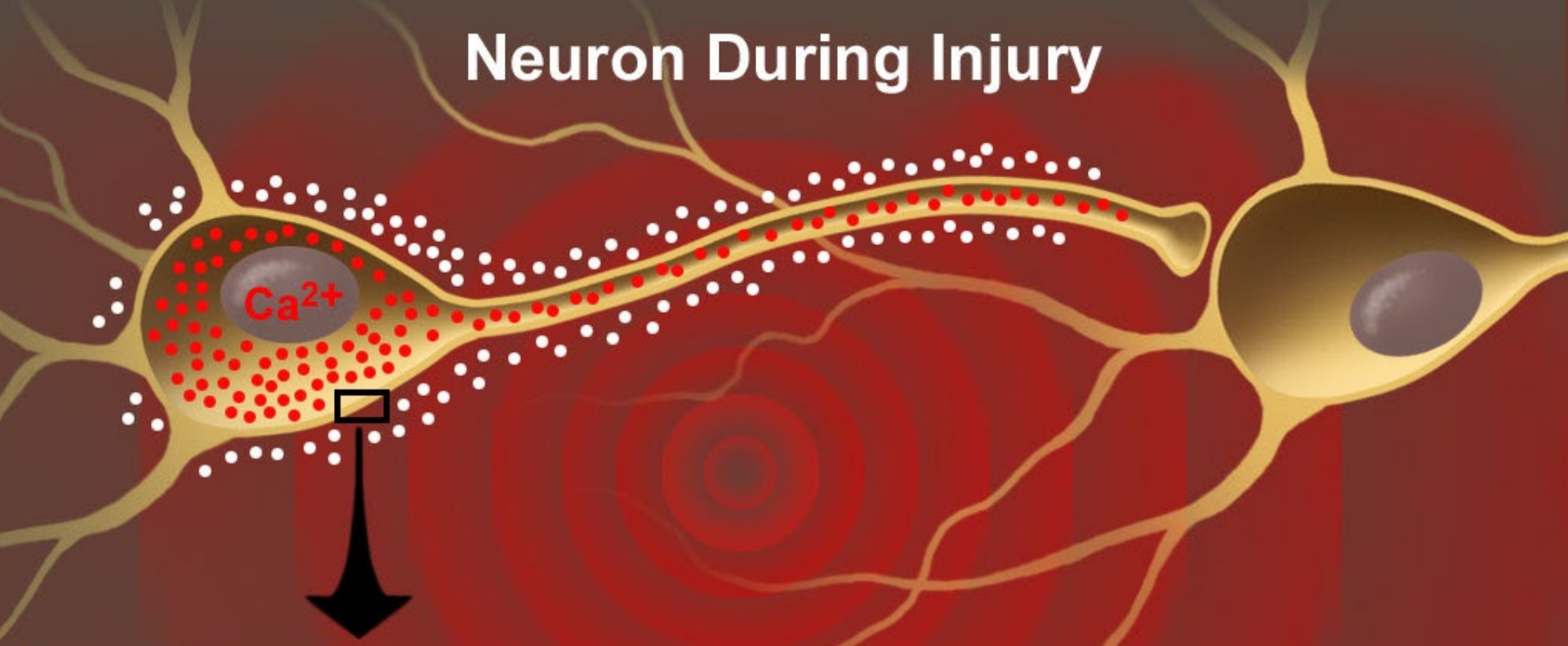


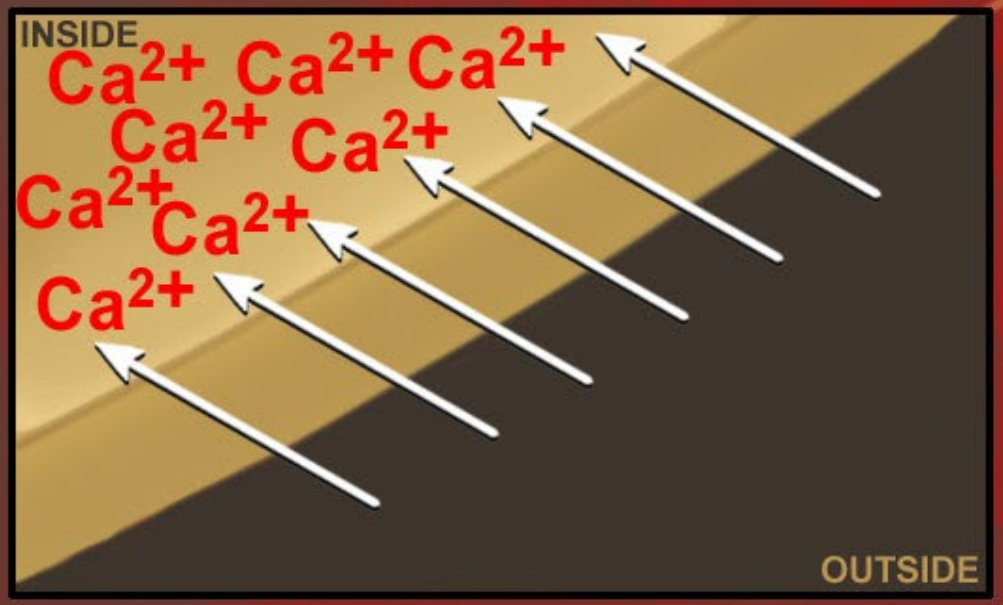
Neuron During Injury



During injury, potassium ions (K^+) rush out of the cell...

Neuron During Injury





...and toxic calcium ions (Ca^{2+}) rush into the cell, leading to metabolic dysfunction.

Neuron Following Concussion

Metabolic dysfunction results in ENERGY CRISIS

Massive release of neurotransmitters interferes with cell communications

Nerve cell is extremely vulnerable in this condition, and further injury or stress may cause cell death or serious cell damage.

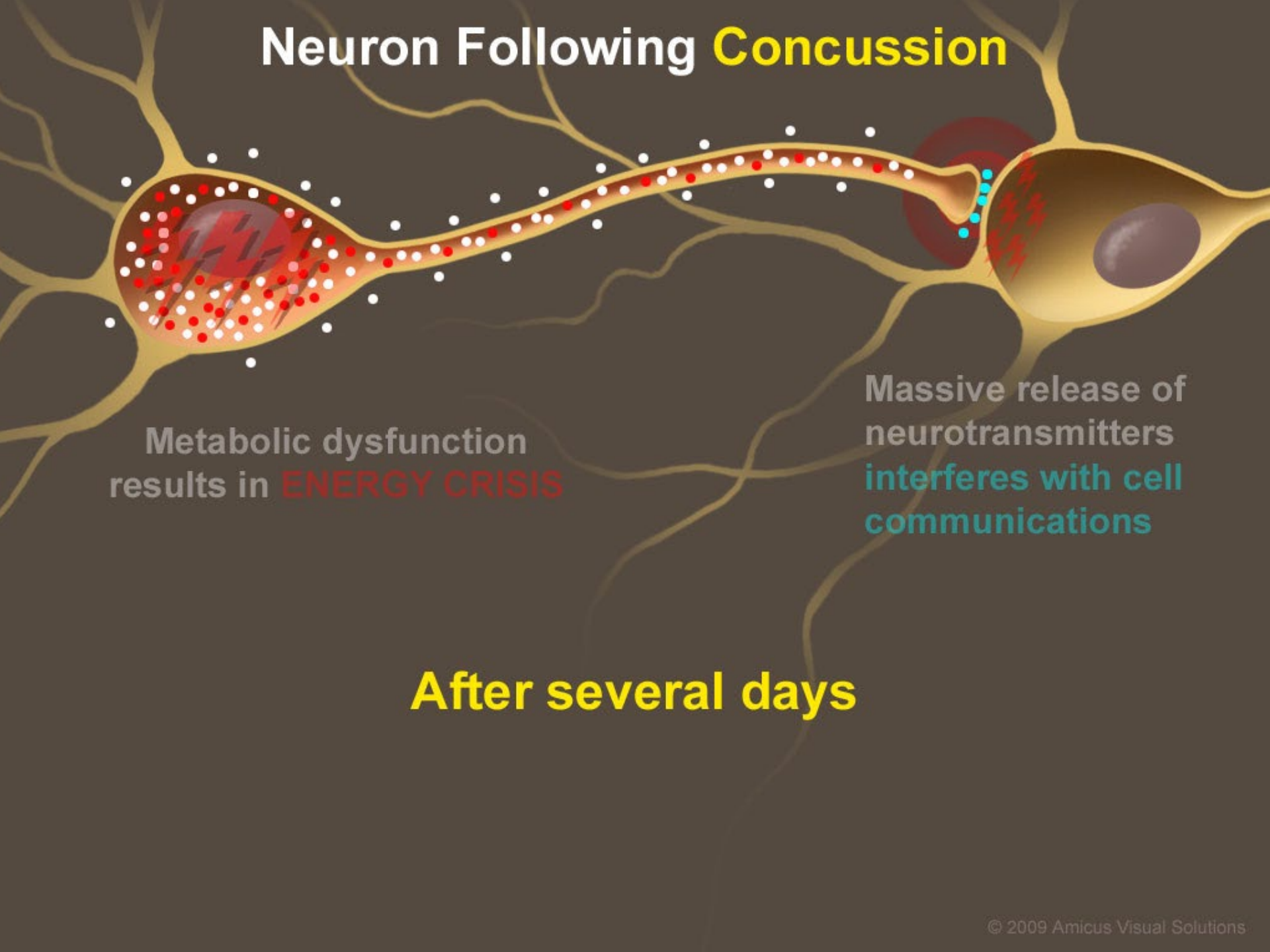
Neuron Following Concussion

Metabolic dysfunction results in ENERGY CRISIS

Massive release of neurotransmitters interferes with cell communications

It may take many days for the nerve cells to return to their normal condition.

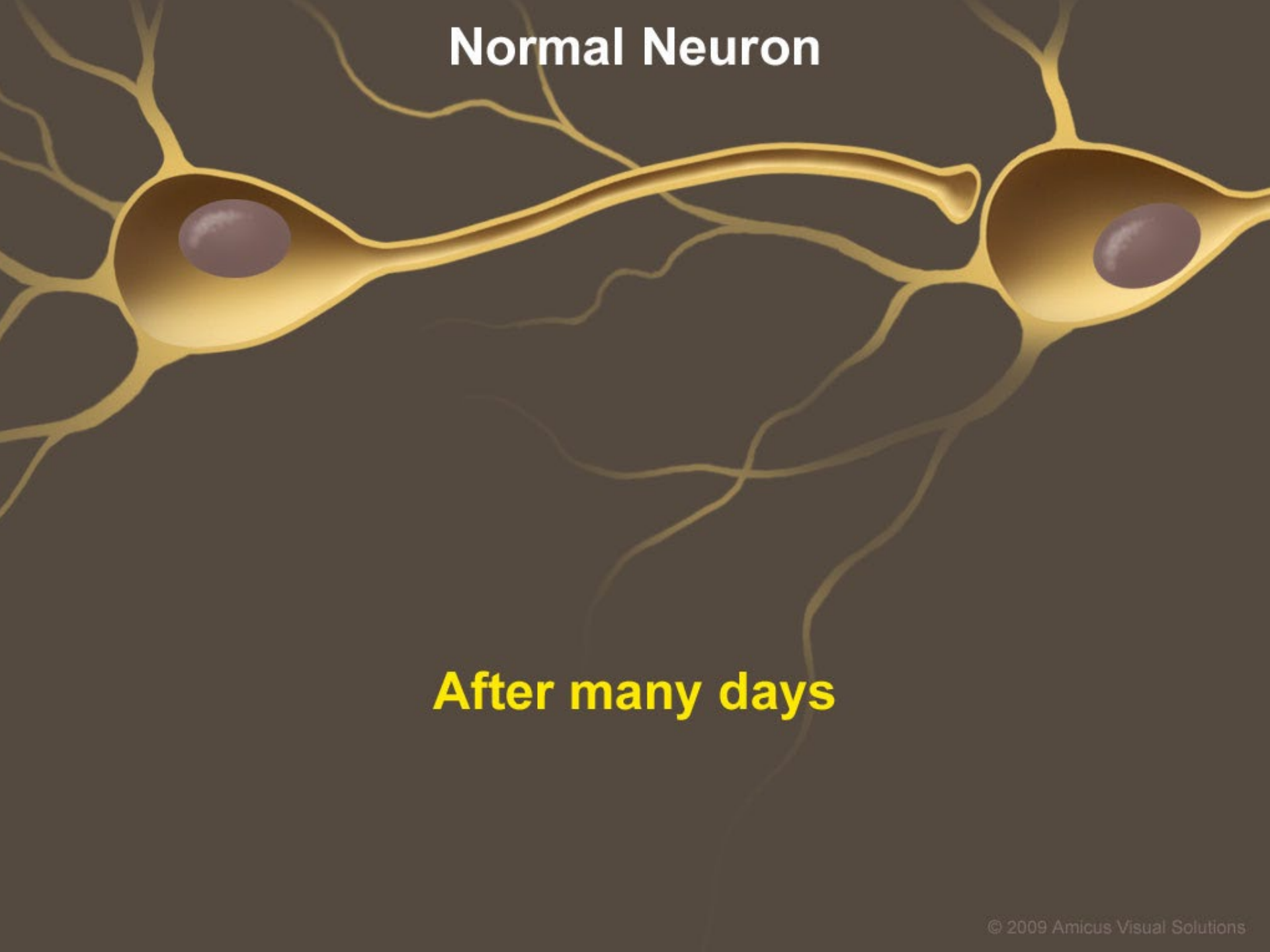
Neuron Following Concussion



After several days

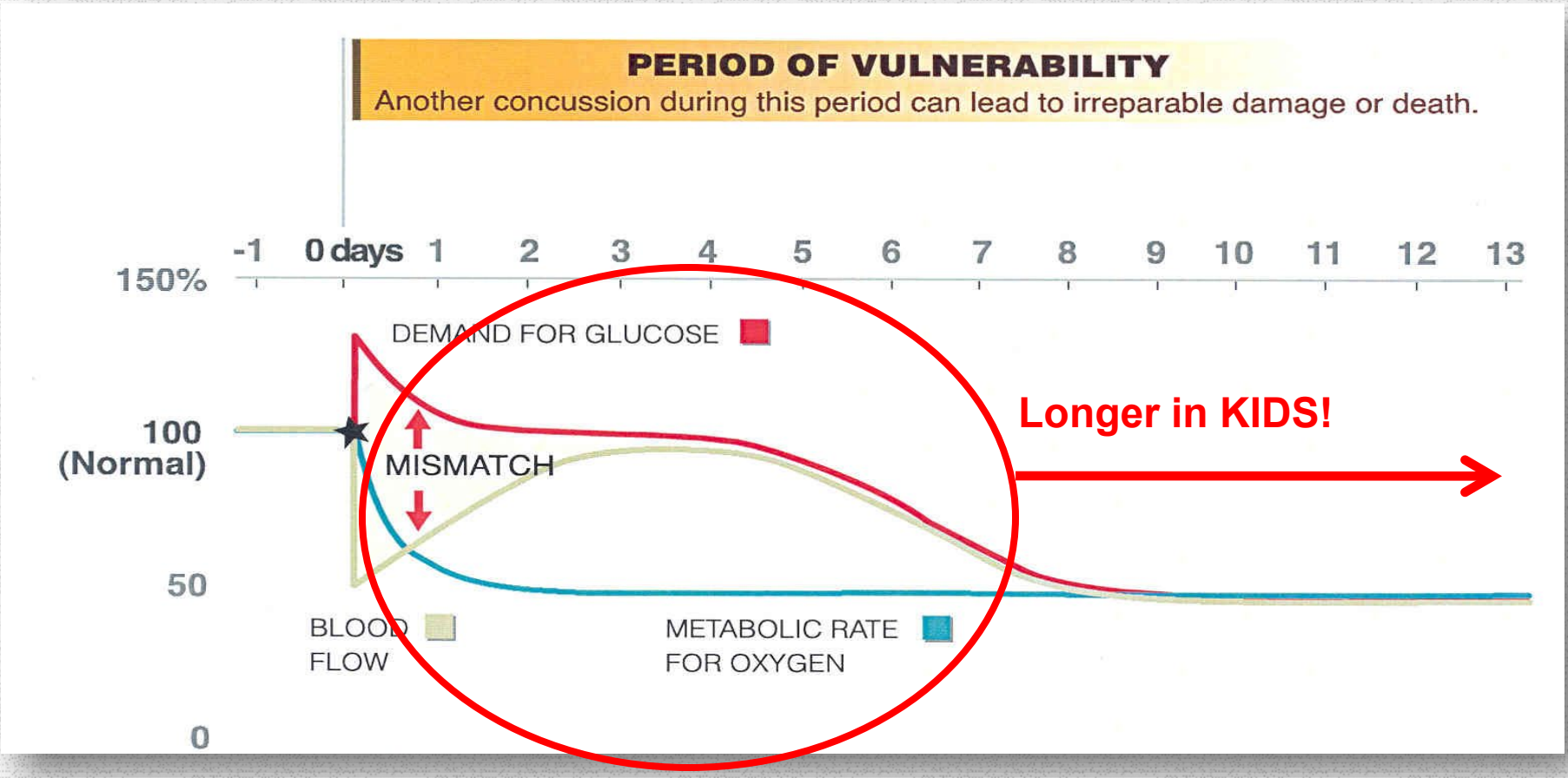
Neuron Following Concussion

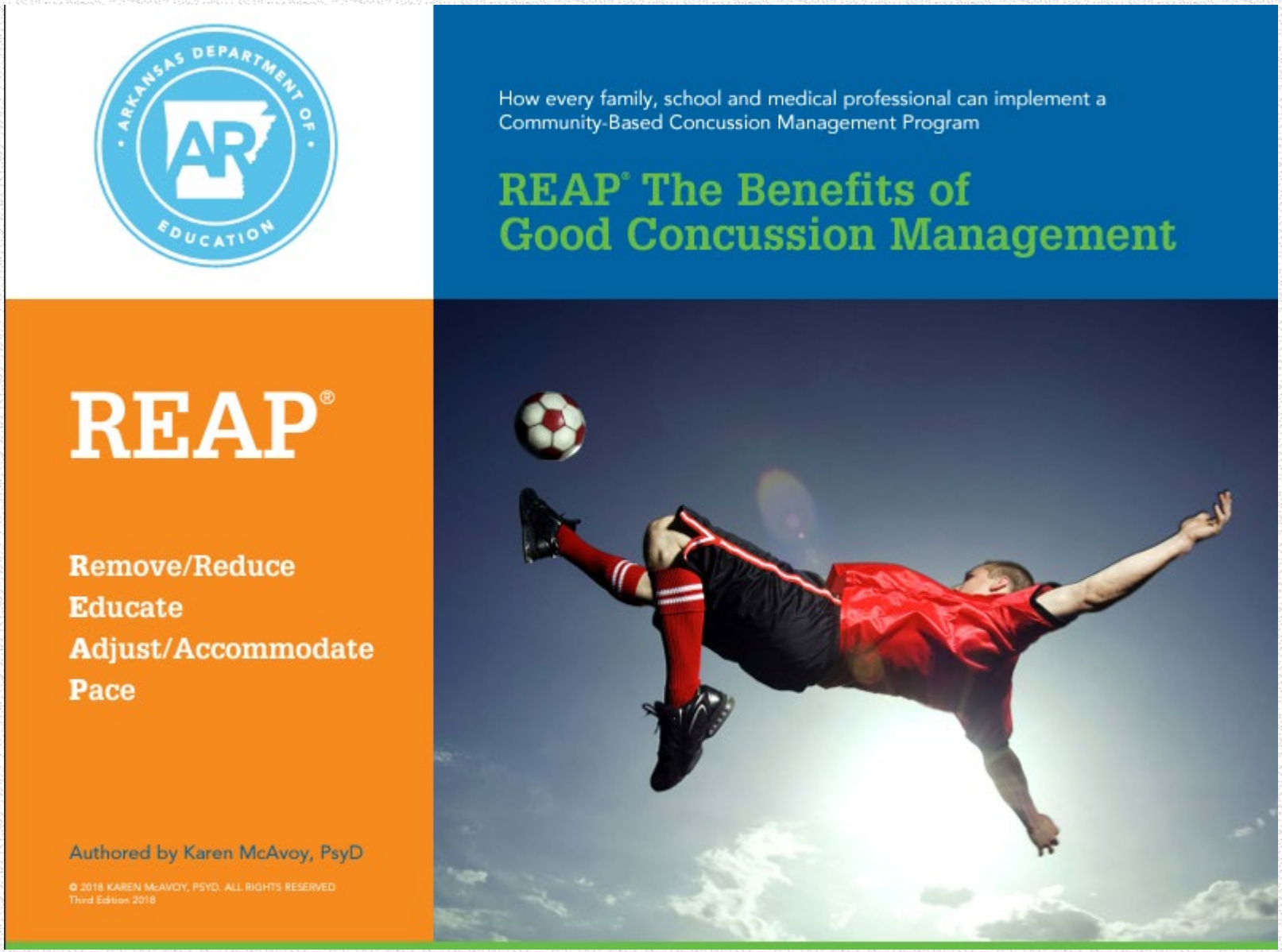
After many days



Neurometabolic Cascade

- **Mismatch between energy demand and resources**
- **The concussed brain becomes LESS efficient**
  - **Hybrid Car → Large SUV**



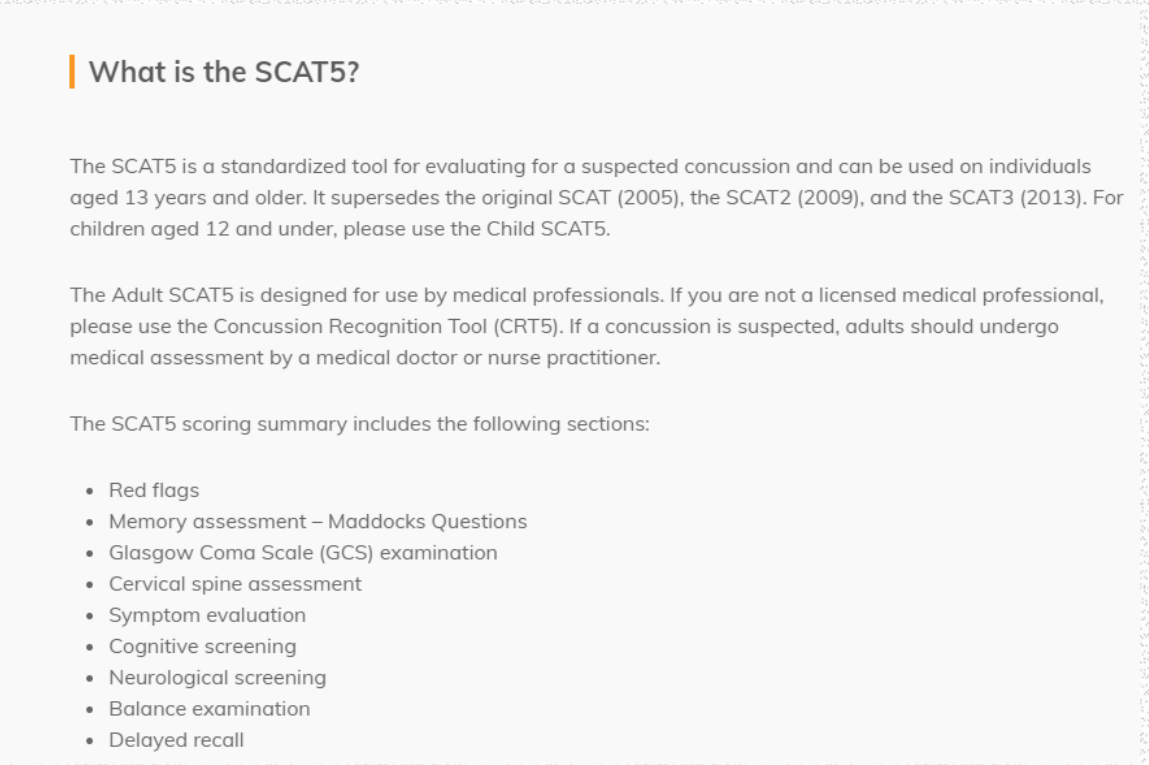


https://arbraininjury.org/wp-content/uploads/2021/06/Arkansas2021REAP.pdf

CRITICAL QUESTIONS FOR THE EMT WHEN ASSESSING CONCUSSION

Is This Concussion?

- Sport Concussion Assessment Tool – SCAT 5
  - Red Flags
  - Memory Assessment
  - C-Spine Assessment
  - Symptom Evaluation
  - Cognitive Screening
  - Neurological Screening
  - Balance Examination
  - Delayed Recall



What is the SCAT5?

The SCAT5 is a standardized tool for evaluating for a suspected concussion and can be used on individuals aged 13 years and older. It supersedes the original SCAT (2005), the SCAT2 (2009), and the SCAT3 (2013). For children aged 12 and under, please use the Child SCAT5.

The Adult SCAT5 is designed for use by medical professionals. If you are not a licensed medical professional, please use the Concussion Recognition Tool (CRT5). If a concussion is suspected, adults should undergo medical assessment by a medical doctor or nurse practitioner.

The SCAT5 scoring summary includes the following sections:

- Red flags
- Memory assessment – Maddocks Questions
- Glasgow Coma Scale (GCS) examination
- Cervical spine assessment
- Symptom evaluation
- Cognitive screening
- Neurological screening
- Balance examination
- Delayed recall

https://cattonline.com/scat/
accessed 8/1/23

Box 1: Red Flags

- Neck pain or tenderness
- Seizure or convulsion
- Double vision
- Loss of consciousness
- Weakness or tingling/burning in more than 1 arm or in the legs
- Deteriorating conscious state
- Vomiting
- Severe or increasing headache
- Increasingly restless, agitated or combative
- GCS <15
- Visible deformity of the skull

"What On-Field Signs/Symptoms Should I be Looking for?"

- Not always "crystal clear"
  - Evidence of mechanism (e.g., LOC vs "I have a headache")
  - Athlete does/does not tell you about their symptoms
  - Symptoms present, but then resolve
  - Coach and parent issues…

Sport Concussion Assessment Tool 6 - SCAT6™

Step 1: Observable Signs

Witnessed ☐ Observed on Video ☐

Lying motionless on playing surface	Y	N
Falling unprotected to the surface	Y	N
Balance/gait difficulties, motor incoordination, ataxia: stumbling, slow/ laboured movements	Y	N
Disorientation or confusion, staring or limited responsiveness, or an inability to respond appropriately to questions	Y	N
Blank or vacant look	Y	N
Facial injury after head trauma	Y	N
Impact seizure	Y	N
High-risk mechanism of injury (sport-dependent)	Y	N

Signs and Symptoms

- Subjective
  - Athlete lack of knowledge of signs/symptoms
  - Minimize/don't tell anyone
- Individualized
- However…

- Assessing symptoms is more than just a yes/no!
- What do the symptoms tell us about the injury?
  - How do they change during recovery and how can we use this information to make management decisions

More Questions…

- ”This could be a _____”
  - Concussion
  - Migraine
  - Fatigue
  - Hunger
  - Hyponatremia
  - Heat Illness
  - Attention-seeking behavior
  - Teenager displaying normal, weird everyday behavior
  - Adult displaying normal, weird everyday behavior

What Should You Tell Parents and Coaches?

- **NO SAME DAY RETURN TO PLAY!**
- Monitor for deteriorating signs
- Seek medical assistance for clearance

Quick Concussion facts!

- Often have a delayed presentation – therefore diagnosis is not immediate! – Proceed with caution!
- Concussions usually recover within 2 weeks
- Risk factors for a long recovery
  - On-field dizziness
  - Post-traumatic migraine
  - Not removed from play
  - Prior head injury
  - History of anxiety/depression/ADHD/learning disability
  - Prior headache/migraine condition

Arkansas Activities Association Guidelines

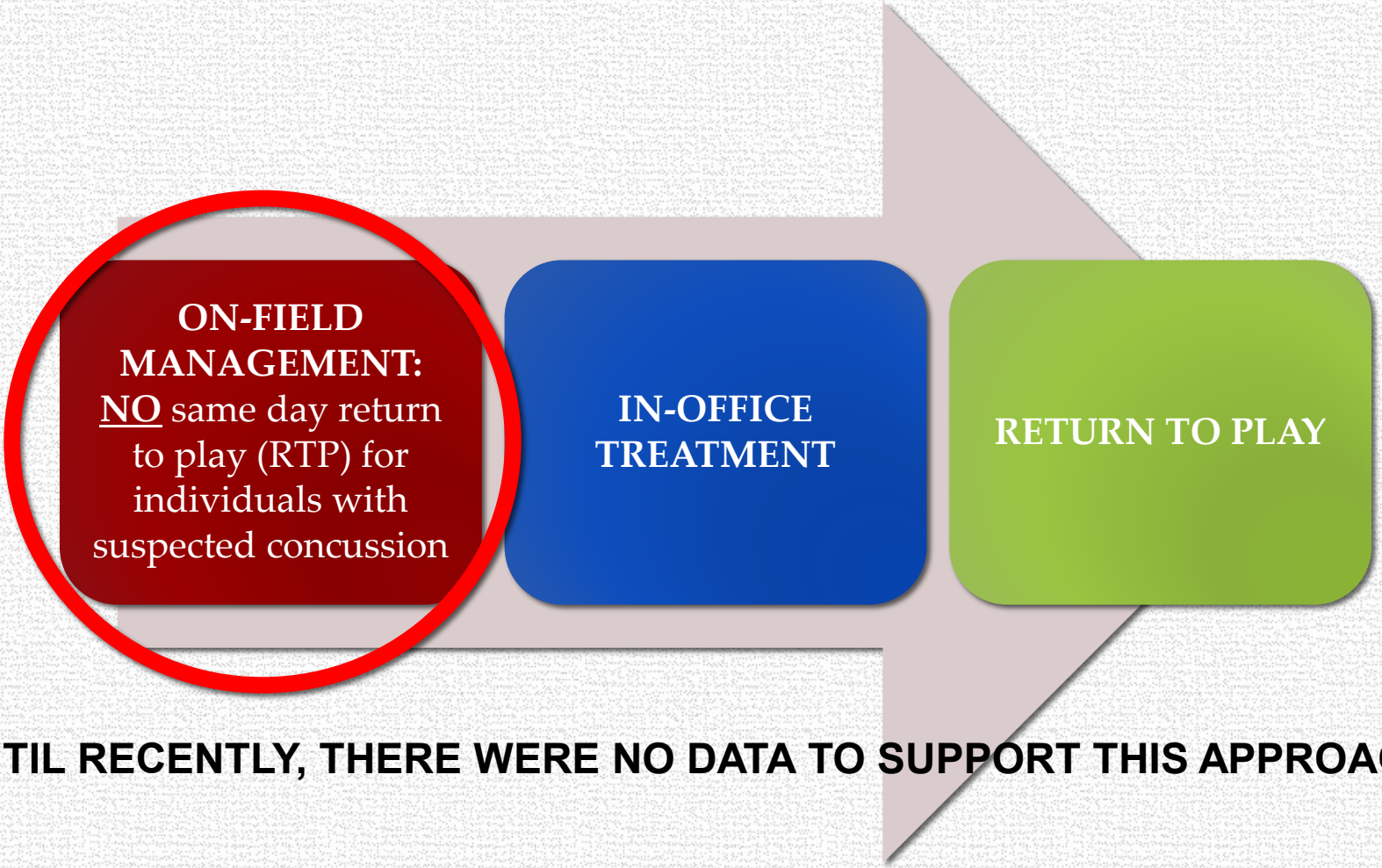
Arkansas Activities Association Concussion Guidelines

1. Every coach and registered volunteer must receive training on concussions once every three years.
2. Every athlete and parent must read and sign a "Concussion Fact Sheet for Athletes and Parents".
3. Any athlete who is suspected by their school's personnel or school medical staff of having a concussion should not return to play or practice on the same day.
4. Any athlete suspected of having a concussion should be evaluated by an appropriate healthcare professional that day (Neuropsychologist, MD, DO, Advanced Practice Nurse, Certified Athletic Trainer, or Physician Assistant).
5. Any athlete with a concussion should be medically cleared by an appropriate health-care professional prior to resuming participation in any practice or competition.
6. After medical clearance, return to play should follow a 5 day step-wise protocol for delayed return to play based upon the return of any signs or symptoms.

WHAT HAPPENS IF ATHLETES CONTINUE TO PLAY FOLLOWING CONCUSSION?

Elbin RJ, Sufrinko A, Schatz P, French J, McAlister C, Henry L, Collins MW, Kontos AP. Peds, 2016

Overview of Concussion Management and Treatment



UNTIL RECENTLY, THERE WERE NO DATA TO SUPPORT THIS APPROACH

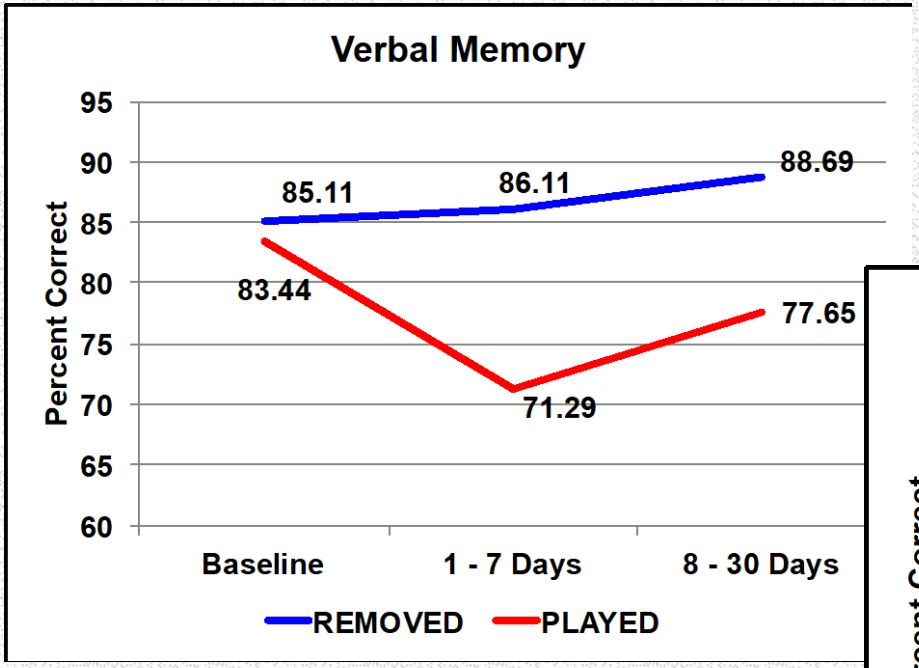
Study Overview

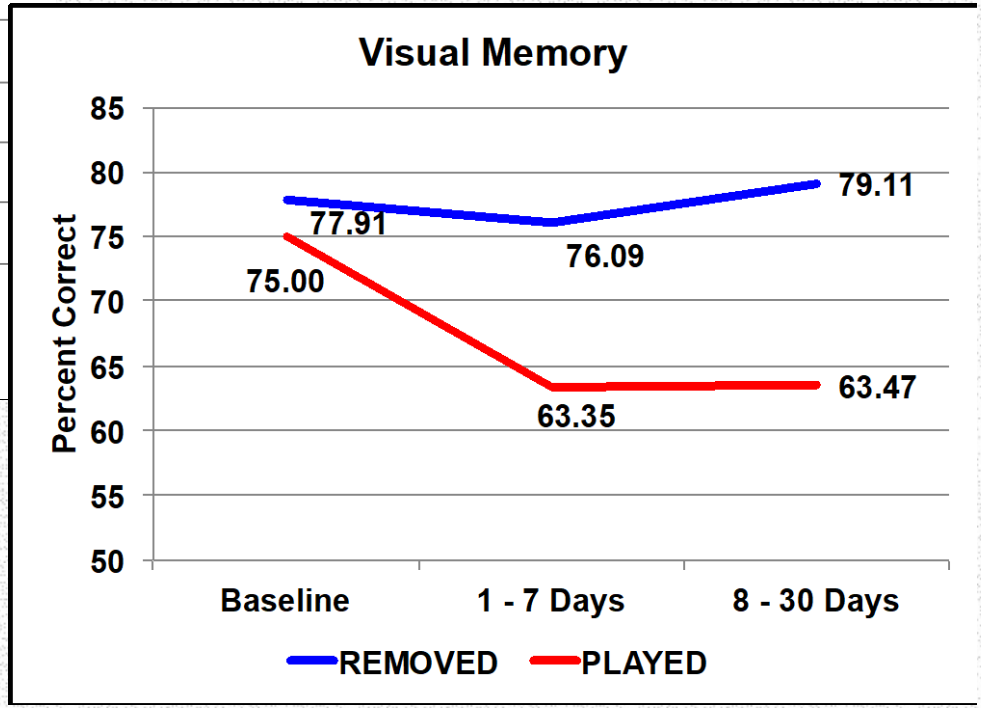
- **Research Design**
  - Prospective repeated measures (Baseline, 1 – 7, and 8 – 30 days post-injury)

- **Participants**
  - 69 athletes (12 – 19 yrs) with concussion were recruited from a concussion specialty clinic
    - 35 = REMOVED
    - 34 = PLAYED

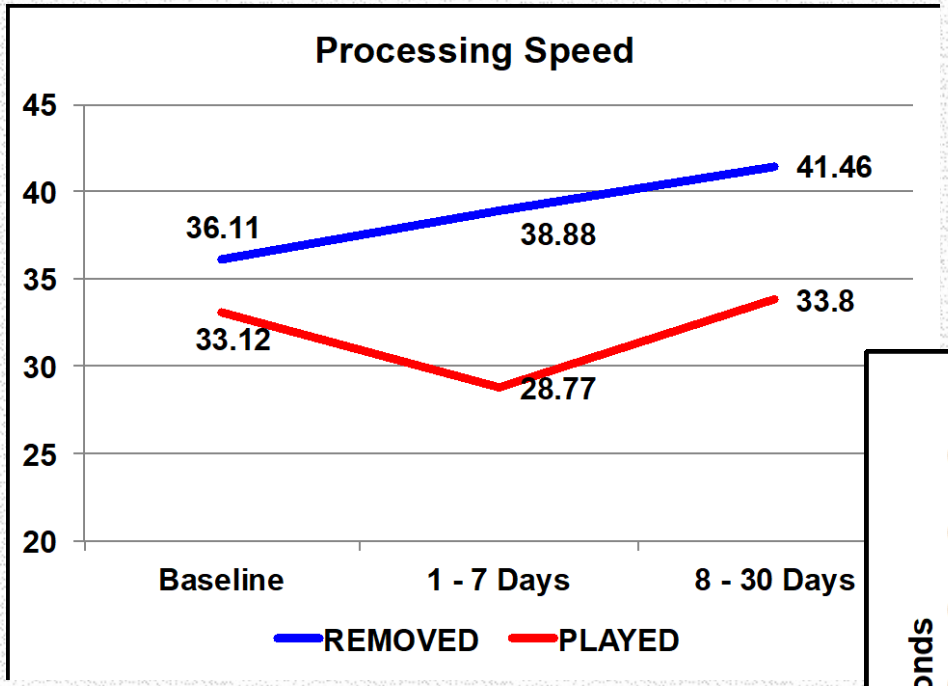
- **Measures**
  - Athletes completed neurocognitive (ImPACT) and symptom reports at 1-7 and 8-30 days; also collected recovery time data

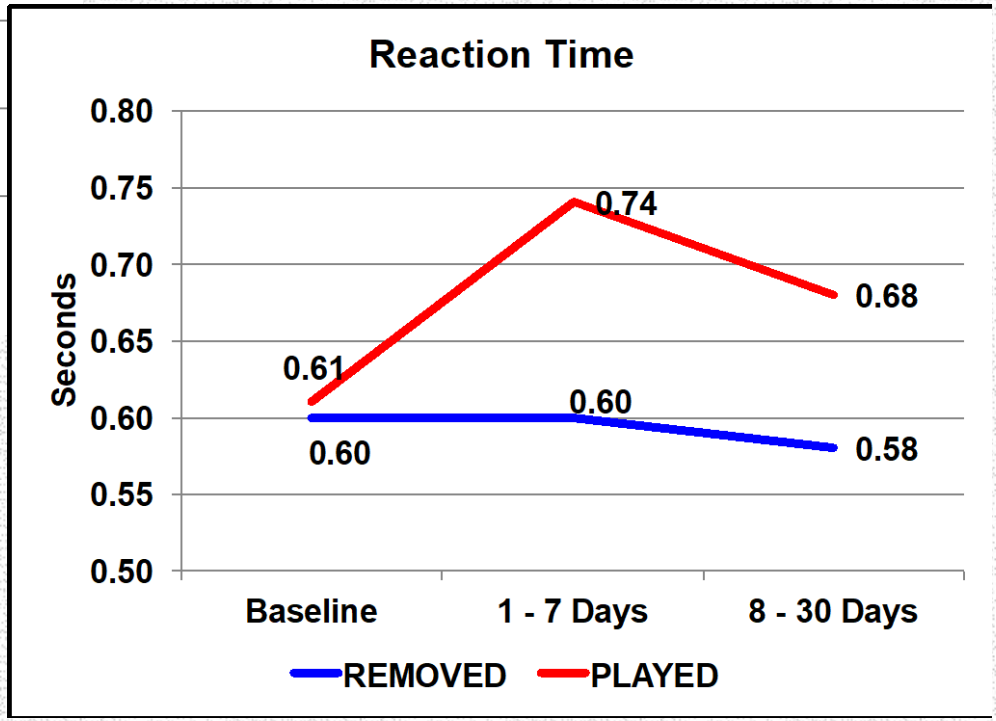
Results


Verbal Memory
Percent Correct
95
90
85
80
75
70
65
60
85.11
86.11
88.69
83.44
71.29
77.65
Baseline
1 - 7 Days
8 - 30 Days
REMOVED
PLAYED

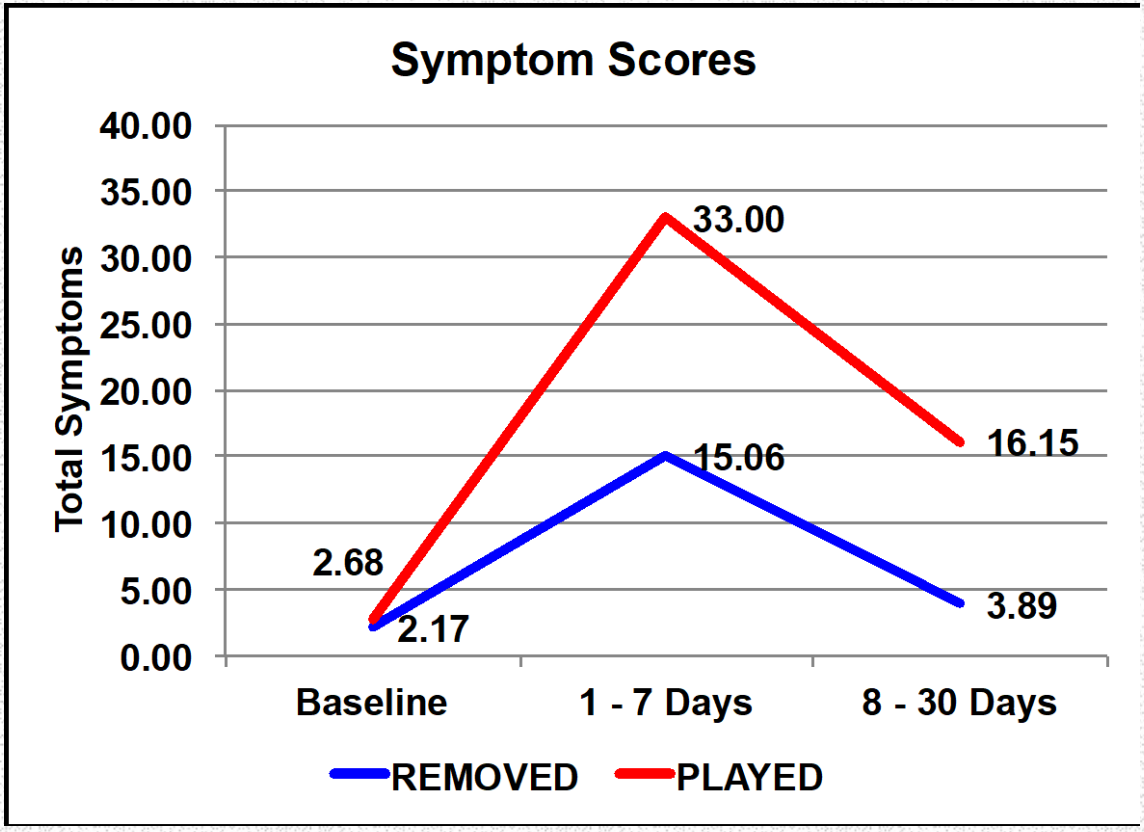

Visual Memory
Percent Correct
85
80
75
70
65
60
55
50
77.91
76.09
79.11
75.00
63.35
63.47
Baseline
1 - 7 Days
8 - 30 Days
REMOVED
PLAYED

Results


Processing Speed
45
40
35
30
25
20
36.11
38.88
41.46
33.12
28.77
33.8
Baseline
1 - 7 Days
8 - 30 Days
REMOVED
PLAYED


Reaction Time
Seconds
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.61
0.74
0.68
0.60
0.60
0.58
Baseline
1 - 7 Days
8 - 30 Days
REMOVED
PLAYED

Results


Symptom Scores
Total Symptoms
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
33.00
16.15
15.06
2.68
2.17
3.89
Baseline
1 - 7 Days
8 - 30 Days
REMOVED
PLAYED

Continuing to Play with Concussion DOUBLED Recovery Time

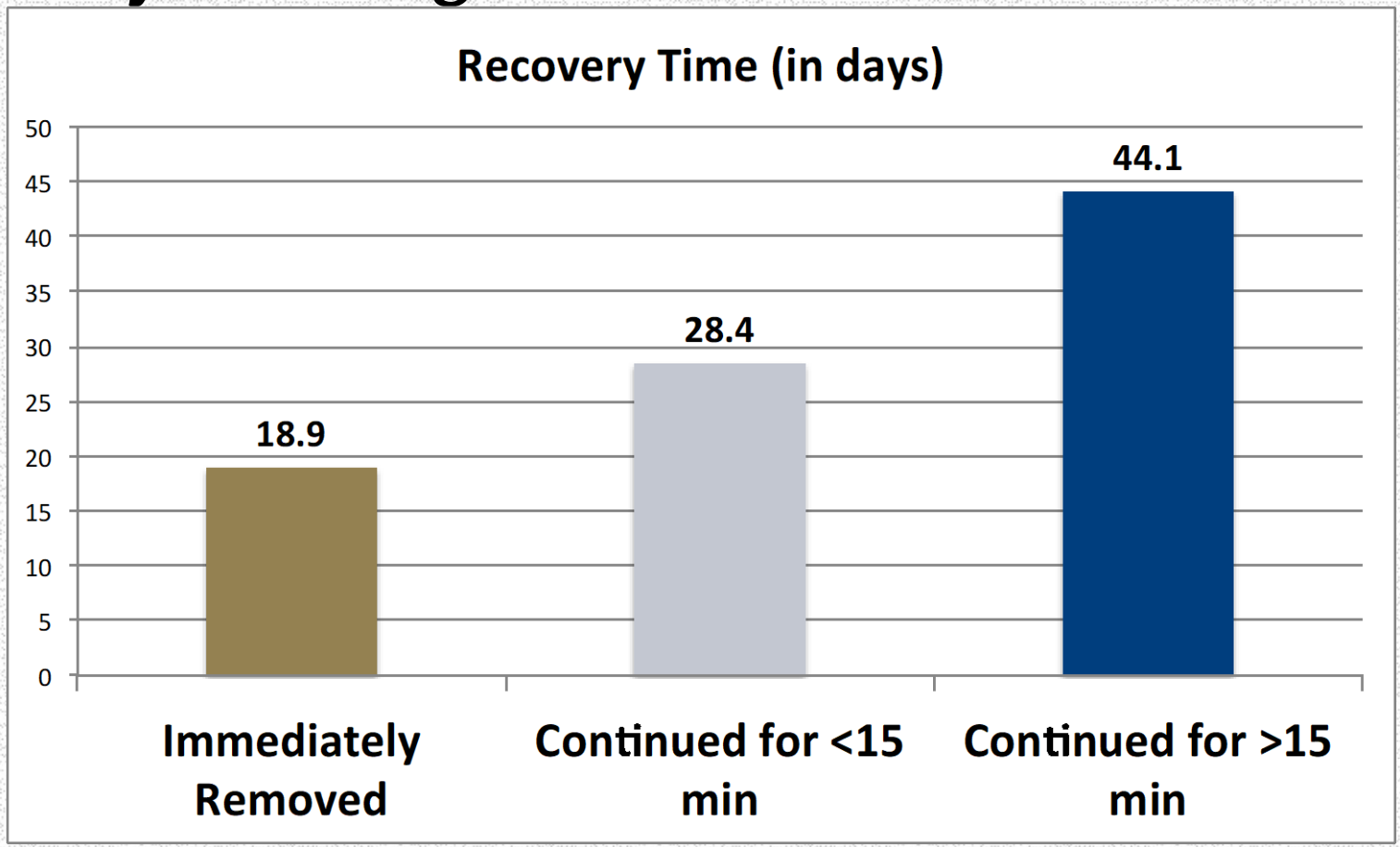
	REMOVED (n = 32)	PLAYED (n = 30)
Recovery Time*	21.97 ± 18.68 Days Range: 8 – 88	44.37 ± 36.03 Days Range: 10 - 164

*p = .001

Athletes that continued to PLAY with a concussion were 8.80 times more likely to have prolonged recovery ≥ 21 days ($\chi 2 = 14.86$, $p < .001$)

Elbin RJ, Sufrinko A, Schatz P, French J, McAlister C, Henry L, Collins MW, Kontos AP. Peds, 2016

Evidence for a Dose-response for Continuing to Play following Concussion



Continuing to play even for a few minutes extends recovery time.

Concussion Research Findings

- Continuing to play was associated with worse:
  - Memory, Reaction Time, Symptoms

- Athletes who "stay in the game" will take longer to recover

- Continuing for just a few minutes can have adverse effects on recovery time.

Box 1: Red Flags

- Neck pain or tenderness
- Seizure or convulsion
- Double vision
- Loss of consciousness
- Weakness or tingling/burning in more than 1 arm or in the legs
- Deteriorating conscious state
- Vomiting
- Severe or increasing headache
- Increasingly restless, agitated or combative
- GCS <15
- Visible deformity of the skull

THE ATHLETE HAS BEEN REMOVED…What happens next?

- EMS personnel are in an ideal situation to provide education and guidance for medical follow up
- How do we equip EMS to provide this information?
- How we assure the student/athlete:
  - safely returns to play?
  - safely returns to class?

BRAIN INJURY ASSOCIATION OF NC

PROGRESSION BASICS

SIMPLE STEPS WITH HUGE IMPACT

24 HOURS BETWEEN STEPS

Generally, each step should take at least 24 hours, so that, assuming the individual/athlete does not experience a recurrence of concussion symptoms at rest or with exercise as they progress through the exercise program, they will be able to return to activity/sports in about a week's time after symptoms have cleared.

FALL BACK IF SYMPTOMS RETURN

DON'T OVEREXERT

If the individual/athlete experiences a recurrence of concussion symptoms during any of the steps, they need to drop back to the previous level at which they were symptom-free, and try to progress again after a further 24-hour period of rest has passed.

SEEK ASSESSMENT & TESTING

A healthcare professional with concussion expertise might be a certified athletic trainer, school/team/primary care/sports medicine physician, or neuropsychologist.

COGNITIVE REST PERIOD

APPROPRIATE REST, MORE BENEFITS

Research indicates complete cognitive rest for up to 48 hours after injury. This means no phone, TVs, reading, activity, etc. After that period it is suggested to start moving and engaging slowly in the absence of symptoms.

ACCOMMODATION EXAMPLES

VOICE YOUR NEEDS

- Books on audio tape or text to speech software
- Detailed notes provided, written instructions or outline of material/project
- Extended time (for assignments, tests, projects, etc.)
- Preferential seating or environment change (with dividers, quieter area, more/less light, etc.)
- Modified schedule or flexible timing (leaving early, frequent breaks, remote work, etc.)
- Use of iPad/phone apps for reminders, lists, or calendar
- Breaking information into manageable chunks
- Noise cancelling headphones

RETURN TO ACTIVITY

AFTER CONCUSSION

SCHOOL, WORK, AND HOME

REST AFTER INJURY

Emphasis on cognitive and physical rest to allow the brain and body to rest as much as possible.

LIMITED ACTIVITY

Gradual reintroduction of regular activities that do not provoke any symptoms.

LIGHT TO MODERATE ACTIVITY

Increase cognitive activity building up to short intervals of cognitive work (5-15 minutes) at a time.

PART-TIME WITH ACCOMMODATIONS

Participation in environment (sitting & listening) with breaks, provided notes, flexible times, and focus on essential tasks.

FULL DAY WITH ACCOMMODATIONS

Gradually increase demands with greater amount, length of time, and difficulty as long as symptoms do not worsen.

FULL DAY WITHOUT ACCOMMODATIONS

Partial if not full accommodations removed when individual can participate fully in work at school, job, and/or at home without triggering symptoms.

RETURN TO ACTIVITY

Participation in normal activity.

SPORTS, ACTIVITY, AND EXERCISE

REST AFTER INJURY

Emphasis on cognitive and physical rest to allow the brain and body to rest as much as possible.

LIMITED ACTIVITY

Gradual reintroduction of regular activities that do not provoke any symptoms.

LIGHT AEROBIC EXERCISE

Increase heart rate - walking or stationary cycling at a slow to medium pace without resistance.

SPORT-SPECIFIC EXERCISE

Add movement with no head impact activities (i.e. skating, running).

NON-CONTACT TRAINING DRILLS

Progress to harder training drills/exercise with increased coordination and thinking; stop or slow if starting to experience symptoms.

FULL CONTACT PRACTICE

Following medical clearance, participate in normal training activities with close observation by coaches/staff.

RETURN TO PLAY

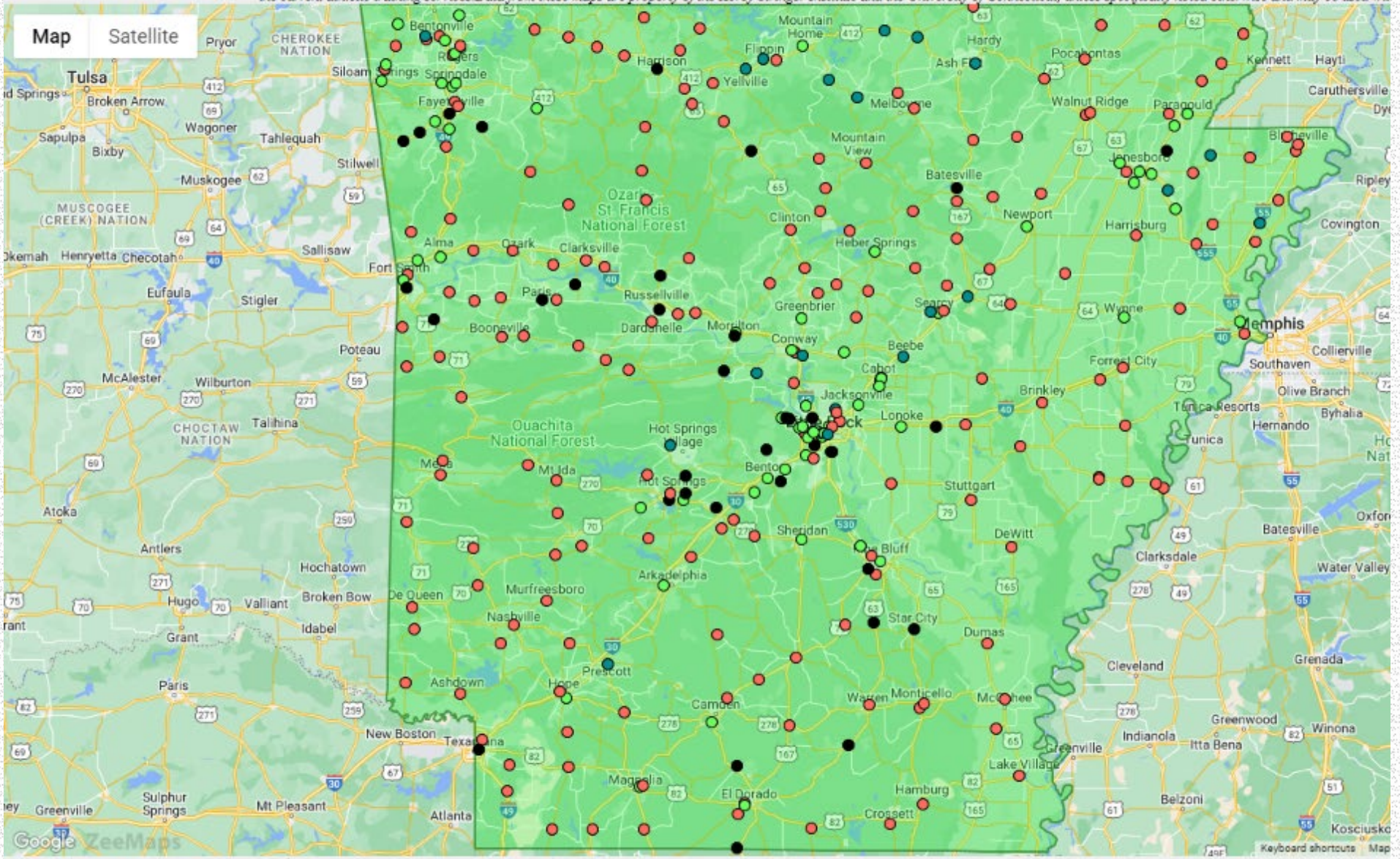
Participation in normal game play.

Present System of Care

- Athletic Intervention
  - Coaches and ATs
    - Return to Play
    - Return to School
- Parent Involvement
- Clinics
  - ACH Concussion Clinic
  - UAMS Northwest Sports Medicine
  - Local Family Practice
- Schools
  - Teachers, school nurses, administrators/counselors
- Brain Injury Program Call Center

Arkansas Athletic Training Locations & Services: A.T.L.A.S Project

Disclaimer: The information displayed in these maps were collected as a part of a research project entitled Athletic Training Services in Public Secondary Schools: A Benchmark Study partially (NATA) from 2012-2015 and were obtained from personal communication with a representative from each school. Data from 2015-present were obtained through an online self-report survey tak Korey Stringer Institute (KSI) with assistance from the NATA Secondary School Committee and its members. Depending on the last date of communication with each school and changes in medi the current athletic training services Data from these maps are property of the Korey Stringer Institute and the University of Connecticut, unless specifically noted otherwise and may be used wit



All | No Athletic Trainer | Part Time Athletic Trainer | Full Time Athletic Trainer | No Response/Unknown

How Might It Work:

- Before AAA events
- Pregame Safety Time Out

4

STEP 4: NEUROLOGICAL SCREEN

See the instruction sheet (page 7) for details of test administration and scoring of the tests.

Can the patient read aloud (e.g. symptom check-list) and follow instructions without difficulty?	Y	N
Does the patient have a full range of pain-free PASSIVE cervical spine movement?	Y	N
Without moving their head or neck, can the patient look side-to-side and up-and-down without double vision?	Y	N
Can the patient perform the finger nose coordination test normally?	Y	N
Can the patient perform tandem gait normally?	Y	N

BALANCE EXAMINATION

Modified Balance Error Scoring System (mBESS) testing[5]

Which foot was tested
(i.e. which is the non-dominant foot)

☐ Left
☐ Right

Testing surface (hard floor, field, etc.) _____

Footwear (shoes, barefoot, braces, tape, etc.) _____

Condition	Errors
Double leg stance	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at the back)	of 10
Total Errors	of 30

EMS Concussion Protocol

- Be an advocate
- Seek consent from parents/guardian
- Any suspicion of moderate-severe TBI
  - Initiate emergent care
- Release of Medical Information
  - Forward to School Administrator or School Nurse
  - Forward to Licensed Professional with Concussion Training
- Provide parents/guardian with medical support information

EMS & EMS Medical Director Considerations

- This may be a culture change for EMS at high school sporting events.
- EMS professionals will NOT make a diagnosis.
- The SCAT5 (Sports Concussion Assessment Tool) is merely an evaluation tool.
- We'll also need to address EMR and sharing of personal information
  - An information and routing form must be available to parents at the scene
  - A copy should be forwarded to the School Administrator or School Nurse
- EMS professionals must be aware of the medical and educational supports for pediatric concussion in their respective communities (i.e. pediatric clinics, school nurses, etc)
- Language must be specific to protect EMS from litigation.

Field Assessment

- SCAT5 Neurological Assessment
- Check memory by asking months of the year and start with December and go backwards.
- Recognize and Remove
- A head impact by either a direct blow or indirect transmission of force can be associated with a serious and potentially fatal brain injury. If there are significant concerns, including any of the red flags listed in Box 1, then activation of emergency procedures and urgent transport to the nearest hospital should be arranged.

AAA Return to Play Protocol

MEDICAL RELEASE FOR GRADUATED RETURN TO PLAY PROTOCOL

Student Name _____ Date of Birth_____ Grade_____ Date of Injury_____

Sport Injury Details_____

_____

Student is cleared to initiate and proceed through the protocol as detailed below after a full day of normal activity with no symptoms. Follow the gradual and progressive steps of the training sequence below. There should be at least 24 hours between each step. If any symptoms return at any time during these activities, stop the workout. Rest until symptom-free for 24 hours then return to the previous asymptomatic step. If symptoms return or worsen, seek medical attention.

Other information _____

Completed by (print name)_____Signature_____ Date_____

____Neuropsychologist ____ MD ____ DO ____ Nurse Practitioner ____ Certified Athletic Trainer ____Physicians Assistant

GRADUATED RETURN TO PLAY PROTOCOL / SUPERVISED BY SCHOOL PERSONNEL

STEP	DATE COMPLETED	ACTVITIY	COMMENTS
1. Light general conditioning exercises (Goal: Increase heart rate).		*Begin with sport specific warmup. Do 15-20 minute workout: stationary bicycle, fast paced walking or light jogging, rowing or freestyle swimming *Attend full day of school if in session.	
2. Moderate general conditioning and sport specific skill work; individually (Goal: add movement, individual skill work).		*Sport specific warm-up. Slowly increase intensity and duration of workout 20-30minutes. Begin sport specific skill work within the workout. No spins, dives or jumps. *Attend full day of school if in session.	
3. Heavy general conditioning, skill work; individually & with teammate. NO CONTACT. (Goal: Add movement, teammate skill work).		*Continue with general conditioning up to 60 minutes. Increase intensity and duration. Begin interval training. -Continue individual skill work. -Begin skill work with partner-no contact. -Continue with individual skill work as in Step 2. *Attend full day of school if in session.	
4. Heavy general conditioning, skill work and team drills. No live scrimmages. VERY LIGHT CONTACT (Goal: Team skill work, light static contact).		*Resume regular conditioning and duration of practice. -Increase interval training and skill work as required -Gradually increase skill level of spins, dives, jumps -Review team plays with no contact. -Very light contact and low intensity on dummies *Attend full day of school if in session.	
5. Full team practice with body contact		*Participate in a full practice. If a full practice is completed, discuss with the coach about getting back in next game. *Attend full day of school if in session.	

I verify Graduated Return to Play Protocol has been completed. Signature_____ Date _____

*** Recommended by AAA Sports Medicine Advisory Committee to keep Medical Release forms for 3 years.**

AAA Return to Learn

Directions: Use a team approach with the student's teachers, coach, AT, counselor, assistant principal, and nurse to complete this form based on needs and symptoms. Have the student track symptoms. Most symptoms resolve by 28 days, during which students may need adjustments in the classroom. Closely monitor the student's progress and reconvene the team as needed. The goal is to engage the student as much as possible while keeping below their symptom threshold. Give this form to all teachers. This form is not intended to diagnose a TBI and is not inclusive of all possible adjustments.

Signature of assigned staff member:_____ **Student Name:**_____ **Date:**_____

Return to School Progression: Mild TBI/Concussion

Attendance plan https://tinyurl.com/tbidays	1. No school until:	2. Partial days (as tolerated by student) until: Hours:
Physical limitations:	No P.E. until:	Alternate P.E. plan*:
	No recess until:	Alternate recess plan*:
*Try to promote social interaction/reduce isolation. Ex: quiet play with peer, board games, coach's helper, walk the track/gym with peer.		

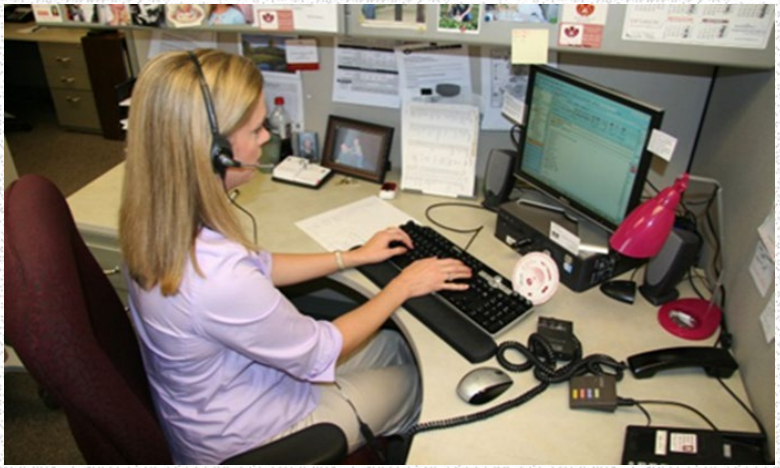
Areas of concern	Suggested adjustments for Return to School (circle all needed)	What adjustments were made and when
Fatigue (Tired), specifically mental fatigue and brain fog	• Allow student to go to quiet area as needed (for exams, etc) • Schedule rest breaks, offer water/ snacks to keep student nourished • Provide copies of notes as alternative to student note-taking • Reduce workload to essential assignments/content (odd/even problems)	
Difficulty with attention and concentration	• Simplify tasks or break into segments, checklists • Extra tutoring/assistance • Reduce workload to essential assignments/content (odd/even problems) • Allow alternate ways to demonstrate knowledge (presentation vs. essay)	
Slow to process or understand/ slowed reading or calculating	• Provide extended time to complete assignments • Check in more frequently to make sure student is not off track • Work with a peer buddy • Use audiobooks/screenreaders/calculators	
Difficulty with memory	• Simplify tasks, provide copies of notes, written checklist • Reduce overall amount of in-class work or (no) homework • Repeat or break-up assignment • True/false, multiple choice, matching, fill in the blank w/ word bank & test questions	
Emotional symptoms (i.e. anxiety, irritability)	• Develop an emotional support plan for the student (w/escalation plan) • Schedule time with school counselor/identified staff member • Reassurance from staff	
Difficulty with balance/dizziness	• Transition before bell/avoid hallways • Elevator pass, alternate route to classes	
Headache	• Offer rest breaks and if no improvement, shorten the school day • Allow time and space for short naps (like nurse's office)	
Light/noise sensitivity	• Wear sunglasses/hat, visor, seating away from bright sunlight, ear plugs • Limit exposure to noise and crowds (lunchroom, hallway, etc.)	

For assistance, contact arbraininjury.org Resources: REAP: https://reapconcussion.com/, Return to School: https://returntoschool.org/

Return to Learn & Return to Play

- Return to Learn
  - https://5starassets.blob.core.windows.net/multi-media/4/stateassociationhub/Return%20to%20Learn.pdf
- Return to Play
  - https://drive.google.com/file/d/1NQrRbVjCwWK30W2E5Kp-a5Dt9tunUzQM/view

Brain & Spine Call Center



- FREE 24/7 Nurse Call Center for medical questions related to SCI or TBI
- For:
  - Individuals living with SCI or TBI
  - Healthcare Professionals
  - Families

855-767-6983

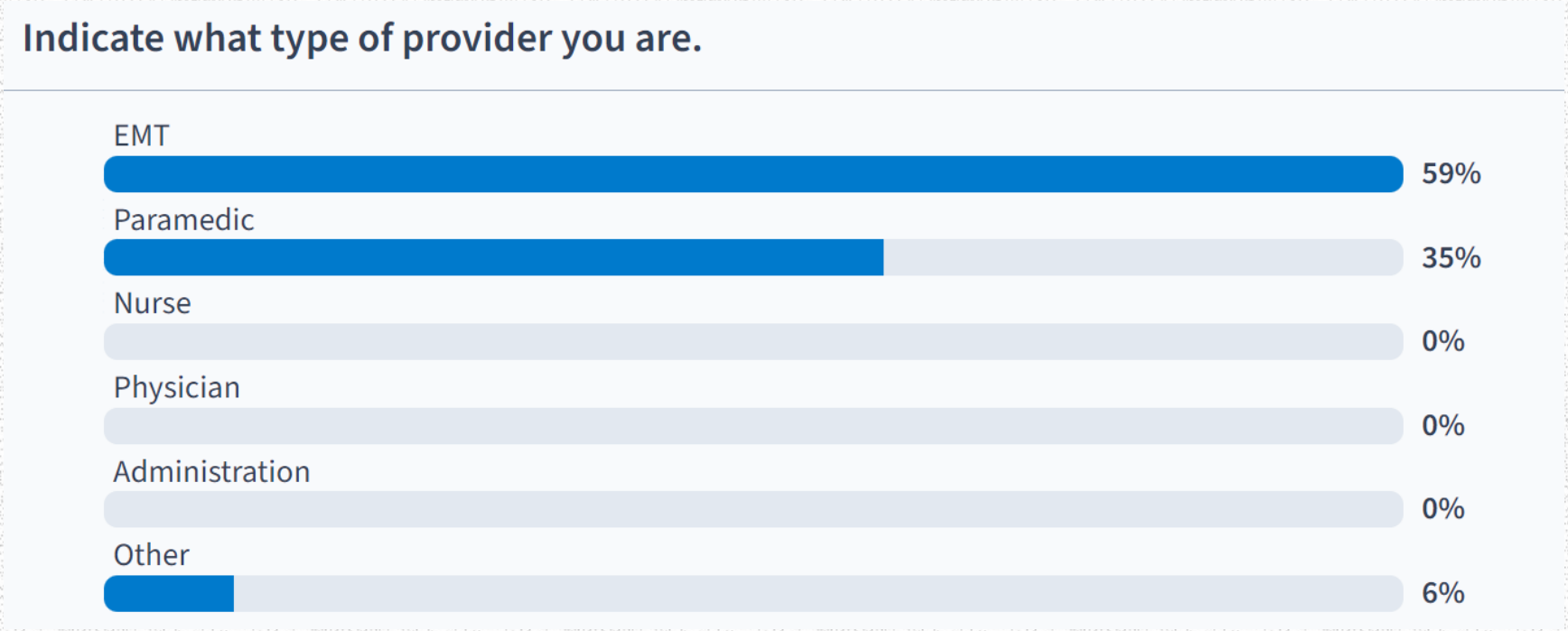
UAMS | Institute for Digital Health & Innovation

Brain Injury Program

Let's find out what you think!

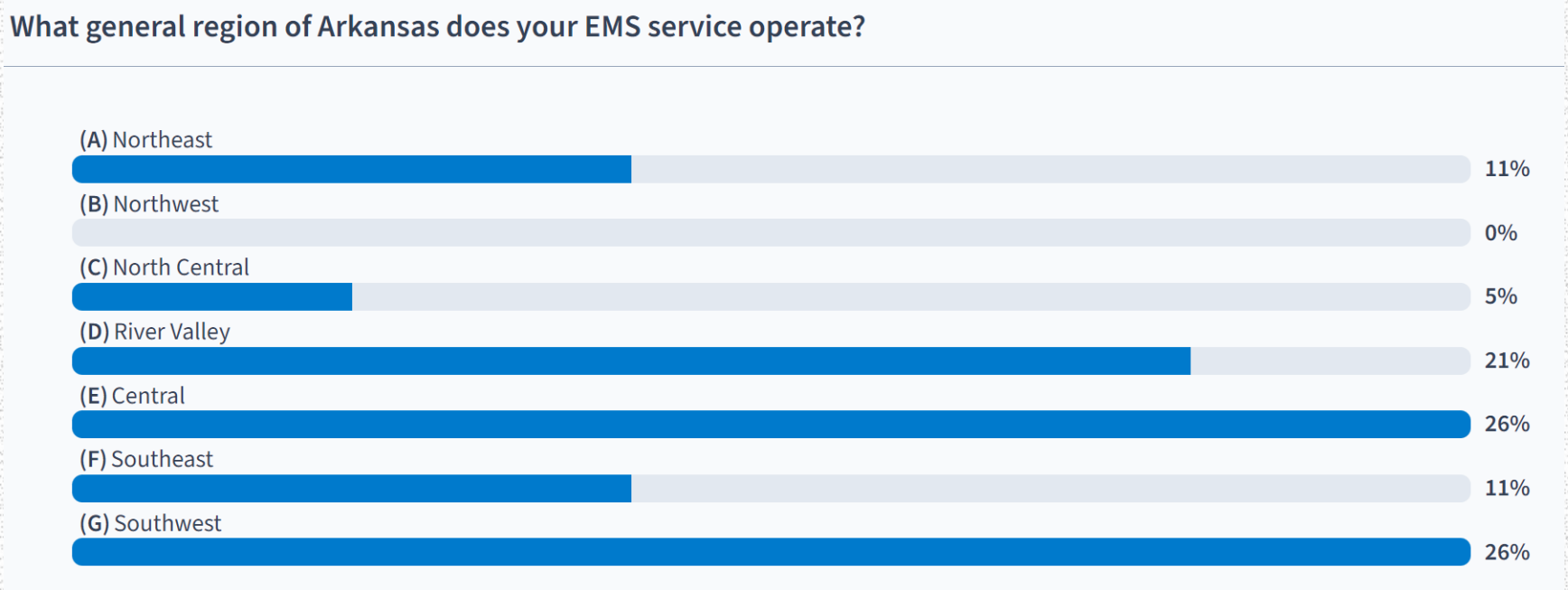
- Join by Web
  - **PollEv.com/dannybercher034**
- Join by Text
  - Send **dannybercher034** to **22333**
- Join by QR code

EMSP Responses: Provider Type



n=17

Trauma Region



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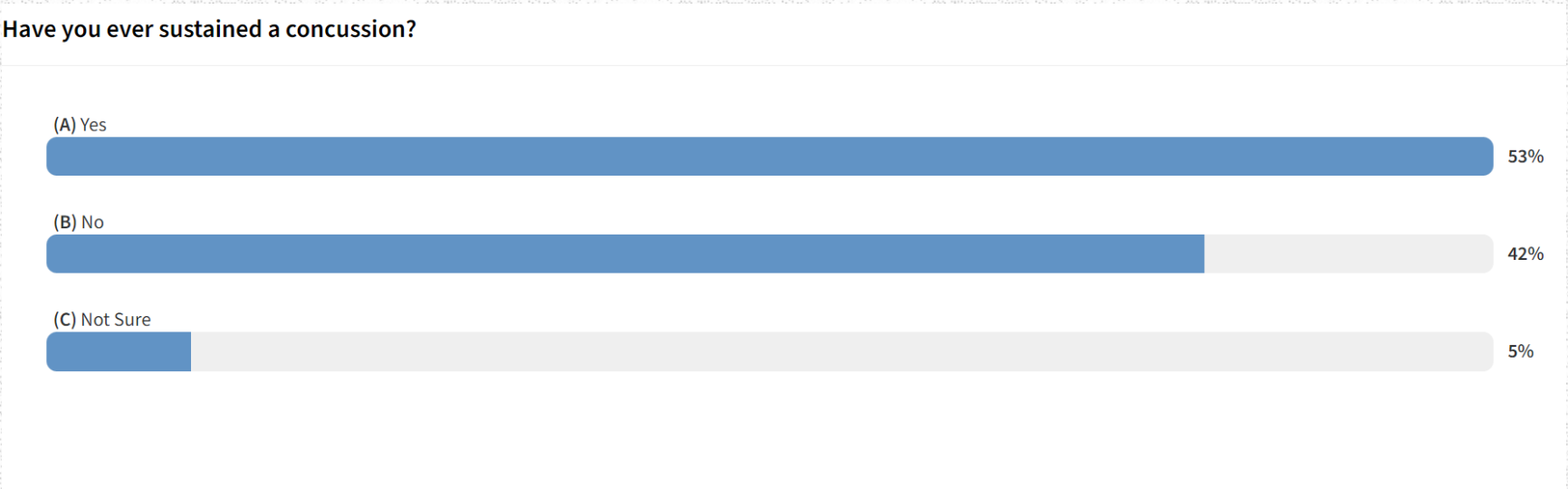
Concussion Hx



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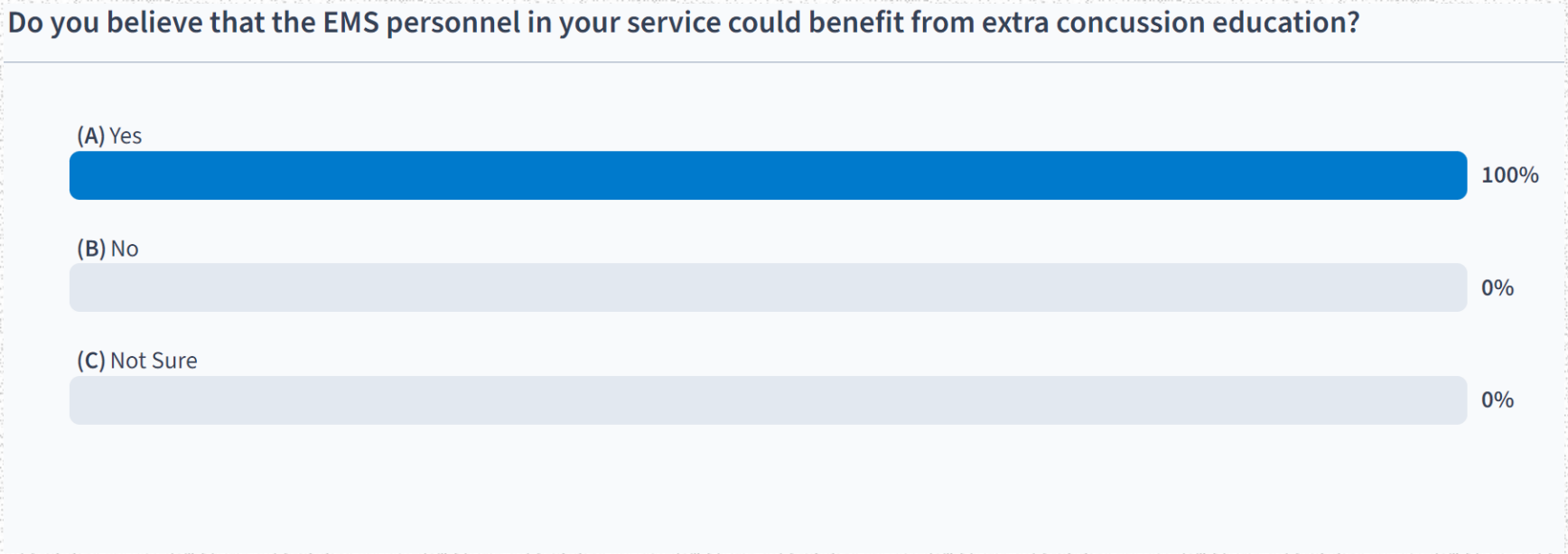
AAA Rule Awareness

n=18

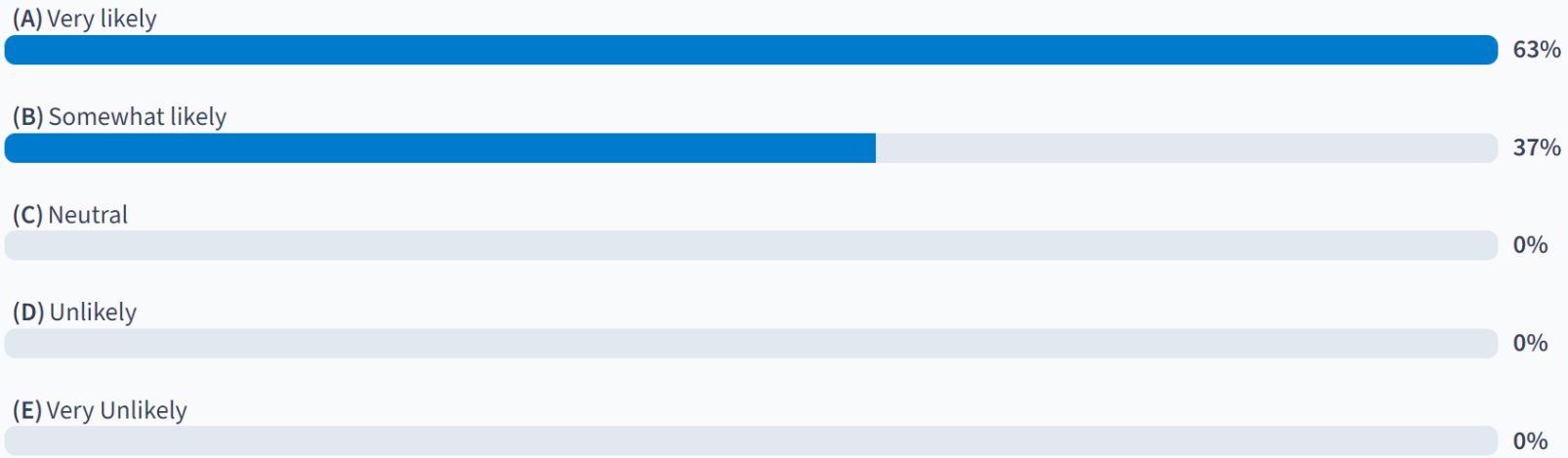
Concussion Education



n=18

Service Involvement

Would you be interested in your EMS service being involved in active assessment and intervention for student athlete sports concussion incidents in the future?



n=19

Questions?

dlbercher@uams.edu

Thank you!

References

- Bruns Jr, J., & Hauser, W. A. (2003). The epidemiology of traumatic brain injury: a review. *Epilepsia*, *44*, 2-10.
- Elbin RJ, Sufrinko A, Schatz P, French J, Henry L, Burkhart S, Collins MW, Kontos AP. Removal From Play After Concussion and Recovery Time. *Pediatrics*. 2016 Sep;138(3):e20160910. doi: 10.1542/peds.2016-0910. PMID: 27573089; PMCID: PMC5005026.
- Steenerson, K., & Starling, A. J. (2017). Pathophysiology of sports-related concussion. *Neurologic clinics*, *35*(3), 403-408.