

A stylized, light blue brain graphic is centered in the background. It is overlaid with a network of thin, glowing blue lines that resemble neural pathways or circuitry. The background is a dark blue gradient with a subtle grid pattern.

A Multimodal, Regenerative Approach to Traumatic Brain Injury

Dr. John C. Hughes, D.O.

OMED 2018 – San Diego, CA

October 8th, 2018

The background of the slide features a series of thin, curved lines in a light gray color, creating a sense of motion or a globe-like pattern. These lines are more prominent on the left side and fade towards the right.

Disclaimer

I have no relevant financial relationships with any commercial interests to disclose.

The content of this presentation has been peer reviewed for fair balance and evidence based medicine.

Learning Objectives

Define

Define the clinical, biochemical and metabolic effects from TBI

Identify

Identify mainstream and alternative treatments for TBI

Understand

Understand the regenerative model of TBI treatment

Clinical Symptoms from TBI



Physical

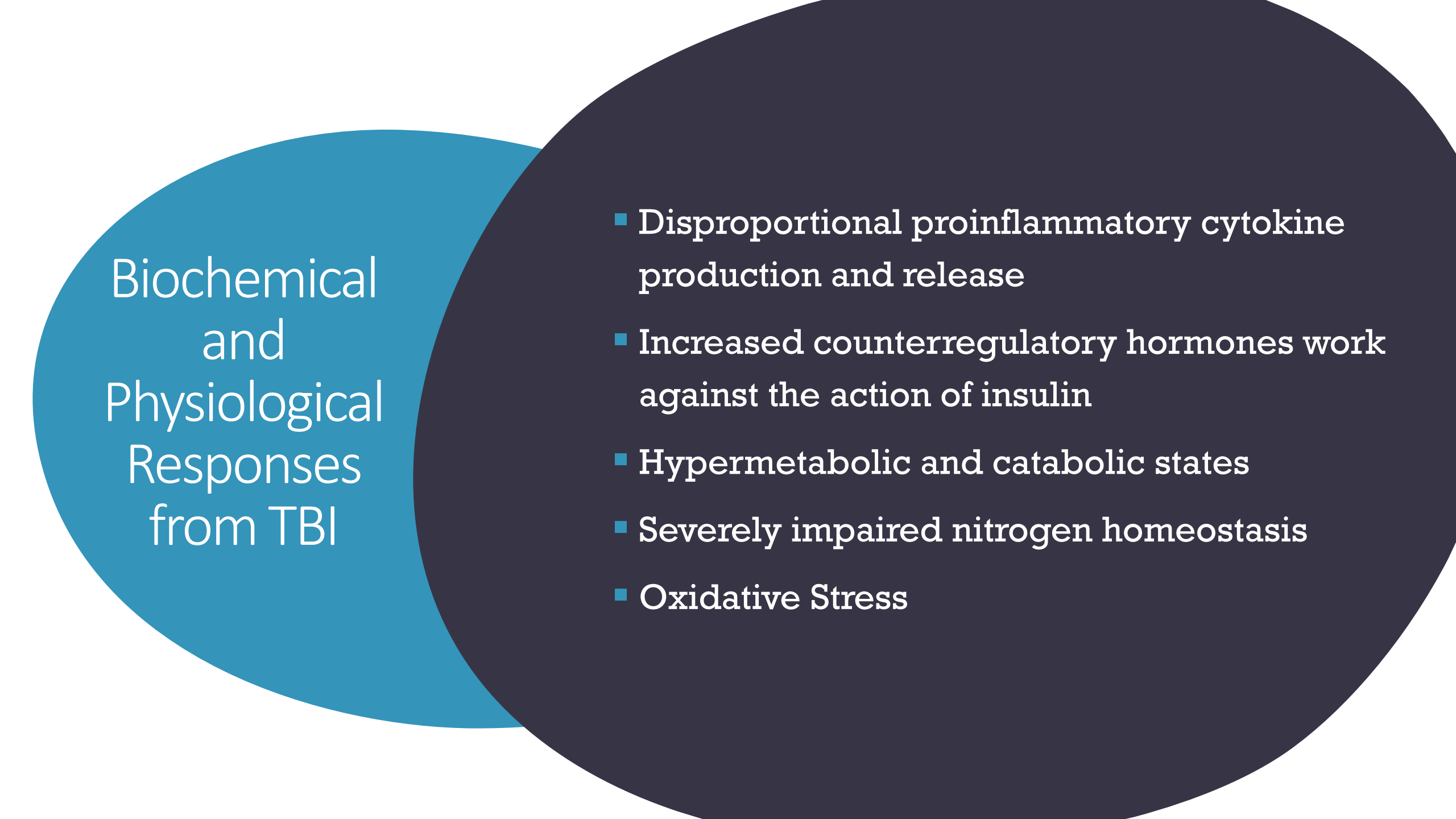
Headache
Fatigue
Sleep disorders
Vertigo or dizziness
Tinnitus or hyperacusis
Photosensitivity
Anomia
Reduced tolerance to psychotropic medications
Disorientation
Loss of mobility
Seizures
Loss of smell

Cognitive

Memory decline / loss
Slow reaction time
Inability to pay attention
Executive dysfunction
Slow learning
Interrupted speech
Difficulty understanding
Unable to concentrate
Confusion
Difficulty communicating thoughts
Unable to plan, reason, problem-solve

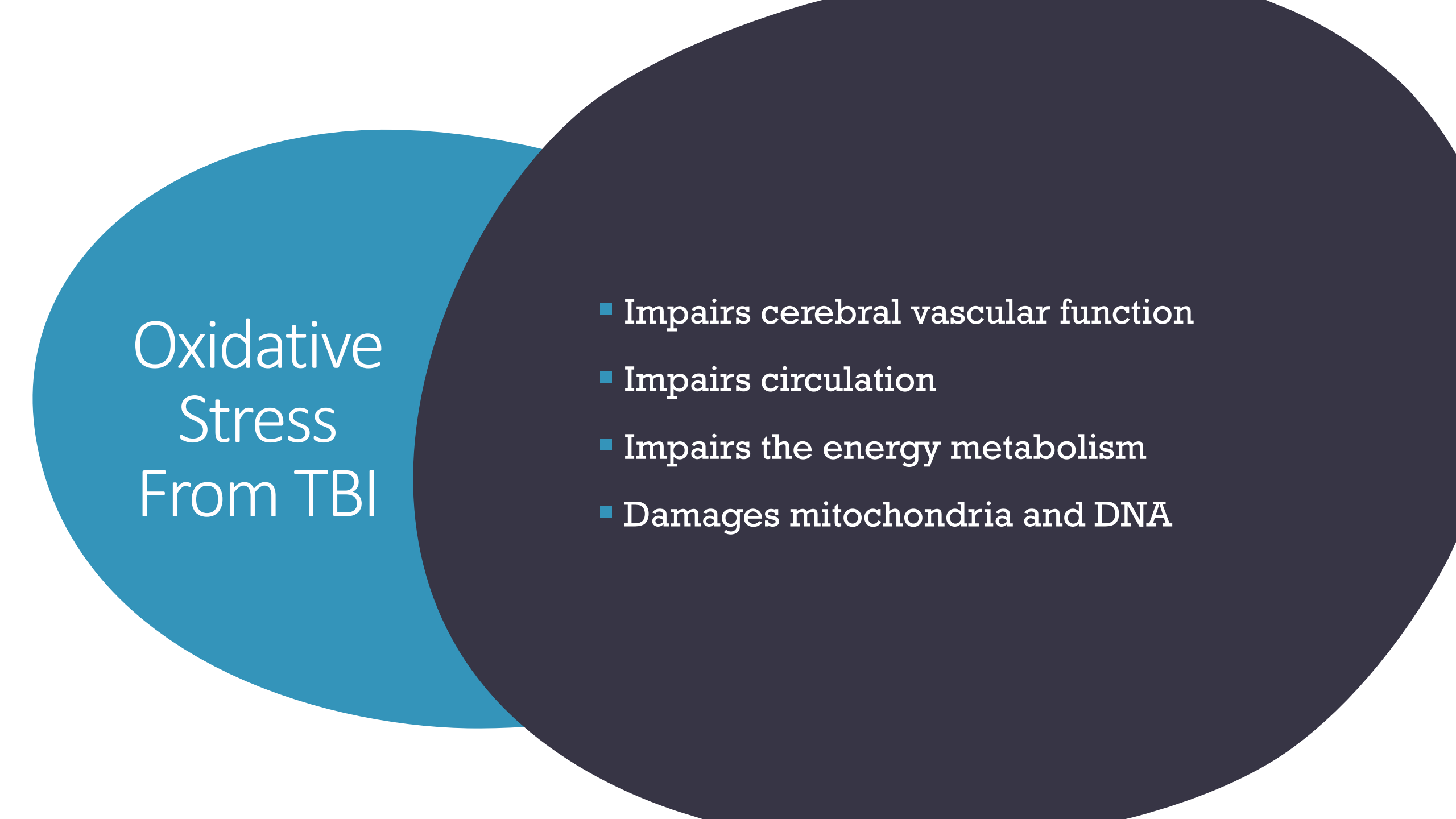
Psychological

Irritability
Easy frustration
Tension
Anxiety
Affective lability
Personality changes
Disinhibition
Apathy
Suspiciousness
Suicidality
Depression
PTSD



Biochemical and Physiological Responses from TBI

- Disproportional proinflammatory cytokine production and release
- Increased counterregulatory hormones work against the action of insulin
- Hypermetabolic and catabolic states
- Severely impaired nitrogen homeostasis
- Oxidative Stress



Oxidative Stress From TBI

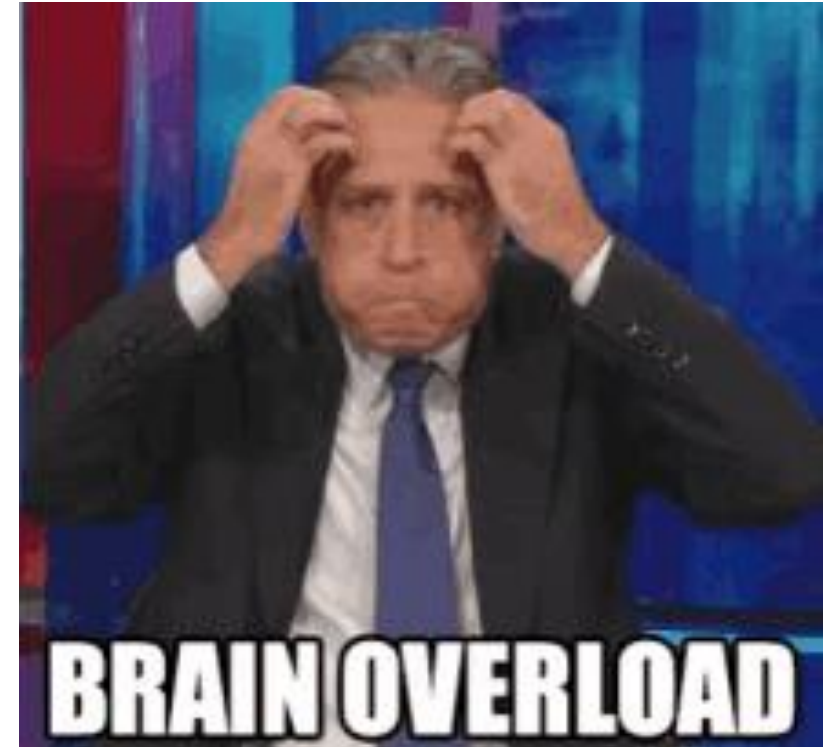
- Impairs cerebral vascular function
- Impairs circulation
- Impairs the energy metabolism
- Damages mitochondria and DNA

What Happens Metabolically with a TBI?

“The brain is in a metabolic crisis in a concussion, potassium ion from inside the cell going extracellular, calcium ions going intracellular, neurotransmitters widely released in a chaotic manner. It takes energy to pump that potassium back, put the neurotransmitters back on so the cell can function.”

Dr Robert Cantu, MD

An Energy Crisis





Mainstream Treatments

- Occupational and physical rehabilitation
- Speech therapy
- Pharmaceutical drugs
- Cognitive maintenance exercises
- Patients resign to simply cope with their condition as they reach a plateau of overall treatment benefit.

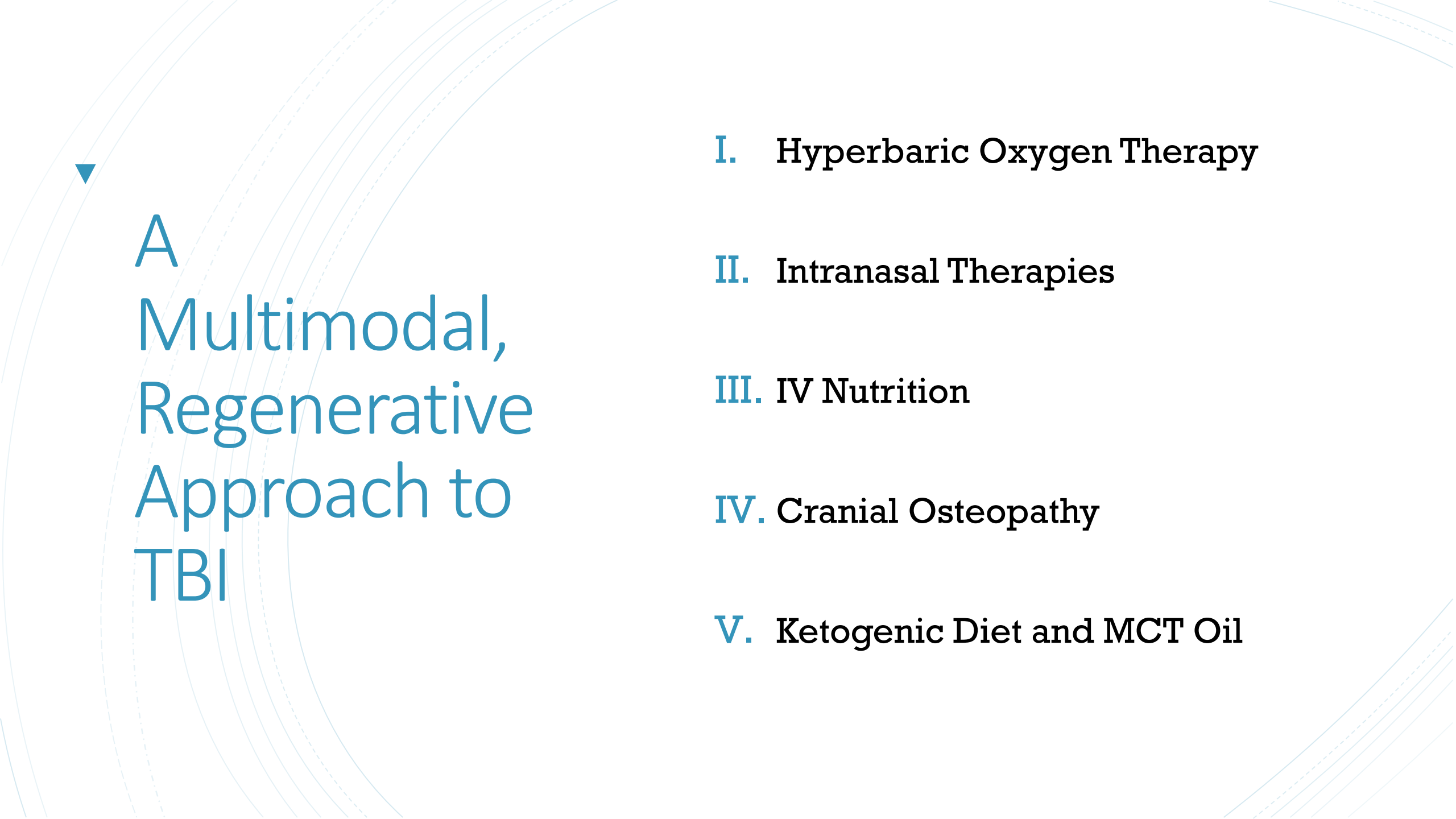
Alternative Treatments



- Do not seek to regenerate but rather simply treat symptoms
- Do not combine regenerative treatments in a multimodal manner in order to maximize patient benefit
- Singular treatments can be prohibitive for patients and their families, both in cost and time

A Multimodal, Regenerative ▼ Approach to TBI

It is hypothesized that the practical, effective combination of multiple regenerative TBI therapies can produce synergistic benefits to the patient that exceed the use of one particular TBI treatment.



A Multimodal, Regenerative Approach to TBI

I. Hyperbaric Oxygen Therapy

II. Intranasal Therapies

III. IV Nutrition

IV. Cranial Osteopathy

V. Ketogenic Diet and MCT Oil

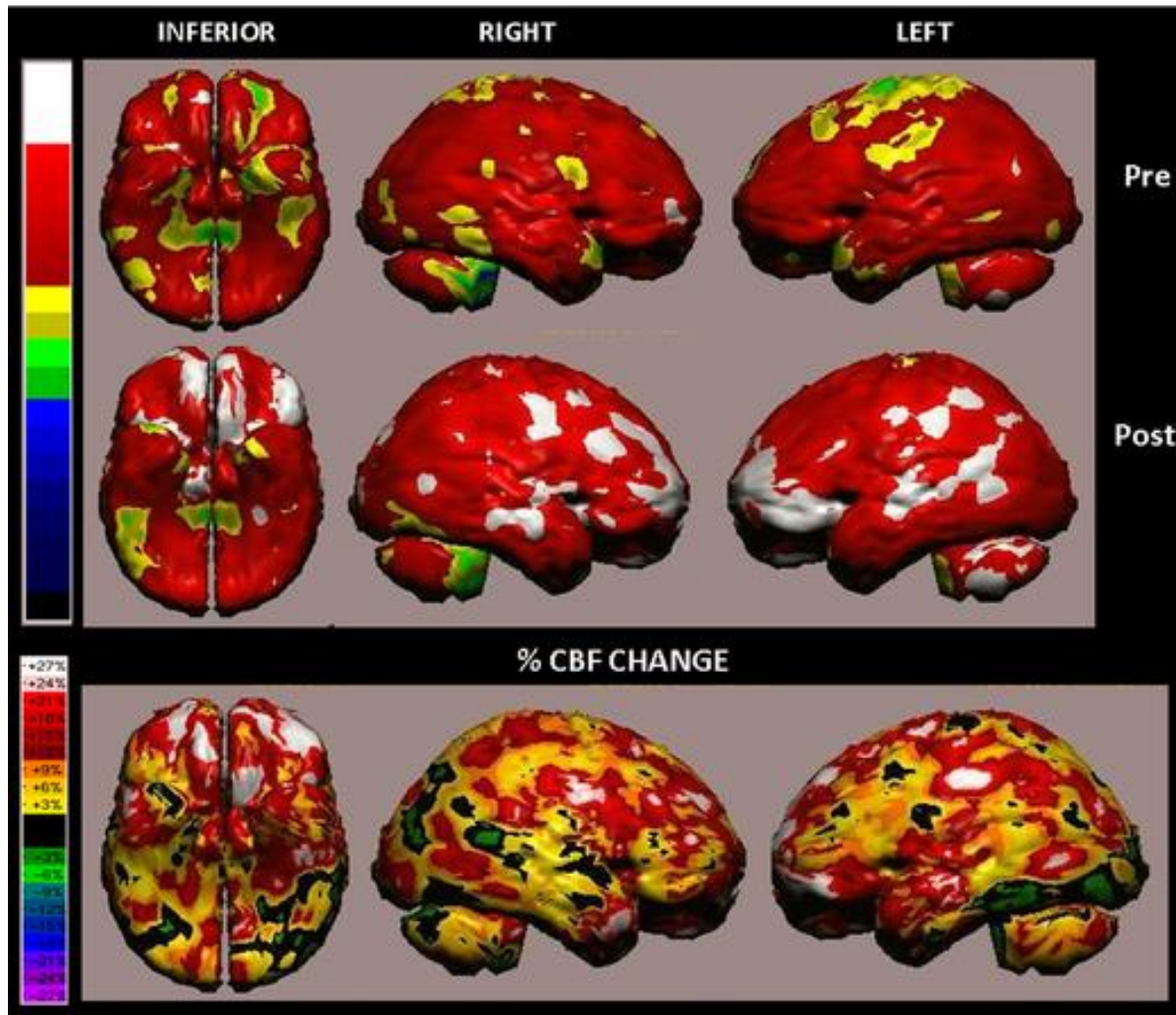
A photograph of a hyperbaric oxygen chamber. The chamber is white with a large, rounded rectangular window. Inside, there is a blue sheet covering the floor and a white pillow on the left side. The window is divided into two horizontal sections by a thin white line. The top section contains the text 'Part I' and the bottom section contains the text 'Hyperbaric Oxygen Therapy (HBOT) for TBI'.

Part I

Hyperbaric Oxygen Therapy (HBOT) for TBI

Hyperbaric Oxygen Therapy (HBOT)

- Allows the body to absorb about 10-15 times its normal supply of oxygen
- Stimulates the growth of tissue, bone and blood vessels, and reduces inflammation



Volume rendered Brain SPECT perfusion maps of a 51-year-old woman suffering from mTBI that had occurred 2 years prior to inclusion in the study

HBOT for TBI

- Induces neuroplasticity
- Increases tissue oxygenation
- Generates new capillary networks
- Restores blood supply
- Increases stem cells in the blood

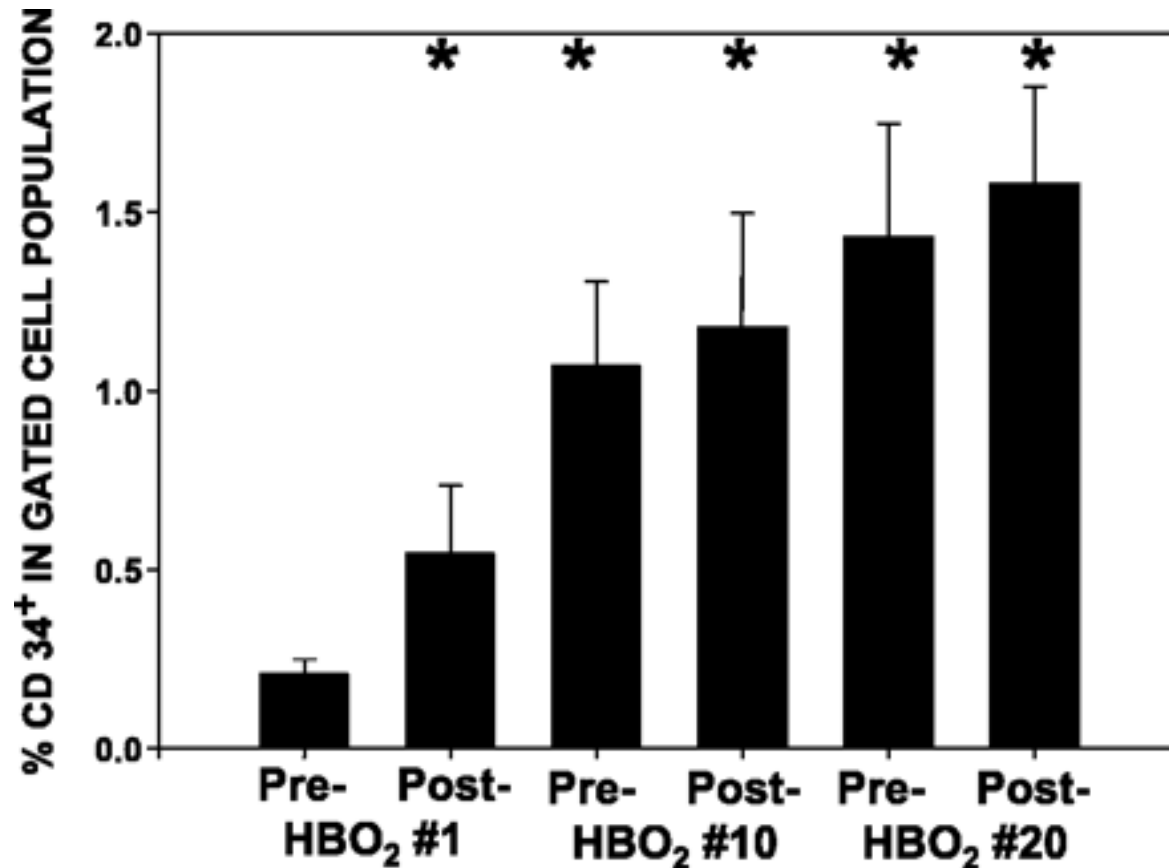


HBOT Mobilizes Stem Cells

- 2 hours of HBOT triples the patients own circulating stem cells
- 20 sessions of HBOT increases circulating stem cells to 8 fold (800%)

Thom, S. R., Bhopale, V. M., Velazquez, O. C., Goldstein, L. J., Thom, L. H., & Buerk, D. G. (2006). Stem cell mobilization by hyperbaric oxygen. *American Journal of Physiology-Heart and Circulatory Physiology*, 290(4), H1378-H1386.

Mean CD34+ population
in blood of humans
before and after HBO2
treatments.



- Data are the fraction of CD34+ cells within the gated population using leukocytes obtained from 26 patients before and after their 1st, 10th, and 20th HBO2 treatment.



STEPHEN THOM, MD, PH.D. (2005)

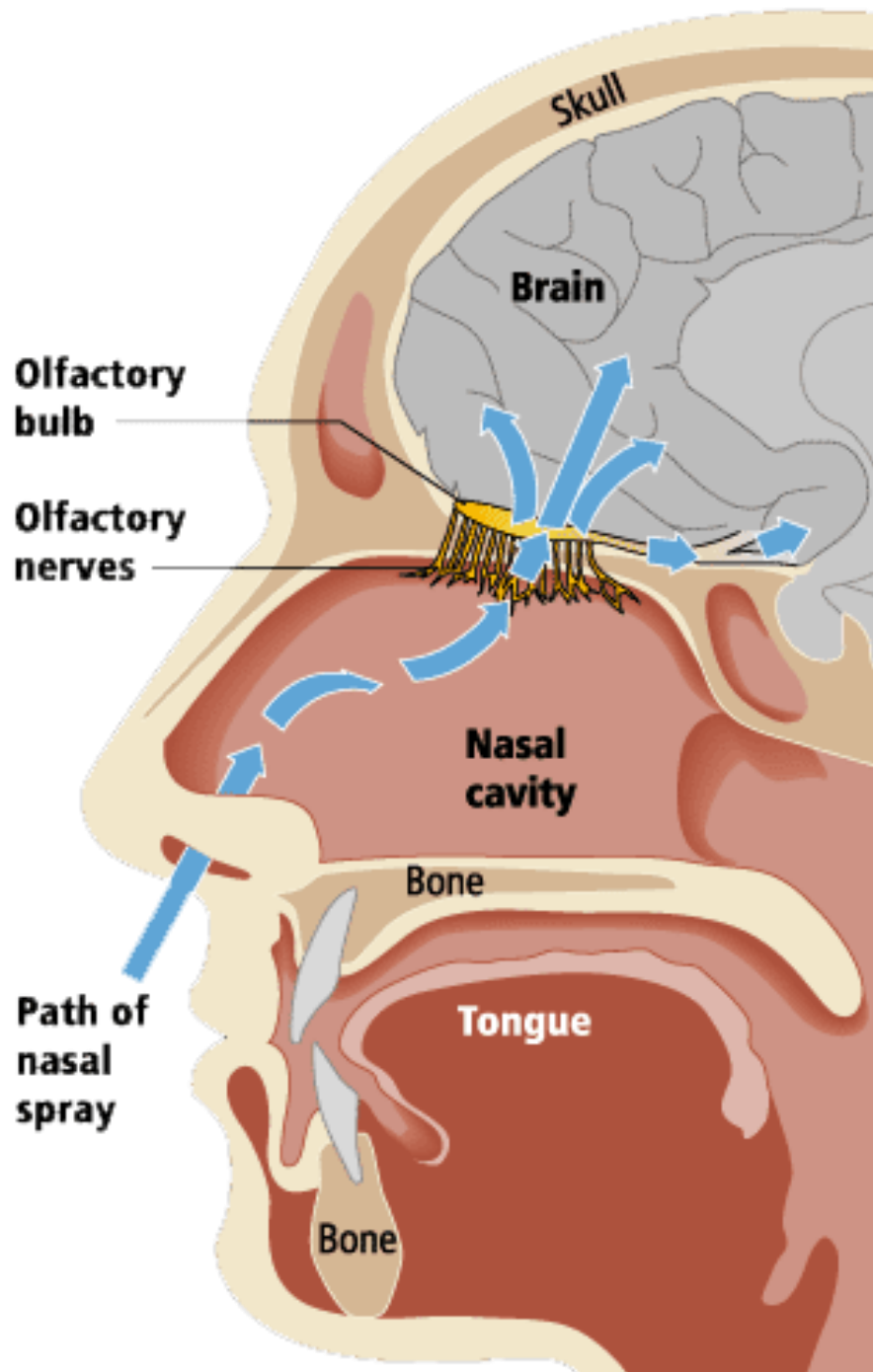
“[Hyperbaric oxygen therapy] is the safest way clinically to increase stem cell circulation, far safer than any of the pharmaceutical options.”



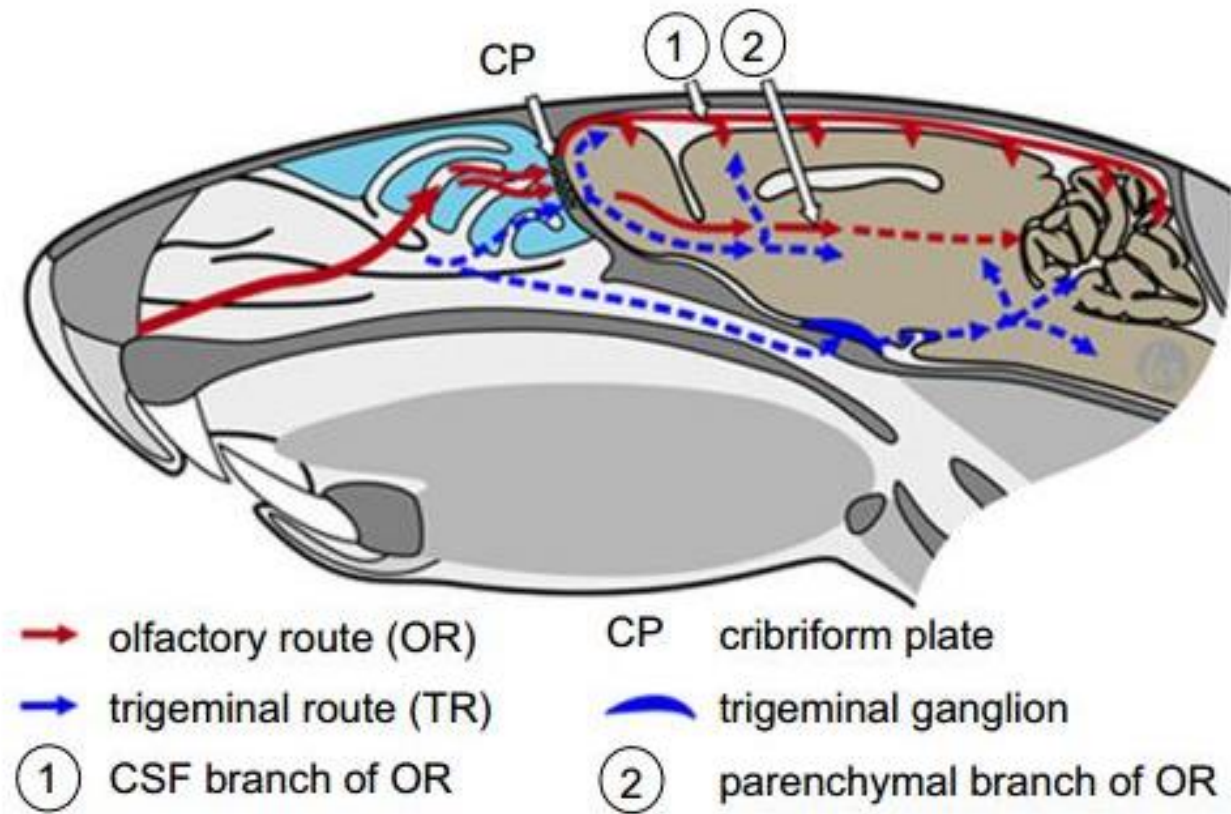
Part II

Intranasal Therapies (Insulin, PRP, and Stem Cells) for TBI

Journey Through the Nose



- Through the olfactory nerves
- Bypasses the blood-brain barrier
- Into the CSF within 10 minutes



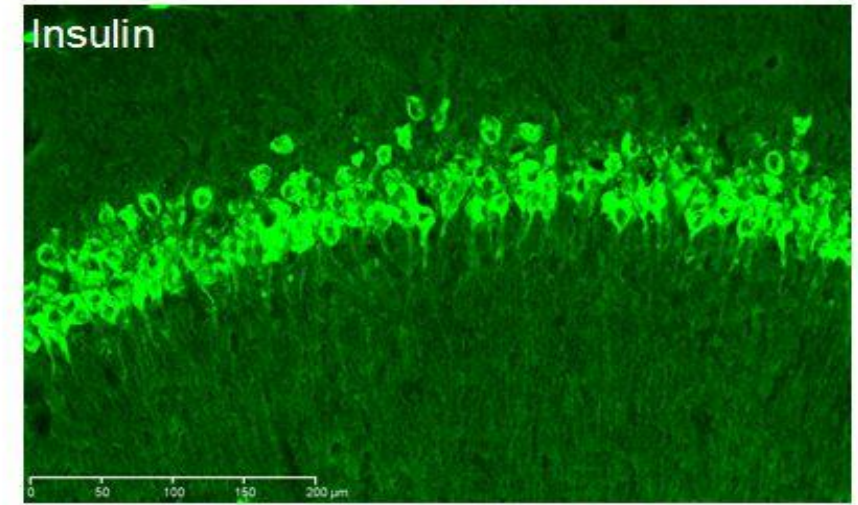
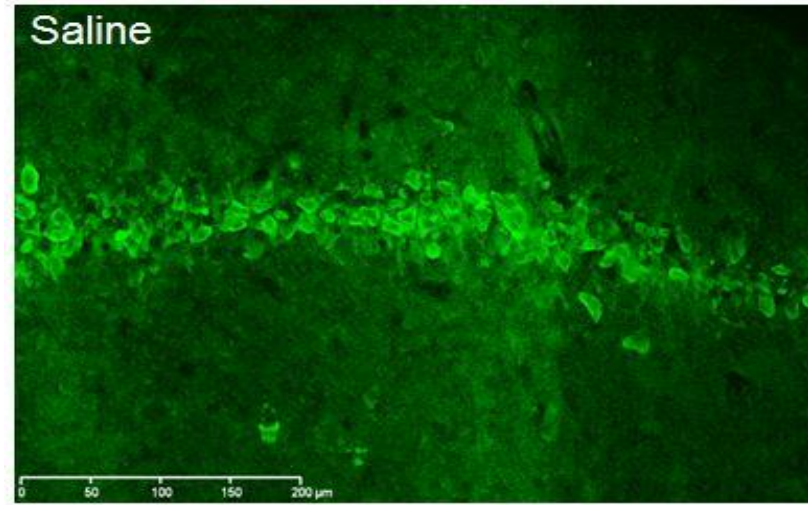
Solid arrows represent the paths of migration of cells into the brain, dashed arrows reflect possible hypothetical routes of cell delivery

Intranasal Insulin for TBI

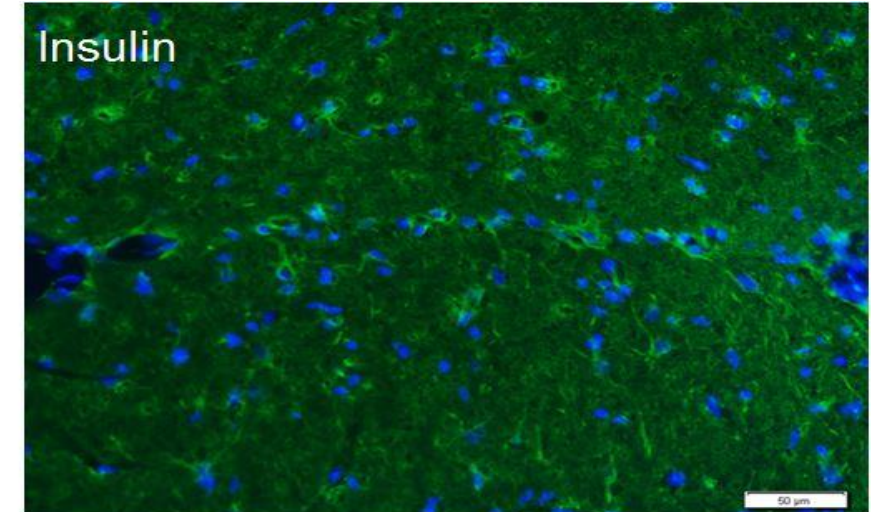
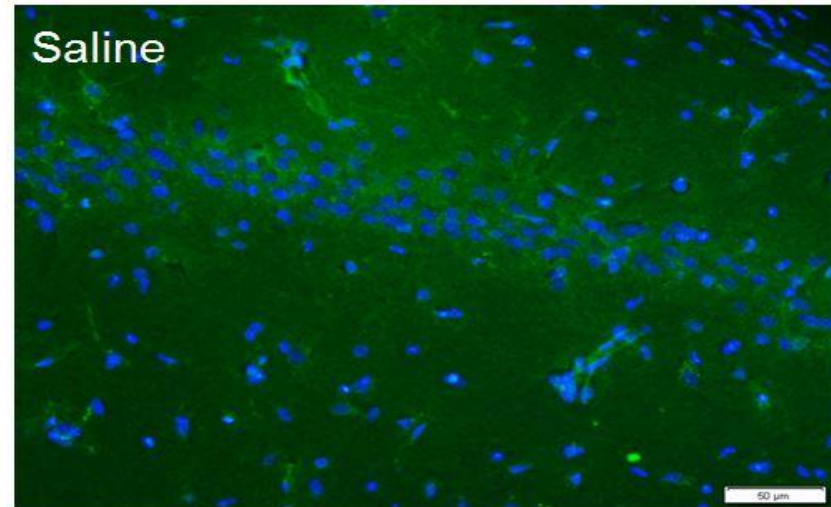
- Improves brain ATP production
- Decreases CSF cortisol
- Improves neuronal viability in the hippocampus
- Increases the expression of anti-inflammatory microglia
- Reduces beta-amyloid and tau protein deposition



NeuN, an immunohistochemical marker of neurons, was used to examine the effect of intranasal insulin on neurons after injury. Qualitative assessment of histology showed improved neuronal viability in the hippocampus of the insulin treated rats.



Intranasal insulin increases the expression of anti-inflammatory microglia in the hippocampus.



Platelet Rich Plasma (PRP)



The infusion of concentrated platelets results in an exponential increase in numerous growth factors at the sight of infusion



Plasma cytokines control inflammatory mediators cox1, cox2 and guide stem cells to areas of injury

Intranasal Platelet Rich Plasma (PRP) for TBI

- Autologous plasma contains growth factors and cytokines to aid the injured brain:
 - VEGF, EGF increases angiogenesis
 - PDGF, TGF- β enhance collagen growth
 - IGF-1 stimulates protein synthesis
- Enhanced collagen IV in neurons of the brain has been shown to have a neuroprotective effect and reduce amyloid-beta proteins.

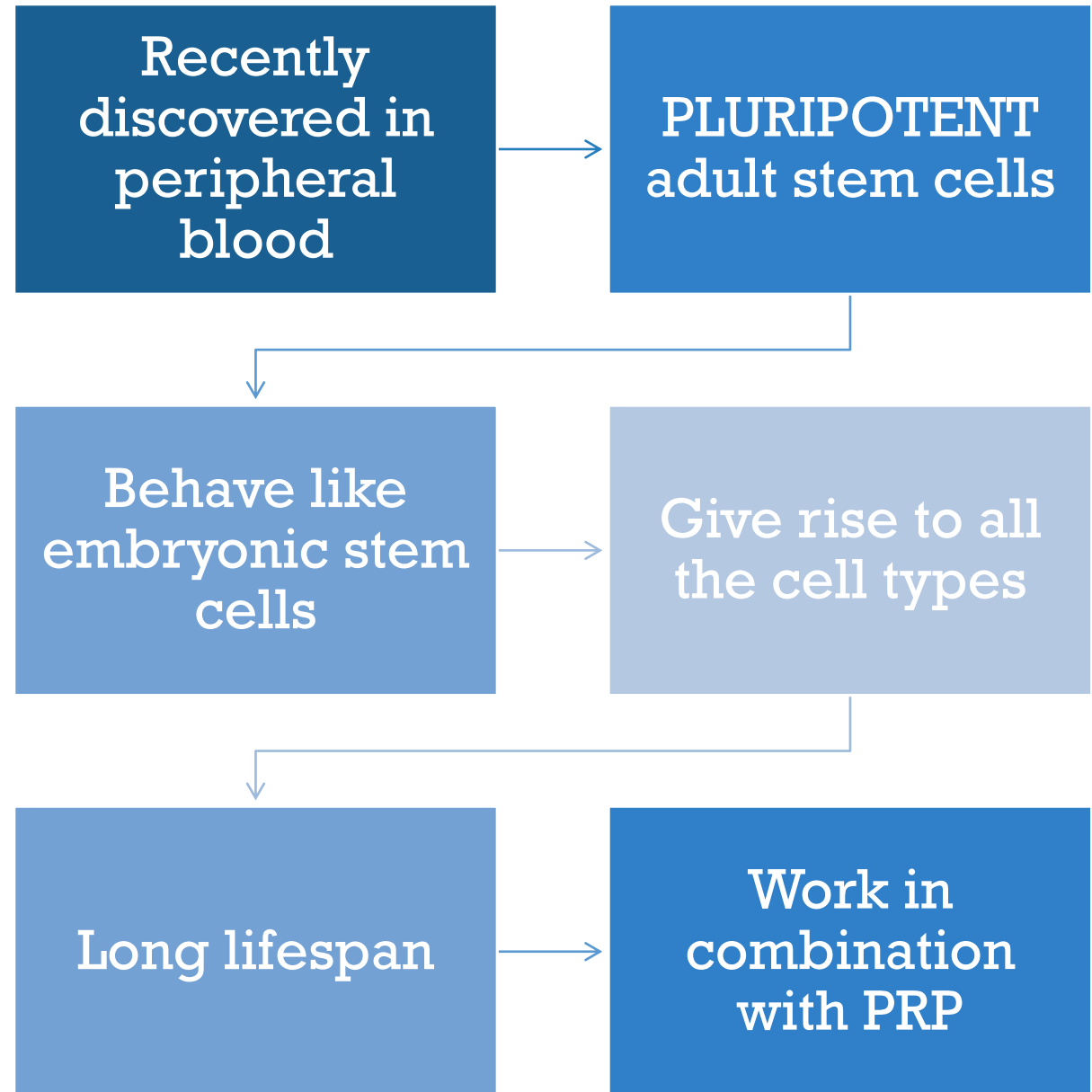
Intranasal Platelet Rich Plasma (PRP) for TBI

- “Basic fibroblast growth factor infusion enhances injury-induced cell proliferation in the dentate gyrus and improves cognitive function in rats following fluid percussive injury.”



- “Other studies have found that infusion of S100 β or VEGF can also enhance neurogenesis in the hippocampus and improve the functional recovery of animals following TBI.”

Peripheral Blood Based Adult Stem Cells



Intranasal Peripheral Blood Stem Cells for TBI



- Plasma contains millions of these cells per mL
- Have regenerative and reparative properties
- Have been used to treat ischemic brain damage by reducing gray and white matter loss
- Downregulate neuroinflammatory cytokines

Intranasal Nutrients for TBI



IN glutathione has been used to reduce oxidative stress and enhance cellular detoxification in Parkinson's disease patients.



IN methylcobalamin has been shown to improve QEEG Theta activity in ADHD and autism patients.



Part III

Intravenous Nutrition
(B-vitamins, Minerals,
Vitamin C, Glutathione
and other nutrients)
for TBI

- Includes PRP, stem cells, NAD+, Myer's cocktail with potassium, magnesium, calcium, B-complex, B5, B6, and B12, ascorbate, and glutathione
- B vitamin supplementation improves memory, mood, and energy levels



IV Nutrition for TBI



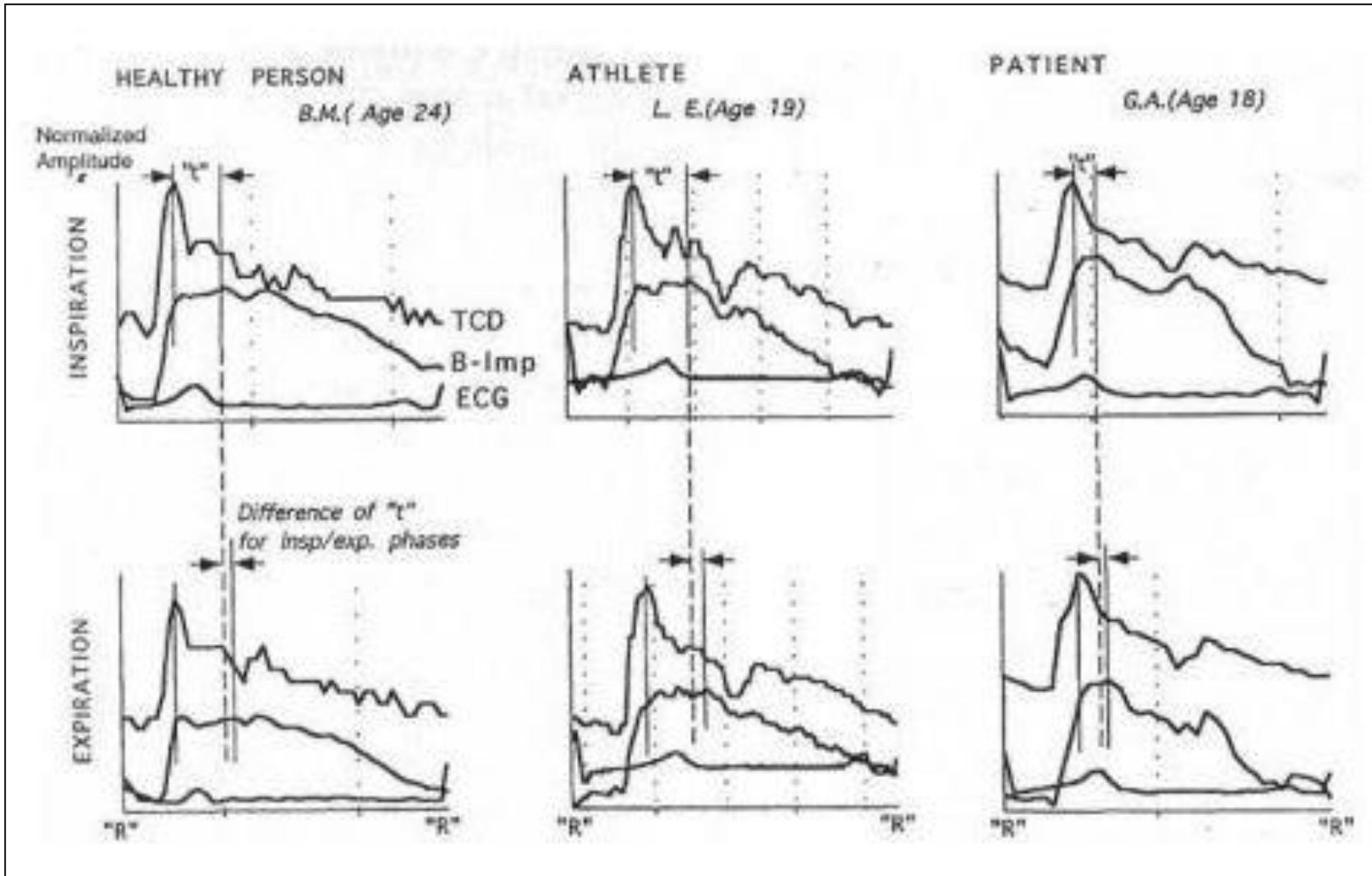
Part IV

Cranial Osteopathy for TBI

Cranial Osteopathy for TBI

- Manual manipulation of the cranial bones and membranes to allow the cerebral spinal fluid to flow properly
- The central nervous system, including the brain and spinal cord, has a subtle, rhythmic pulsation
- This rhythmic pulsation can be blocked in brain injuries - impedes CSF and blood flow
- Effective at treating vertigo and headaches associated with TBIs

The difference of “t” between inspiratory and expiratory phases of the secondary respiration in a Healthy person, Athlete trained in diving and Patient after head injury



- Time shift between peaks of TCD and B-Imp is determined by the replacement of some portion of CSF out from (or into) zone of B-Imp electrodes.
- This time interval represents the mobility of CSF inside the cranium during the pulse cycle. At this period no active processes could operate.
- Investigations under different conditions have shown that "t" reflects CSF mobility.



Part V

MCT Oils and the Ketogenic Diet for TBI

DO NOT EAT

Grains – wheat, corn, rice, cereal, etc.

Sugar – honey, agave, maple syrup, etc.

Fruit – apples, bananas, oranges, etc.

Tubers – potato, yams, etc.

DO EAT

Meats

Leafy Greens

Above ground vegetables

High Fat Dairy

Nuts and seeds

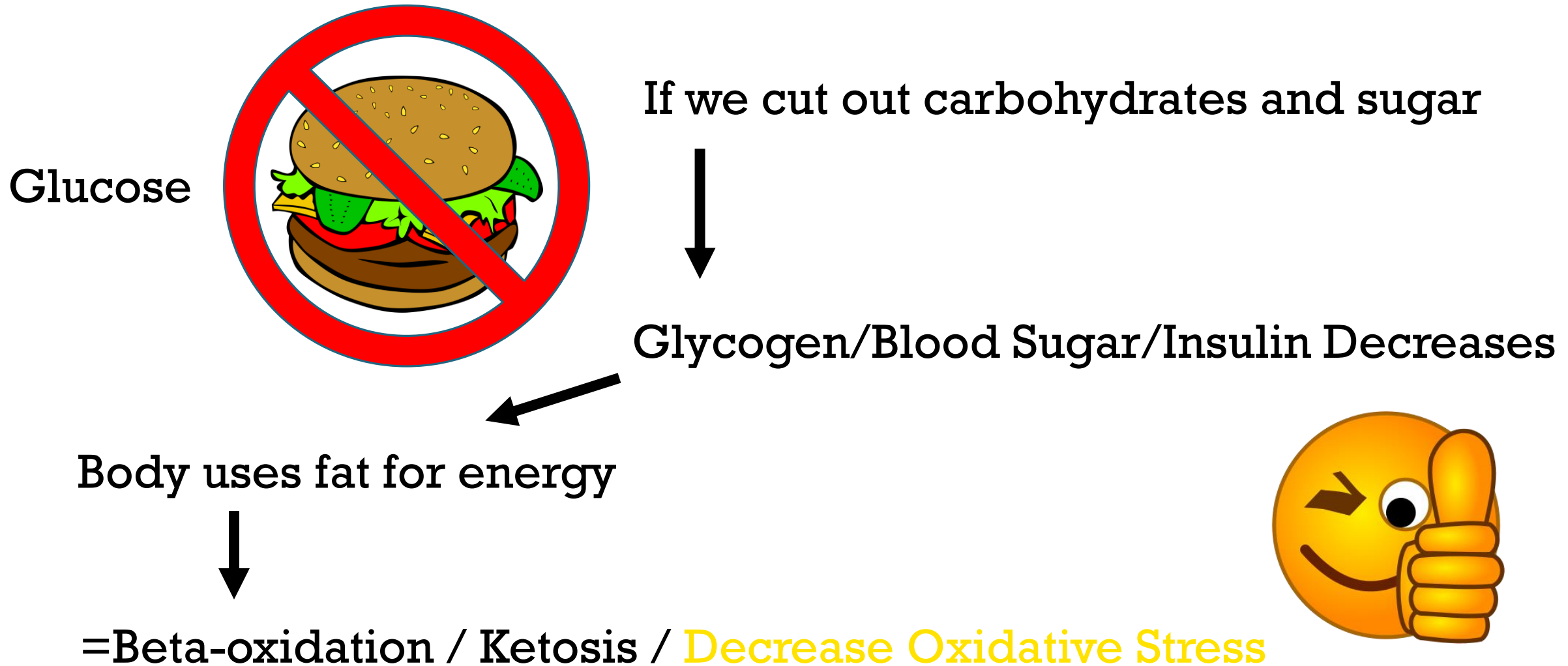
Avocado and berries

Other fats – avocado oil, coconut oil, grass-fed ghee, high-fat salad dressing, saturated fats, etc.

Ketogenic Diet for TBI

- **High-fat**
- **Adequate-protein**
- **Low-carbohydrate**

How does the body create energy?



Which burns more even?



Glucose/Carbohydrates = Kindling



Ketones/Fats = Logs

Ketones are like diesel fuel (Glucose is like gasoline)

- Diesel fuel has a high flash point than gasoline
- Harder to oxidize – Less flammable (excitable)
 - The brain works like a diesel engine
 - Burns more efficiently – lasts longer





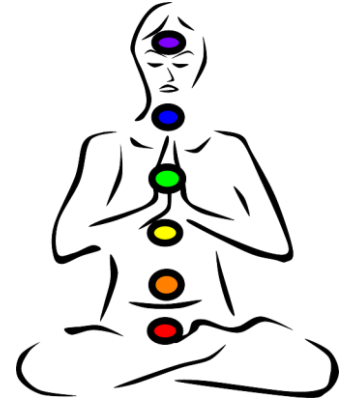
Increases Neuroprotection



Increases GABA



Increases Calming



What else do ketones do?



Decreases Glutamate

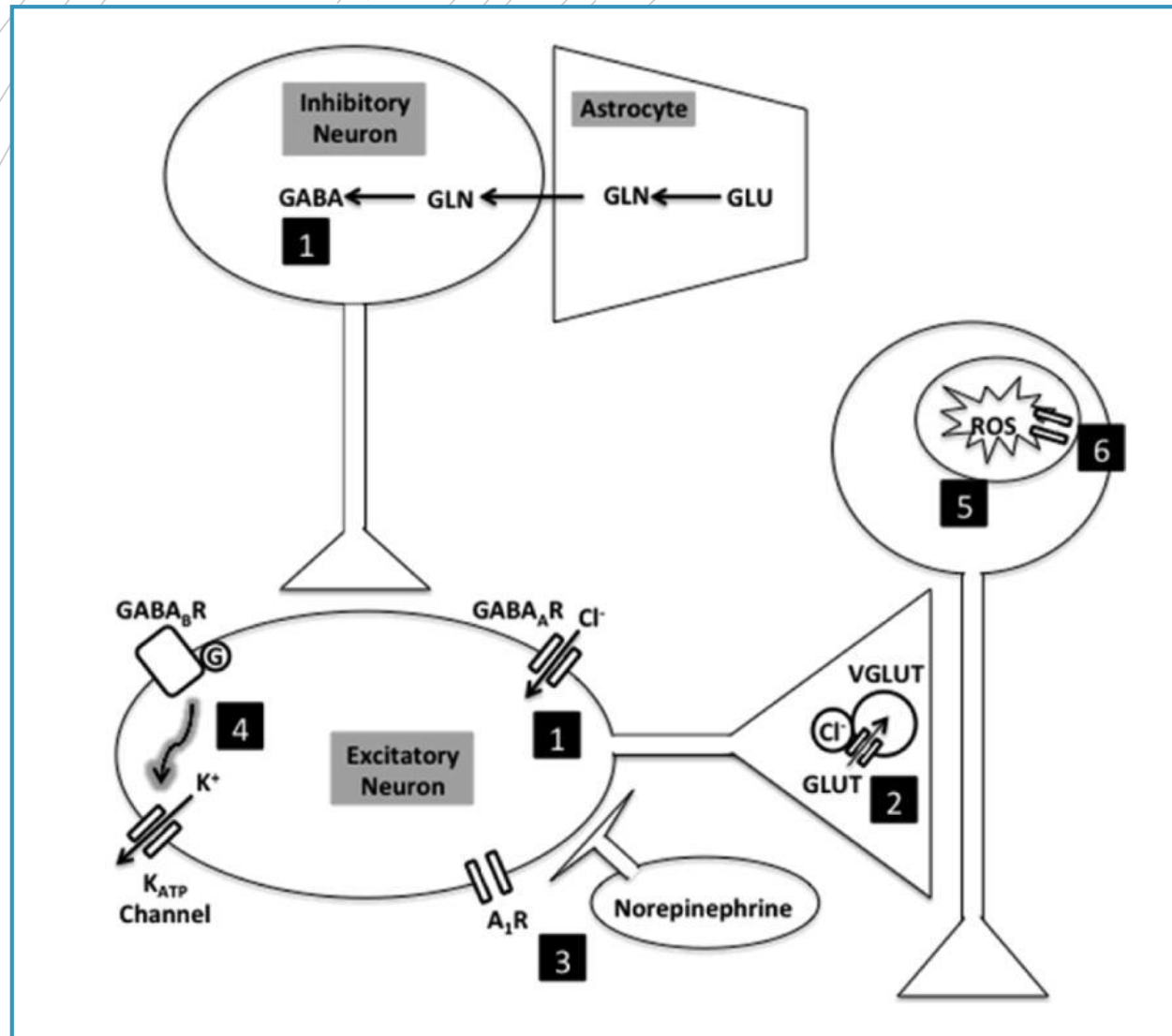


Decreases Depression, Fear,
Anxiety



Decreases Oxidative Stress



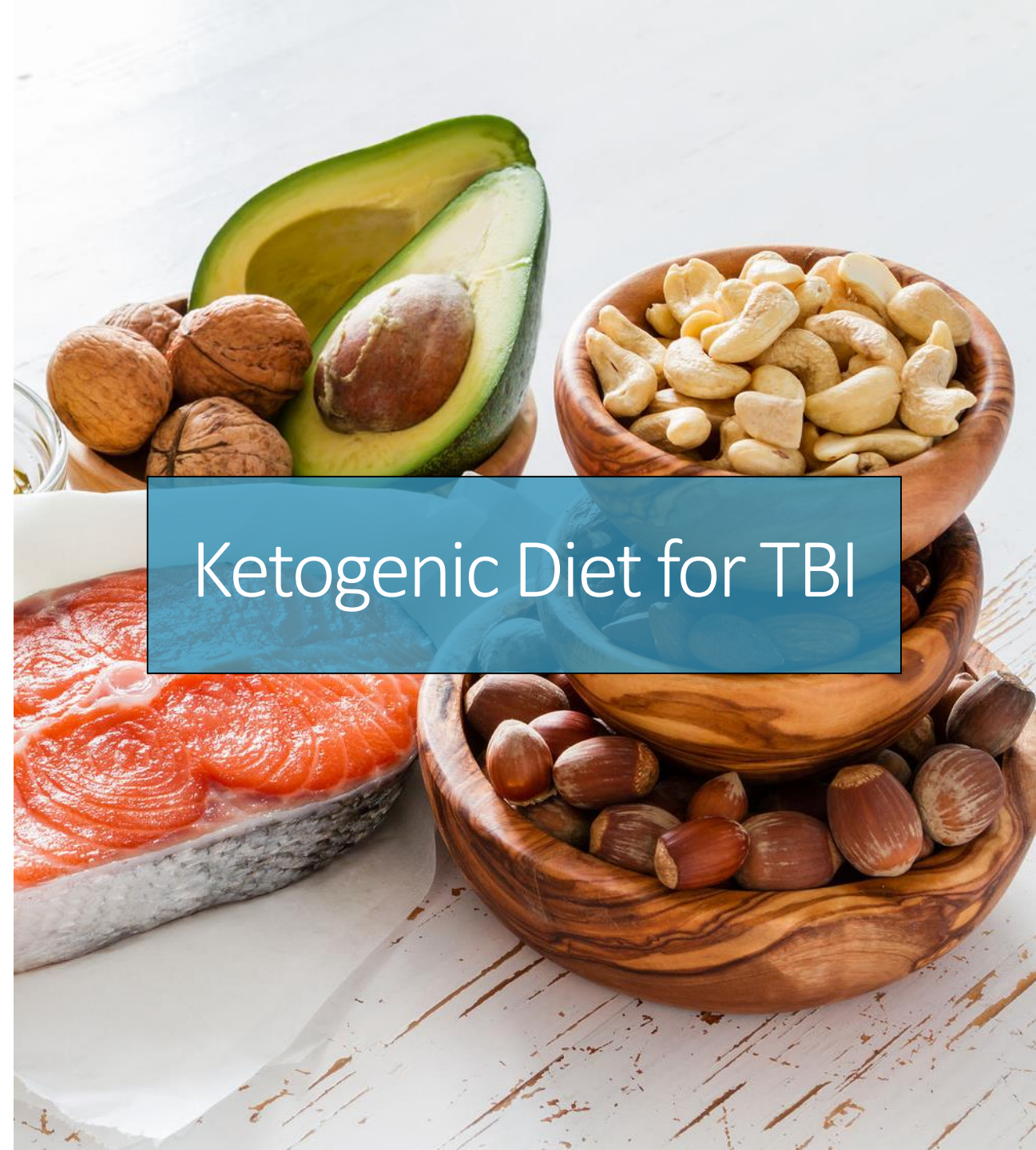


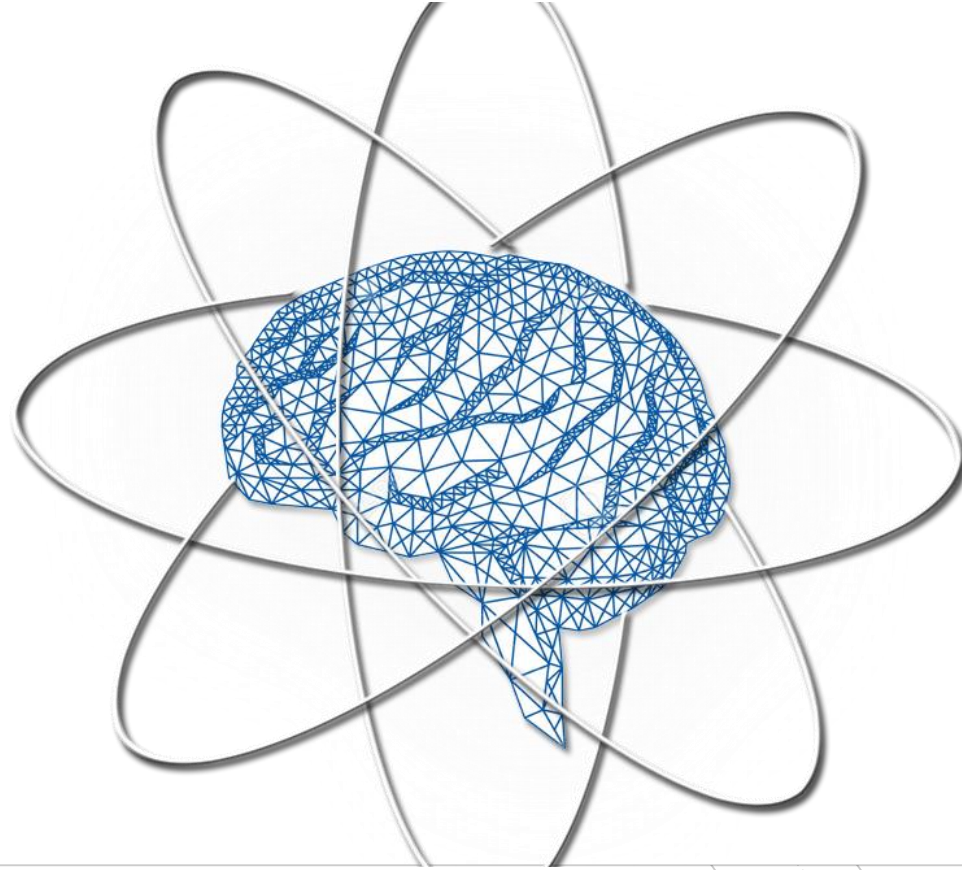
- Possible anticonvulsant effects of ketone bodies on the brain.
- Increased GABA synthesis through alteration of glutamate cycling in glutamate-glutamine cycle or altered neuronal responsiveness to GABA at GABA_A receptors.
- Decreased glutamate release by competitive inhibition of vesicular glutamate transporters.
- Other neurotransmitters, including norepinephrine and adenosine.
- Increased membrane potential hyperpolarization via K_{ATP} channels possibly mediated by GABA_B receptor signaling.
- Decreased reactive oxygen species production from glutamate exposure.
- Electron transport chain subunit transcription.

Neuroprotective Actions of the Ketogenic Diet

- Increases resistance to metabolic stress
- Increases resilience to neuronal loss
- Upregulates energy metabolism genes
- Stimulates of mitochondrial biogenesis
- Enhances alternative energy substrates
- Promotes synthesis of ATP
- Interferes with glutamate toxicity
- Bypasses the inhibition of complex I in the mitochondrial respiratory chain

- Proven treatment for patients suffering from epileptic seizures
- Produce cortical sparing and less apoptotic neuro-degeneration
- Overall improvements in cognitive and motor functioning
- Increase the available calming neurotransmitter GABA
- With less glutamate, there is less oxidative stress and improved neuroprotection
- MCT oils are a rich source of ketone bodies





The TBI Therapy Protocol

The TBI Therapy Protocol

- I. HBOT: at 1.3 ATA to 1.75 ATA from 10 to 40 sessions
- II. Intranasal therapies: utilized 1 to 4 x during HBOT treatment series (IN plasma, insulin, glutathione, B12) administered first followed by IN platelet-derived, pluripotent stem cells within 7 days of IN plasma
 - Patients are also sent home with 10 days IN insulin to self administer
- III. Cranial osteopathy: administered throughout HBOT treatment series
- IV. IV nutrition: administered 1-4 x during HBOT treatment series
- V. Ketogenic Diet, MCT Oils and Supplementation
 - Blueberries, Vitamin D3, and elk antler recommended daily 3 weeks before and after treatment
 - Ketogenic dietary counseling and MCT oils are begun on day 1 of HBOT series and continued for 3 months after treatment

TBI Therapy HBOT Protocol

Medical Grade HBOT

10 - 20

before stem cell
infusion

10 - 20

after stem cell
infusion

Home HBOT Chamber

5 - 7 days/wk

1 month before
stem cell infusion

5 - 7 days/wk

2 - 9 months after
stem cell infusion

TBI Therapy 2-Day Program

Day 1:

Consultation

HBOT

Cranial therapy

IV therapy

Intranasal (IN) PRP and insulin

Day 2:

IV and IN NAD+

IV and IN pluripotent stem cells
(VESLs) from the blood

HBOT

Case Report

46 year-old male from Boulder, CO

Before Treatment:

- Light and sound sensitivity
- Could not drive
- Emotionally unstable
- Headaches daily
- Inability to carry on conversation
- Inability to do math or read
- Loss of libido
- Depression and anxiety
- Insomnia
- Memory loss

After Treatment:

- “Memory download”
- “An awakening”
- Mood and personality improvements
- Improvements intellectually, physiologically, and psychologically
- Improved ability to read
- Able to turn on lights and get on computer / TV
- Able to drive
- Sleep normalized

TBI Therapy: Case Report



“It was like a stream of information had been let loose like a dam that had busted. I felt for the first time in a year that I had some clarity. I was excited and able to read more than 2-3 sentences without triggering a migraine. I found that I was able to get back on the computer and learn more about my trauma and recent treatments. Within the following days it was like an awakening. It seemed like a light switch was turned back on inside my head. The ability to think and plan returned.”

TBI Therapy: Case Report



“I felt well enough that I started saying yes again to facilitating events and speaking gigs. I also experienced relief from anxiety. With the stem cell procedures, the results were never immediate but 8-12 weeks post procedure I experienced a noticeable jump in my healing. TBI Therapy has turned me into a TBI THRIVER, not just a survivor. I’m happy. I enjoy life again, can travel and am doing work in the world that’s more aligned with myself than ever.”

TBI Therapy: Case Report



“The results for me have been are nothing short of MIRACULOUS! Popeye may have his spinach but I have stem cells and PRP! Yes, my brain is strong!”

TBI Therapy: Clinical Results



Out of 100 patients treated, nearly every patient reports:

- More mental clarity
- Improved memory
- Improved executive function/decision making
- More stable emotions and less stress
- Better ability to cope with pain
- More physical and mental energy

TBI Therapy: Clinical Results



Out of 100 patients treated, some patients report:

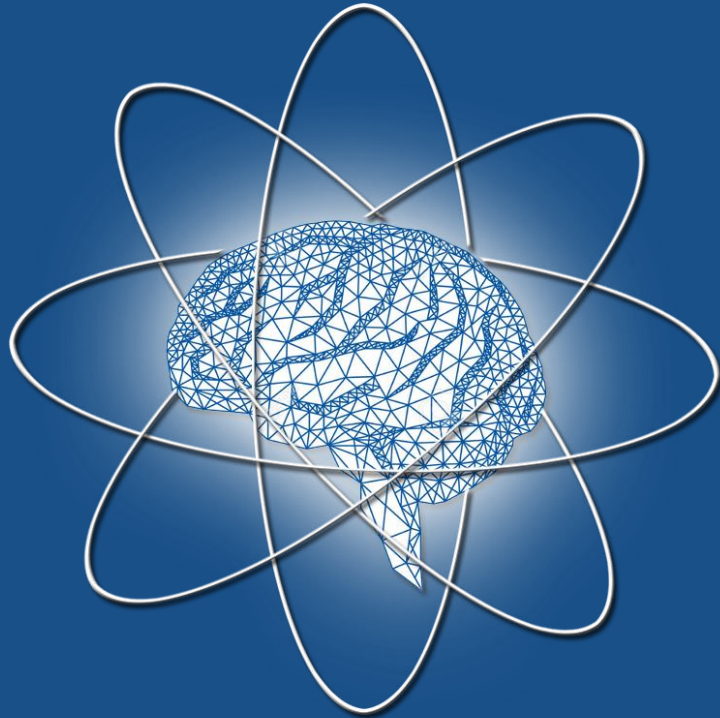
- **Less sound and light sensitivity**
- **Improved eyesight**
- **Improved sleep and libido**
- **Improved motor function (ability to open a clenched fist, ability to walk)**
- **Less muscle spasticity**

Conclusion: The Multimodal, Regenerative Approach is a ▼ Superior Way to Treat TBI

The practical, effective combination of multiple regenerative TBI therapies can produce synergistic benefits to the patient superior to mainstream TBI or single modality TBI treatments

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TBI Therapy

Treats TBI patients by combining regenerative therapies: HBOT, stem cells, PRP, and nutritional therapies.

tbitherapy.com



ASPEN **INTEGRATIVE** M E D I C I N E

Treats chronic pain and major medical problems using modern and natural medicine.

aspenintegrativemedicine.com

HBOT and Peripheral Blood Stem Cells: An Essential Component for Regenerative Treatment

Dr. John C Hughes, DO

OMED 2018 – San Diego, CA

October 8th, 2018

Disclaimer

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- The content of this presentation has been peer reviewed for fair balance and evidence based medicine.

Advanced Evidence Based Medicine = Creative Expertise

The Novice Stage: Learns the basic rules and applies them mechanically with no attention to context.

Second and Third Stages: Increasing depth of knowledge and sensitivity to context when applying rules.

Fourth and Fifth Stages: Rule following gives way to expert judgments - characterized by rapid, intuitive reasoning informed by imagination, common sense, and judiciously selected research evidence.

Advanced evidence based medicine is not rule following.

Advanced Evidence Based Medicine = Creative Expertise

Creative People [Creative Brains] have an “openness to new experience that permits them to observe things than others cannot... [this] openness is accompanied by a tolerance for ambiguity. Creative people do not crave the absolutism of a black and white world; they are quite comfortable with shades of gray. In fact, they enjoy living in a world with unanswered questions and blurry boundaries.”

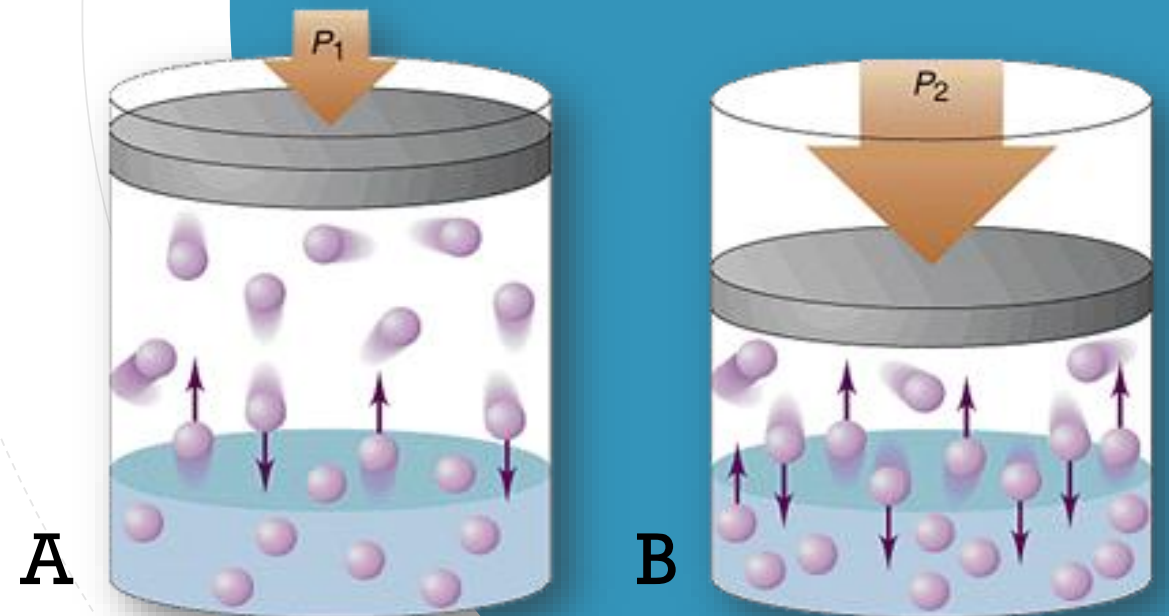


HBOT: An Essential Component for Regenerative Treatment

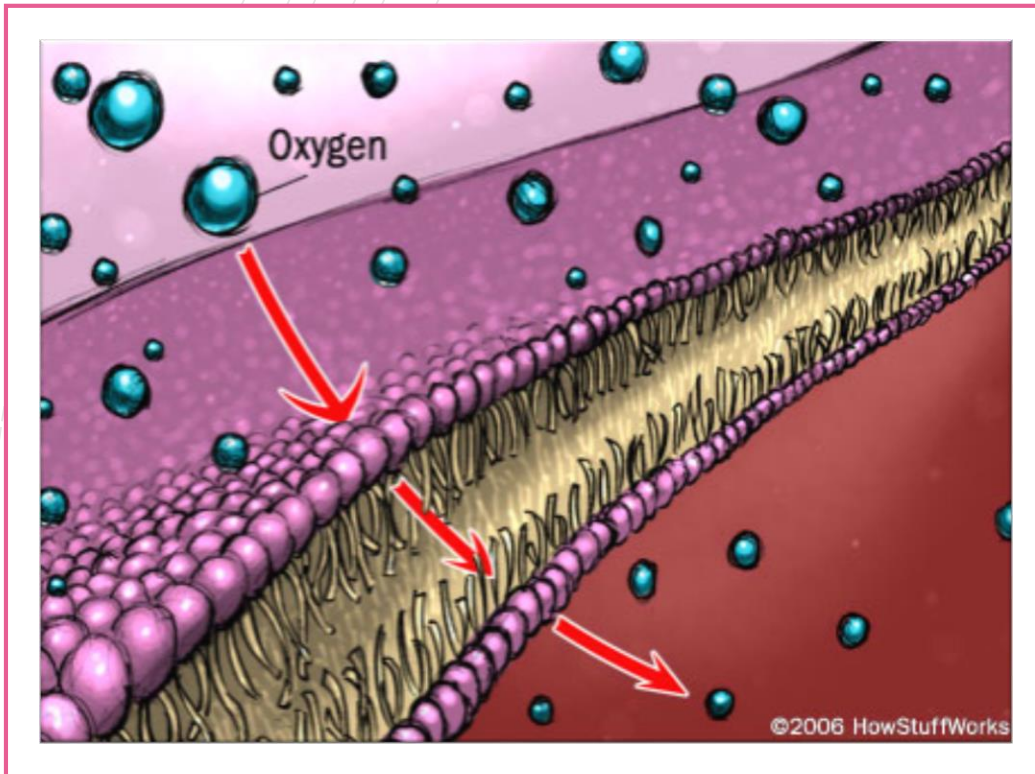
- Introduction to HBOT
- HBOT: Mechanisms for Addressing Chronic Pain
- HBOT: Adjunctive Treatment for Sports Injuries
- HBOT: Upregulates Pluripotent Peripheral Blood Adult Stem Cells
- VSELs over MSCS: Regenerative Treatments with Pluripotent Stem Cells for Sports Injuries and Arthritis

- Henry's Law of Gas Solubility: The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid.
- Increasing the atmospheric pressure increases the amount of gas that is dissolved into a fluid.
- Oxygen → Blood Plasma

Introduction to HBOT: Physics



Introduction to HBOT: Physiology



- **What Gets Hyper-Oxygenated?**
 - Blood Plasma
 - Cerebrospinal Fluid
 - Lymph Fluid
- **Clinical Hyperbaric Pressures**
 - 7 – 22 psi
 - 10 – 15 normal amount of oxygen
 - Bypasses body's normal system of transporting oxygen

Introduction to HBOT: Mechanism of Action

Limits ischemic
damage, cell
death,
inflammation

Promotes collagen
synthesis
(fibroblast
stimulation)

Decreases lactate
production and
tissue acidosis

Aids in oxygen
dependent killing
of bacteria – WBC

Limits leukocyte
adhesion and
degranulation

Decreases tissue
edema



HBOT: Mechanisms for Addressing Chronic Pain

- Decreases inflammation, reduces hypoxia, and improves microcirculation
- For neuropathic pain, analgesic and antinociceptive effects are due to cellular modulation
 - Autophagy in the mitochondria of microglia (mitophagy)

A microscopic image showing numerous mitochondria, which are bean-shaped organelles with internal folds (cristae). They are stained with a blue and red fluorescent dye, making them stand out against a dark background. The mitochondria are scattered across the frame, with some in sharp focus and others blurred in the background.

HBOT: Mechanisms for Addressing Chronic Pain

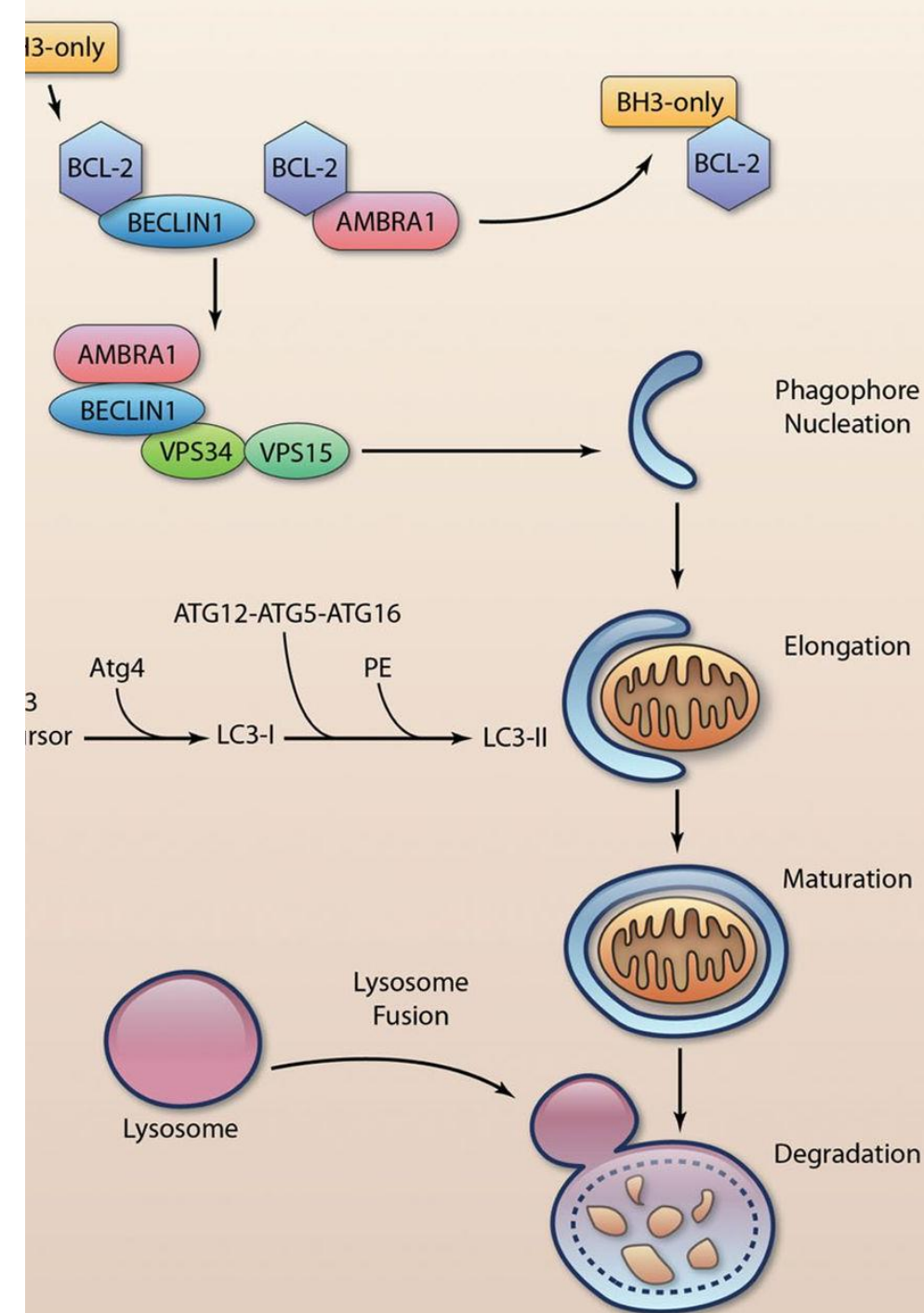
- Mitochondria are the primary source of ROS
- ROS can:
 - Induce mutations in mtDNA causing protein deficiencies
 - Restrict ability to self-repair, leaving cells more vulnerable to ROS attack
 - Damage mitochondrial proteins and lipids by inducing oxidative stress



Latent mitochondria are like campfires left burning all night

HBOT: Addressing Chronic Pain with Mitophagy

- HBOT modulates cellular autophagy (mitochondria of microglia) and directly reduces pain
- Appropriate clearance of mitochondria is important for maintaining homeostasis in cells



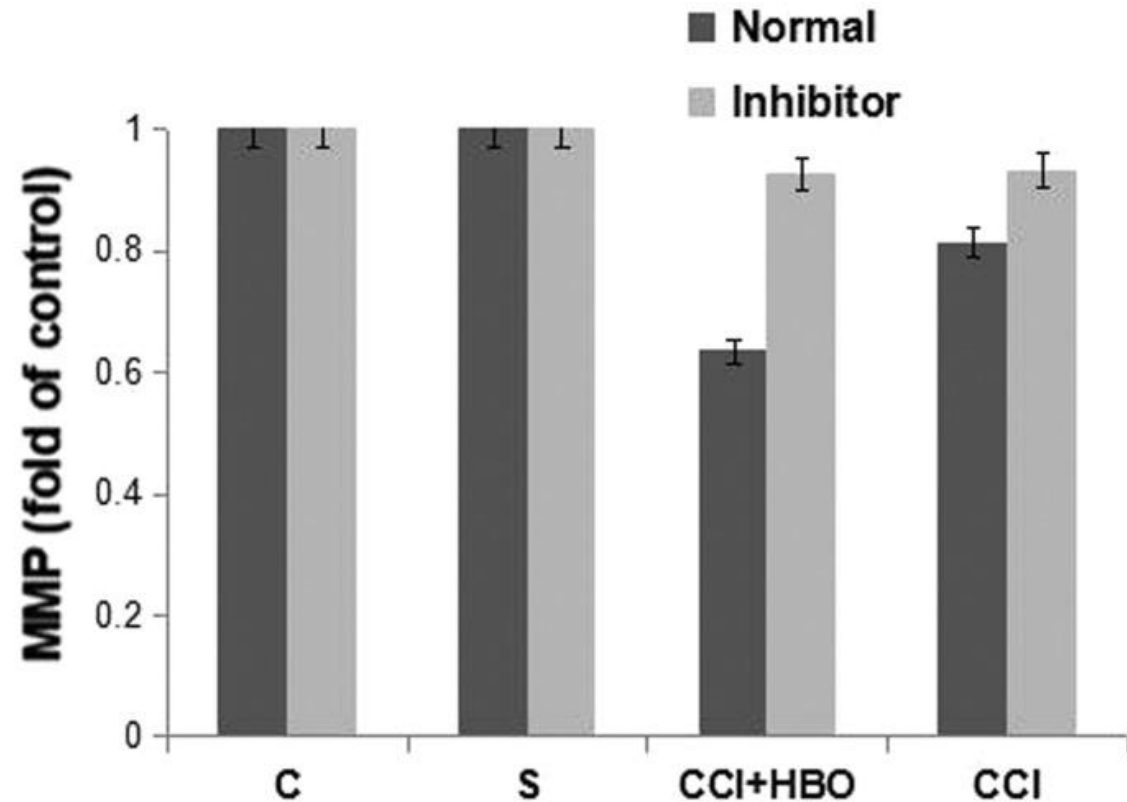


HBOT: Addressing Chronic Pain with Mitophagy

- 20 rats were given a CCI (chronic constriction injury); 20 rats got CCI+ HBOT
- 20 rats were sham CCI and 20 rats were controls
- All 80 rats were given CSI (a mitophagy inhibitor) before testing
- MMP was used to measure mitophagy (lower MMP observed with more mitophagy)

HBOT: Addressing Chronic Pain with Mitophagy

- HBOT improved mitochondrial permeability via transitive pores on the mitochondrial membrane
- More permeability results in more mitophagy (see as lowered MMP) which reduces ROS calming neuro-inflammation and pain



Control & Sham – minimal to no mitophagy (no change in MMP)

MMP: Mitochondrial membrane potential

CCI: Chronic constriction injury

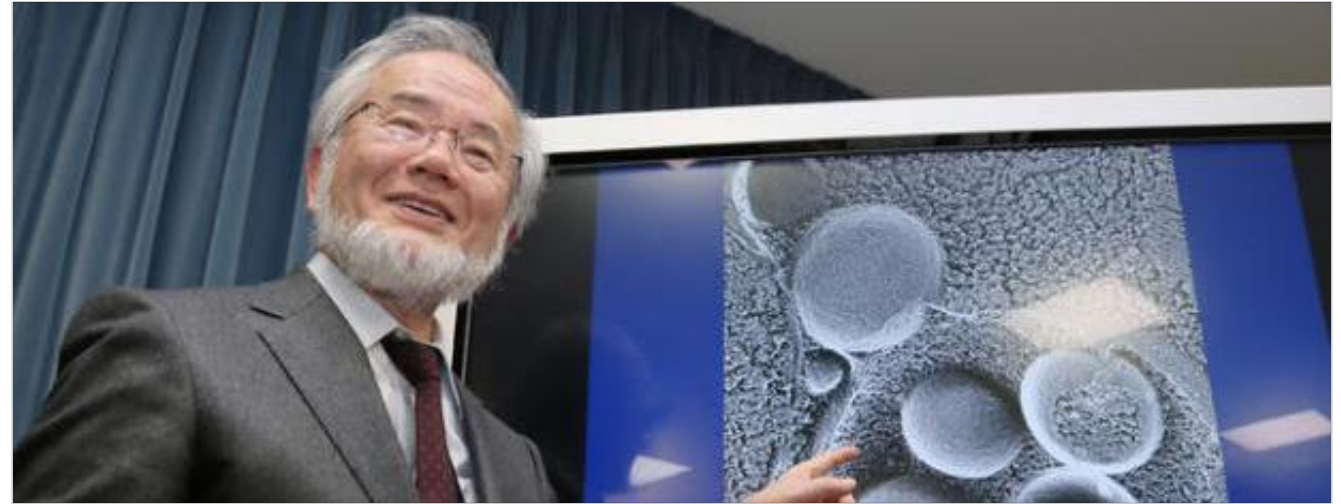
Mitophagy is putting the mitochondrial fires out by involuting the ashes and soil upon the remaining embers. Without mitophagy, wildfires (of pain) get out of control.



July 4th, 2018 Basalt, CO (Courtesy of Pete McBride)

Fun Fact

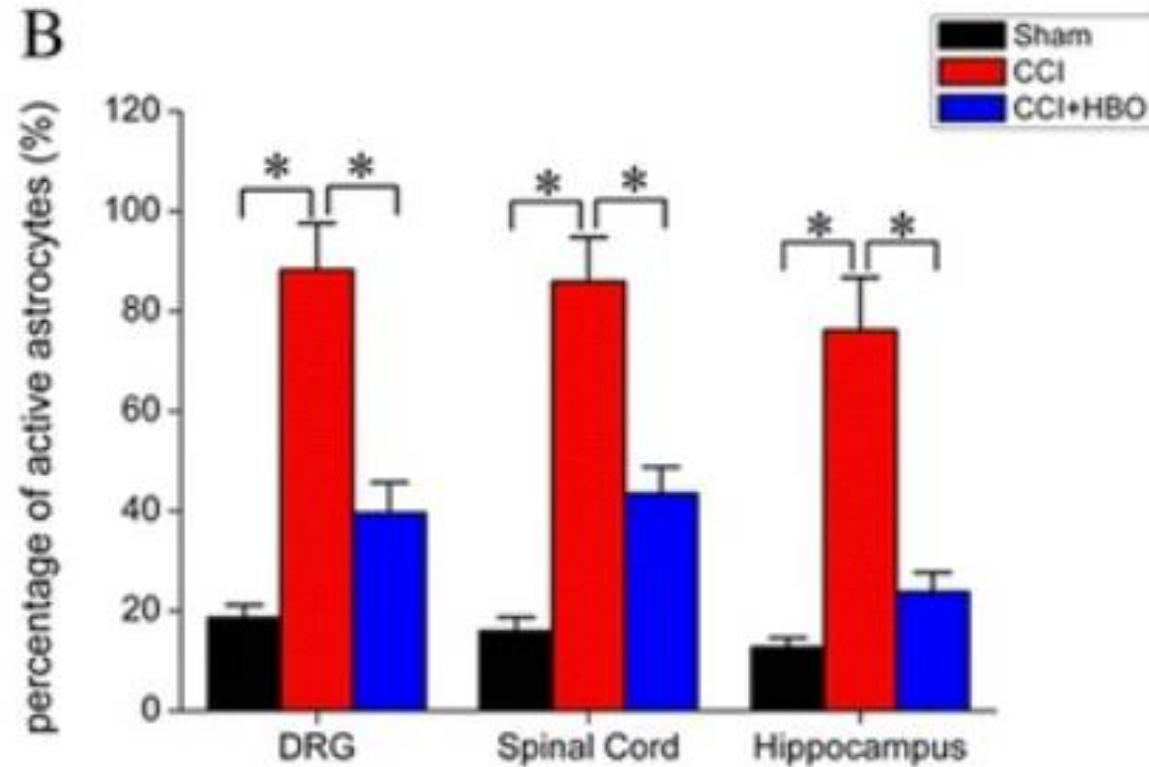
What else encourages cellular autophagy (including neuronal autophagy)?




Intermittent Fasting!

- Dr. Yoshinori Ohsumi Wins Nobel Prize for this discovery
- <https://www.garmaonhealth.com/intermittent-fasting-cellular-autophagy/>

HBOT: Other Mechanisms for Addressing Chronic Pain



- Suppresses pro-inflammatory cytokines, such as IL-1, IL-6 and TNF- α and simultaneously releases anti-cytokines
- Suppresses astrocyte activation and inflammatory responses (stopping gliosis) by:
 - Decreasing TNF- α
 - Decreasing Kindlin-1 and Wnt-10a in the dorsal root ganglia (DRG), spinal cord, and hippocampus of rats



HBOT: Mechanisms for Chronic Pain: Case Study

- 40 year old spinal cord injury (C4 burst fx from mtn biking accident) paraplegic patient with chronic spasticity and pain in lower extremities
- Reports almost immediate reduction in neuroplasticity, inflammation, and pain when treated in a HBOT chamber at 2.4 ATA

A low-angle, rear-view shot of a person's legs and feet as they run on a paved road. The runner is wearing black shorts with white trim and red and white running shoes. The road has a yellow dashed line down the center. In the background, there are mountains under a dramatic, cloudy sky with a low sun or moon, creating a silhouette effect on the landscape.

HBOT for Sports Injuries

- Reduces swelling
- Blunts the inflammatory process
- Improves range of motion earlier/ PT
- Increases and enhances tissue growth
 - Fibroblast and osteoblast proliferation
- Improves bone regeneration-faster and stronger fracture repair

Case Study



- Injured on January 5th 2009
- Shearing fracture, surgically repaired
- High risk for Non-Union
- Started HBO January 7th 2009
- 30 tx over 6 week period
- Cleared to ski March 3rd 2009



Image 1



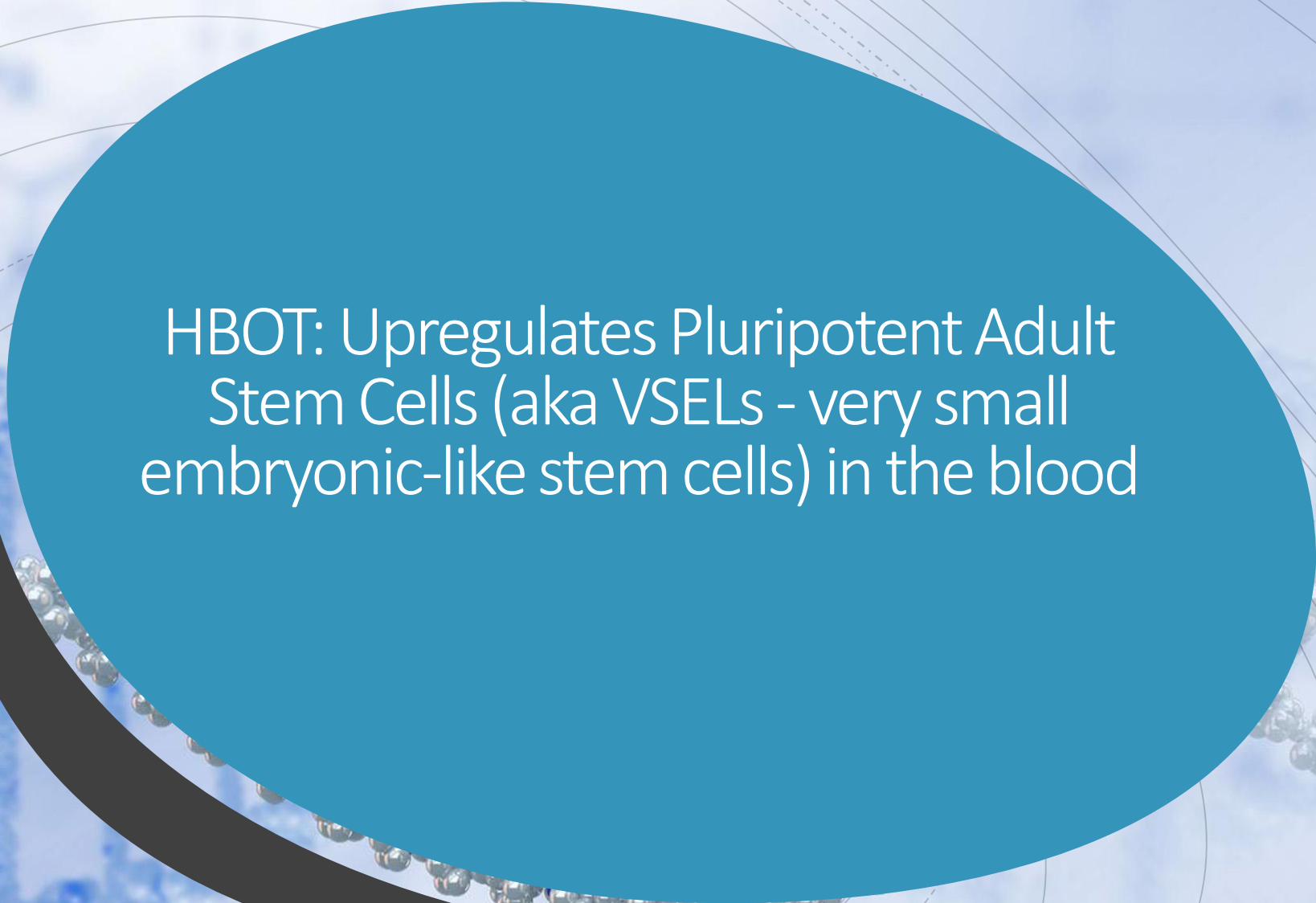
Image 2



Image 3



Image 4



HBOT: Upregulates Pluripotent Adult
Stem Cells (aka VSELs - very small
embryonic-like stem cells) in the blood

Adult Stem Cells

- Derived from bone, adipose, or blood
- Require physician expertise and quality control
- Mostly used for regenerative and cosmetic purposes
- Readily available
- Less expensive
- Autologous use is permitted in US (with restrictions)



Peripheral Blood-Based Adult Stem Cells

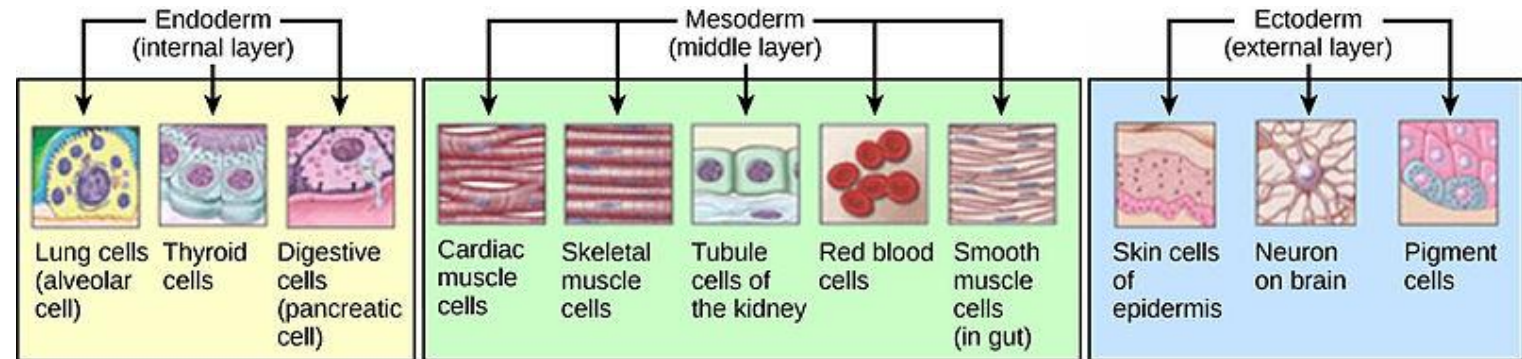
(Pluripotent / Embryonic-Like)

- Originate in bone marrow
- Present in peripheral blood
- Dr. Young (2004)
- Forms cells from the three primary germ-layer lineages
- Also known as very small embryonic-like stem cells (VSELs) or blastomere-like stem cells
- Have a long lifespan (can double more than 70 times)
- *Not derived from umbilical cord blood (mesenchymal)

Peripheral Blood-Based Adult Stem Cells

(Pluripotent / Embryonic-Like)

- Understanding lineage uncommitted pluripotent stem cells requires an understanding of the germ layers



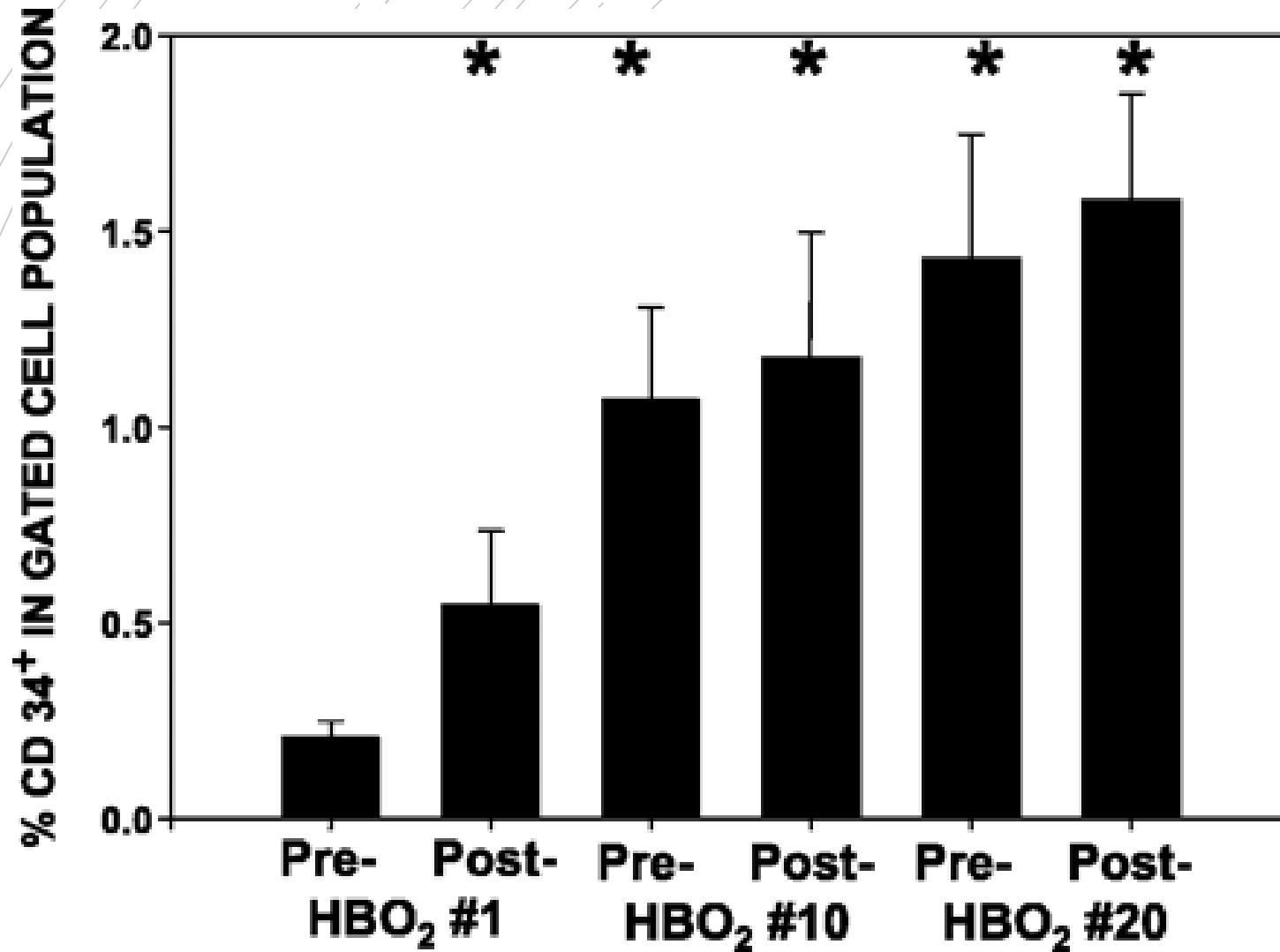
- Lineage uncommitted pluripotent stem cells can produce all types of cells in the germ later

Peripheral Blood-Based Adult Stem Cells

(Pluripotent / Embryonic-Like)

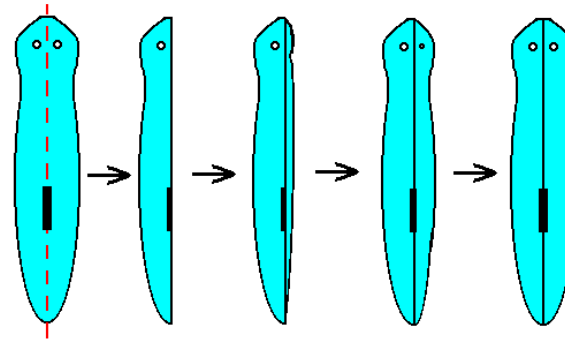
Clinical indications:

- Regenerative in their applications unlike mesenchymal
- Actually develop into new target tissue such as organs, cartilage, neurons, muscle, skin, etc.
- Conditions treated: traumatic brain injury, chronic pain, ligament / tendon injuries, diabetes, osteoarthritis, osteoporosis, Alzheimer's disease, fertility, aging, etc.



Mean CD34+ population (hematopoietic and pluripotent cells) in blood of humans before and after HBO2 treatments. Data are the fraction of CD34+ cells within the gated population using leukocytes obtained from 26 patients before and after their 1st, 10th, and 20th HBO2 treatment.

Peripheral Blood
Pluripotent (VSELs)
vs. Multipotent
(Mesenchymal-
MSCs)



- Many stem cell clinics are focused on the use of mesenchymal stem cells (MSCs)
- MSCs are derived from bone marrow, umbilical, or fat
- MSCs have merit for homologous use (bone marrow to bone marrow or fat to fat transplantation)
- MSCs do not actually transform, in vivo, to new tissues

Pluripotent (VSELs)	Multipotent (Mesenchymal)
Recently discovered in peripheral blood	From bone marrow, fat, and cord blood
Also known as very small embryonic-like stem cells (VSELs)	Mesenchymal stem cells (MSCs)
Does not have a specialized trajectory of development	On a development trajectory
Give rise to all the cell types	Specialization potential limited to one or more cell lines
Lineage uncommitted	Lineage committed
Long lifespan	Short-lived
Not restricted by FDA	Increased FDA restriction for non-homologous tissue use
Best for regeneration	Best for homologous use

Stem Cells and Growth Factors

- Stem cells = seeds
- Growth factors =
soil/water/fertilizer/sunlight
- Without growth factors, the
seed cannot mature and grow

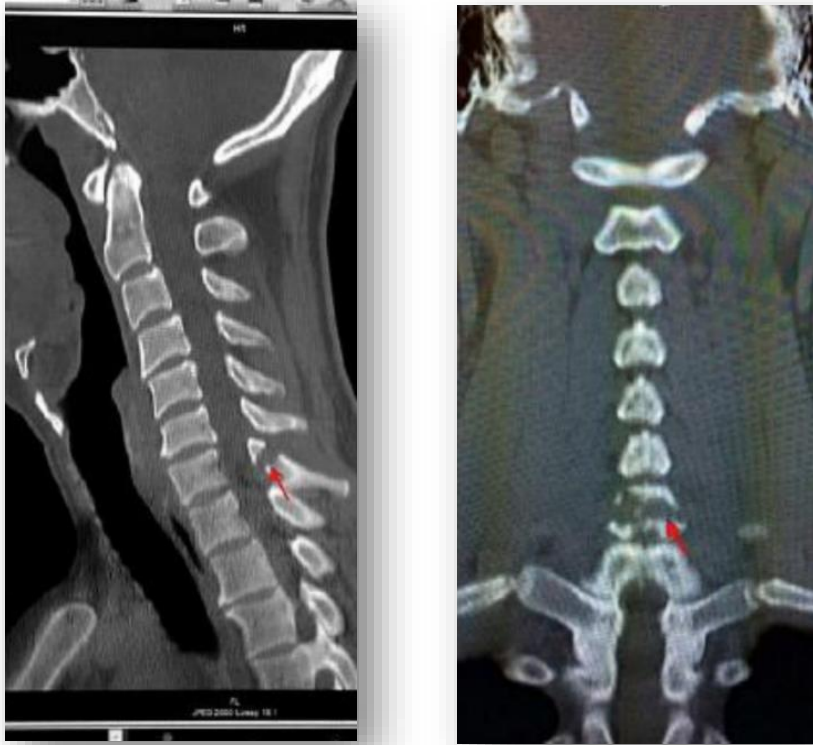


Stem Cells and Growth Factors (PRP)

- Signaling molecules between cells
- Cytokines and hormones that bind to specific receptors
- Promotes cell differentiation and maturation
- Designed to improve metabolism of nutrients
- Stimulate growth of collagen: cartilage, bone, ligaments, tendons, blood vessels, and neurons
- Guide stem cells to area of injury
- Nurture stem cells to maturity

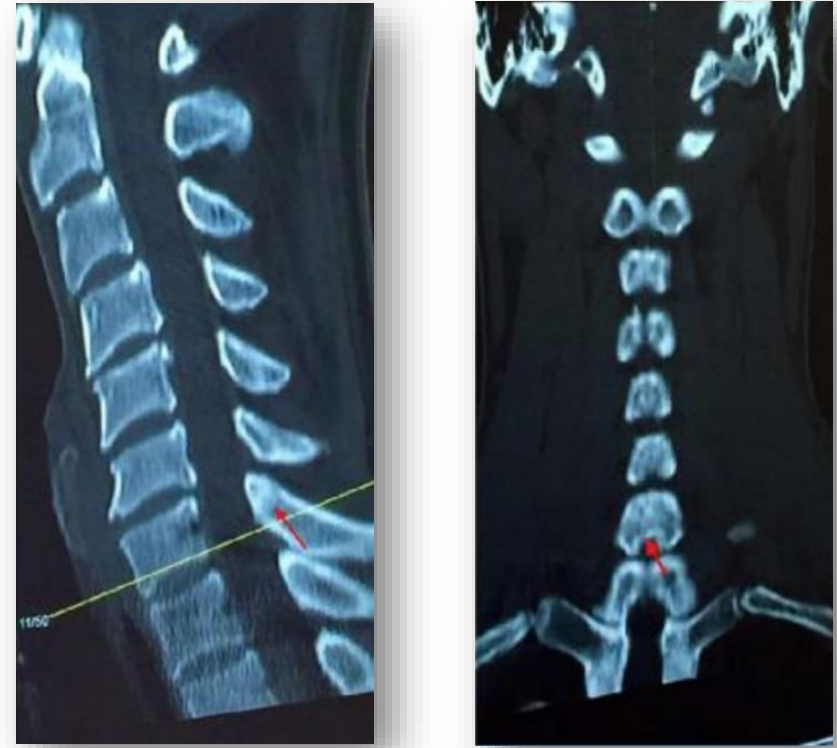
Pluripotent Stem Cells (VSELs)

Pre-Treatment



Displaced (5mm) C-7 proximal spinal fracture failed to heal 9 months post trauma

Post-Treatment



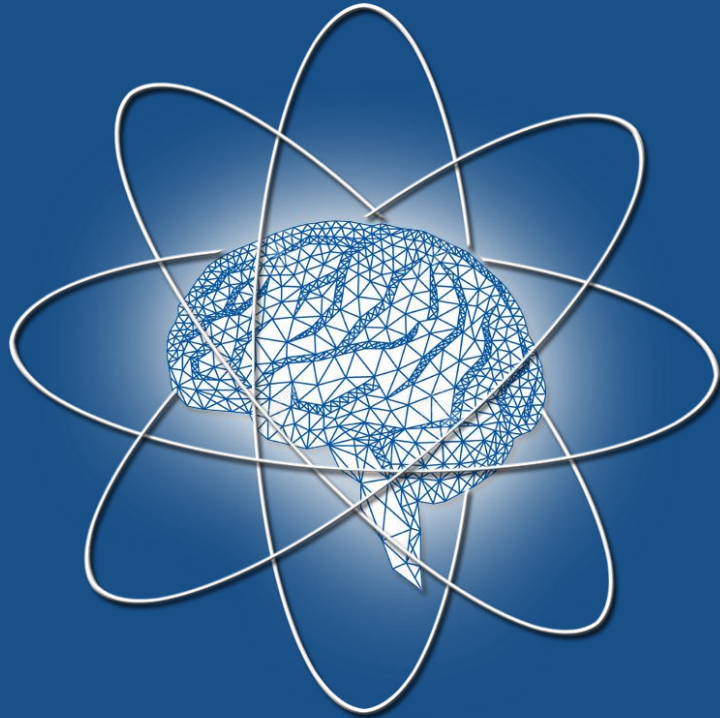
4 months post-treatment of peripheral blood-based stem cells - the fracture is fully healed

Arthritis Case Report

- 80 year old with tricompartmental arthritis x 10 years, confirmed by xray, worse in R knee
- Treated with VSELs in Bilat Knee joints, menisci, and associated ligaments on 2/9/2018
- Reports on 4/13/2018 that her left knee does not hurt
- Reports improvements in walking with less R knee pain on 6/7/2018. Patient provided booster PRP injection into R knee joint and IT band at 6/7/2018
- "The only consistent symptom I have is that it is always uncomfortable when I stand up from a sitting position and when I first get up in the morning. Usually just a few steps and the discomfort is gone."

Conclusion

- The scientific mechanisms and effects of HBOT used in combination with PRP-PBSC (Platelet Rich Plasma and Peripheral Blood Stem Cells) provide a solid basis for use in the treatment of pain, inflammation, tissue damage, and degeneration associated with TBI, sports injuries, and arthritic conditions.



TBI Therapy

Treats TBI patients by combining regenerative therapies: HBOT, stem cells, PRP, and nutritional therapies.

tbitherapy.com



ASPEN **INTEGRATIVE** MEDICINE

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