Overview of Traumatic Brain Injury

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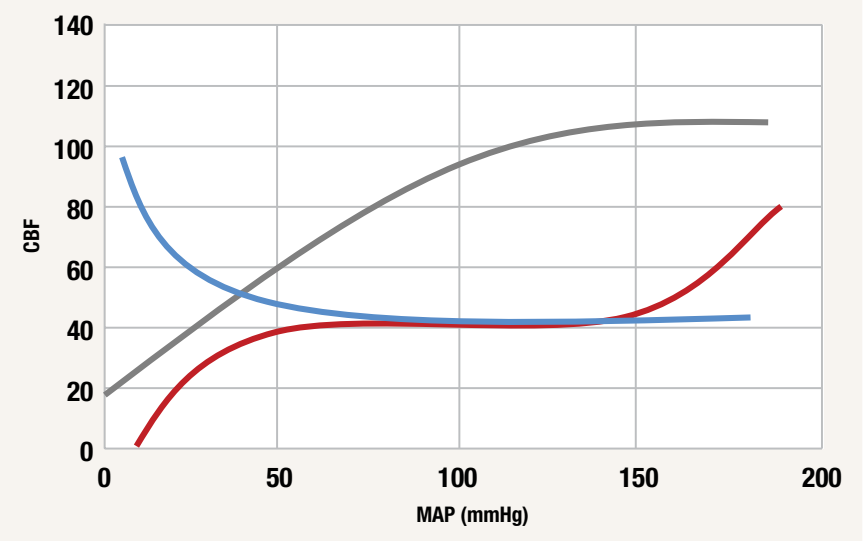
Traumatic brain injury (TBI) can occur in up to 25% of dogs following severe blunt trauma.[1] Head trauma cases are caused by vehicular accidents, purposeful harm, penetrating wounds, crush injury, falls from heights, and other traumas.[2]



Courtesy of Dr. Pamela Fettig

Figure 1. Blood flow to the brain. Blue line = PaO_2; red line = mean arterial blood pressure (MAP); and gray line = $PaCO_2$. The normal brain has the ability to maintain cerebral blood flow (CBF) despite any changes in cerebral perfusion pressure (CPP). This is caused by pressure and by chemical autoregulation, which prevents under- and overperfusion of the brain. A MAP or CPP between 50 mmHg and 150 mmHg helps maintain adequate CBF. Outside this range, blood flow becomes linear with MAP. PaO_2 and $PaCO_2$ can change the diameter of vessels and affect blood flow to the brain. This autoregulation is lost after head trauma.[3,10]

Common head trauma injuries include[3,4]:

- Concussion: A brief loss of consciousness with no underlying histopathologic lesion.
- Contusion: Bruising of the brain associated with hemorrhage and edema.
- Coup and contrecoup lesions: At the site of impact and in the opposite brain hemisphere, respectively.
- Lacerations: Disruption of the brain parenchyma—the most severe injury.
- Hematomas: Several types can occur within the brain parenchyma (axial) or outside the brain (extraaxial) in the subarachnoid, epidural, or subdural sites. Any type of bleeding or hematoma formation can lead to increased intracranial pressure (ICP).

Head trauma consists of primary and secondary brain injuries. Primary injury (eg, fracture, hemorrhage) is the physical disruption of intracranial structures at the time of the event. Secondary injury, which can occur minutes to days following the TBI, is associated with a massive release of excitatory neurotransmitters and decreased availability of adenosine triphosphate (ATP), the energy required by all cells, which leads to cellular and cerebral edema.[5,6] Cerebral cells with low energy availability induce concurrent overproduction of oxygen free radicals, leading to further cell death.[5-7]

Severely increased ICP can ultimately impair blood flow to the brain (see **Figure 1**), leading to increased cerebral CO_2; the subsequent sympathetic nervous system response to increase blood pressure in an effort to restore cerebral blood flow (CBF) can lead to reflex bradycardia (Cushing reflex).[6,7] Hypercapnia can induce vasodilation and increase ICP; hypocapnia can induce vasoconstriction with subsequent cerebral ischemia. Pain and agitation can increase ICP.[6,7]

STEP 2
Treatment Plan ▶

Treatment Plan

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Focus assessment on the ABCs (ie, airway, breathing, circulation) and amelioration of shock. Correction of hypotension, hypoxemia, and either hypercapnia or hypocapnia is primary.[6] Once shock resuscitation and extracranial stabilization have occurred, repeated assessment using the Modified Glasgow Coma Scale can indicate survival probability and response to therapy[6-8] (see **Figure 2**). Avoid worsening other orthopedic injuries.

EXTRACRANIAL THERAPY

- Fluids: Rapidly restore normal extracellular fluid volume and composition to ensure adequate CPP with isotonic saline (in the absence of significant sodium derangements or other electrolyte disturbances) and/or artificial colloids.[4,6,7]
- Oxygen: Aim for PaO_2 of 80 to 100 mmHg or SpO_2 of 94% to 98%; avoid hyperoxemia.[7]
- Ventilation: Aim for low normal values for $PvCO_2$ of 40 to 45 mmHg and $PaCO_2$ of 35 to 40 mmHg, and for end tidal capnography, it can be up to 5 mmHg less than $PaCO_2$.[4,7]
- Blood pressure: Maintain mean arterial blood pressure (MAP) at 80 to 100 mmHg (above 100 mmHg with Doppler[4]); with a Cushing reflex, immediate hyperosmolar therapy to lower ICP is indicated.
- Opioids-mu agonists (reversible): For example, fentanyl.[7]

INTRACRANIAL THERAPY

- Provide hyperosmolar therapy to decrease cerebral edema: Mannitol or hypertonic saline increase the osmotic gradient across the blood brain barrier and improve blood flow through cerebral vessels. Hypertonic saline is preferred with hypotension and increased ICP but contraindicated with severe sodium derangements and dehydration; hypovolemia is a relative contraindication for mannitol.[4,7]
- Aim to maintain normothermia and avoid hyperthermia.[6] Induction of hypothermia has been reported in the literature but not extensively studied in veterinary medicine.[4,6]
- Aggressively treat seizures.[4,7]

FURTHER DIAGNOSTICS

Patients nonresponsive to aggressive medical management may need diagnostics such as a brain CT.[4,7]

GENERAL CARE

Care should include dry, well-padded bedding, bladder care if indicated (intermittent catheterization is preferred), frequent turning, passive range of motion, eye lubrication, GI protectants, nutritional support, and head elevation to increase venous drainage (15°-30° from horizontal).[3,6,7]

CONTRAINDICATIONS

Corticosteroids are not recommended for TBI.[4,6,7,9] Juglar venipucture for blood sampling is also contraindicated.

CONCLUSION

Oxygen, blood pressure, body temperature, and ventilation maintenance are imperative to maintain normal CPP. Hypovolemic shock and extracranial therapy must be instituted before intracranial assessment and therapy; shock can contribute to poor mentation and neurologic status. In the author's experience, these patients can do quite well.

MOTOR ACTIVITY	
Recumbent, constant extensor rigidity	3
Recumbent, constant extensor rigidity with opisthotonus	2
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1
BRAIN STEM REFLEXES	
Pinpoint pupils with reduced-to-absent oculocephalic reflexes	3
Unilateral, unresponsive mydriasis with reduced-to-absent oculocephalic reflexes	2
Bilateral, unresponsive mydriasis with reduced-to-absent oculocephalic reflexes	1
LEVEL OF CONSCIOUSNESS	
Semicomatose, responsive to auditory stimuli	3
Semicomatose, responsive only to repeated noxious stimuli	2
Comatose, unresponsive to repeated noxious stimuli	1

Figure 2. A portion of the **Modified Glasgow Coma Scale.**[8] Total score of 3-18. The lower the score, the more guarded the prognosis. For the complete scale, see veterinaryteambrief.com/modified-glasgow-coma-scale.

STEP 3
Team Roles ▶

Team Roles

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RECEPTIONIST

Client communicator

- Listen to client concerns over the phone; if it is an emergency situation, instruct the client to remain calm and immediately bring the patient to the practice
- Gather patient information to help with paperwork when the client and patient arrive
- Alert the team that an emergent patient is on the way

TECHNICIAN

Client educator, patient caregiver

- Take a brief patient history
- Get information about how and when the trauma occurred
- Help the veterinarian with initial treatment and patient assessment
- Communicate with the client and keep him or her updated throughout the initial triage process

VETERINARIAN

Medical expert, client and team educator

- Examine the patient, looking at the airway, breathing, circulation, neurologic status, orthopedic status, and pain level
- Initiate initial diagnostics and develop a treatment plan
- Be aware of acute and delayed complications of TBI
- Keep the client informed of the patient's status and progress
- Oversee the continued care of the patient

PRACTICE MANAGER

Team and client education facilitator

- Maintain good communication skills
- Have triage protocol and specific trauma guidelines in place to help initiate prompt assessment of patients
- Develop team training guidelines

STEP 4
Team Training Plan ▶

Creating a Practice Protocol

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Because time is critical for TBI patients, the practice should have a protocol in place. Make protocol development a fun team exercise. During a team meeting, ask every team member to write on sticky notes each step he or she should take to handle a TBI situation, using one note per step. Then, ask each team member to stick his or her notes on a wall in step-by-step order. The team should decide if they need to add any missing steps. This exercise will also emphasize each team member's role in aiding the patient and client.

Quick action is essential for TBI cases and every team member must be well-trained in the required steps.

Once the protocol is finalized, the team should role-play a TBI presentation.

Following is a suggested protocol:

- The front-desk team greets the patient and client, recognizes the emergency situation, and visually assesses the patient: Is the patient conscious? Bleeding? Breathing? Having a seizure?
- Often the client is extremely distraught; team members should calm him or her and offer to call friends or family.
- One team member obtains the patient's records and gathers patient and client information.
- Veterinary technicians or assistants carry the patient to the examination or treatment room. Other veterinary technicians should prepare the necessary tools (eg, x-ray machine, IV catheters and fluids).
- The front-desk team members alert the veterinarian, who joins the technicians in evaluating the patient. They stabilize the patient, if possible, and create a treatment plan that includes a probable prognosis.
- The veterinarian meets with the client and discusses the prognosis, including treatment options or euthanasia if the prognosis is extremely poor.
- The veterinary technician reviews the treatment plan and the costs with the client.
- The veterinary technician or a front-desk team member ensures the appropriate forms are signed and a deposit is collected.

Quick action is essential for TBI cases and every team member must be well-trained in the steps required to care for both the patient and the client.

Read All About It

- Boss N. *Educating Your Clients from A to Z: What to Say and How to Say It*. 2nd ed. Lakewood, CO: AAHA Press; 2011.

STEP 5
Communication Keys ▶

Client Communication

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Clients whose pet has a TBI are often extremely upset, and the entire team is responsible for helping soothe and support them. Team members should be able to read client body language and react appropriately. Some clients will be more emotional and want physical contact, whereas others will be more controlled and just want verbal reassurance.

A steady, panic-free veterinary team can provide the most comfort to the client. Feeling that competent, well-prepared team members are caring for his or her pet is encouraging and stress-reducing. Here are some tips for communicating with clients:

- When explaining the patient's care and treatment, all team members should avoid medical language that may be confusing to the client. Describe the situation so that the client can relate. For example, make drawings that show brain swelling or use a pain scale to help with understanding the degree of pain.
- Front-desk team members are likely first to support and calm clients. Show empathy for their distress.
- Veterinary technicians should also show empathy when discussing the treatment process. Let the client know that a test will take 10 minutes rather than leaving him or her in an examination room with no idea what is taking place. Show compassion and collaboration by sitting beside the client instead of standing across the examination table during discussions. Take care to show the value and necessity of suggested services.
- Despite the situation's urgency, the veterinary technician should always take a history. Ask open-ended questions that require the client to tell a story about what happened. Note the difference between *What questions do you have*, which opens the dialogue, and *Do you have any questions,* which likely closes the conversation with *No.*
- If the patient is hospitalized, continue to communicate with the client about any changes in the treatment plan with updates on the patient's progress and treatment costs.
- If the prognosis warrants euthanasia, concern for the client is paramount. Every team member should show compassion and understanding. Make a quiet place available for the client to say *Goodbye*. If necessary, have a team member stay with the client until he or she gains composure, especially if the client is too distraught to drive. Handle the remains with respect.

Editor's note: *Dr. Pamela K. Fettig has had an extensive career as a veterinarian, with a focus in anesthesia. Her interests include traumatic brain injury, acute kidney injury, sepsis, polytrauma, and electrolyte abnormalities.*

Debbie Boone is a practice consultant with more than 30 years of experience—23 as hospital administrator and COO of both small and mixed animal practices. She is a certified veterinary practice manager with a certification in customer service. Her focus is on coaching exceptional communication, client service, and team culture.

References

1. Simpson SA, Syring R, Otto CM. Severe blunt trauma in dogs: 235 cases (1997-2003). *JVECC*. 2009;19(6):588-602.
2. Syring RS, Otto CM, Drobatz KJ. Hyperglycemia in dogs and cats with head trauma: 122 cases (1997-1999). *JAVMA*. 2001;218(7):1124-1129.
3. Freeman C, Platt S. Head Trauma. In: Platt S, Garosi L, eds. *Small Animal Neurological Emergencies*. London, UK: Manson Publishing; 2012:363-382.
4. Fletcher DJ, Syring R. Traumatic Brain Injury. In: Silverstein DC, Hopper K, eds. *Small Animal Critical Care Medicine*. 2nd ed. Philadelphia, PA: Elsevier; 2015:723-727.
5. Dewey CW, Fletcher DJ. Head Trauma Management. In: Dewey CW, ed. *A Practical Guide to Canine & Feline Neurology*. 2nd ed. Ames, IA: Wiley Blackwell Publishing; 2008:221-235.
6. Sande A, West C. Traumatic Brain Injury: A review of pathophysiology and management. *JVECC*. 2010;20(2):177-190.
7. DiFazio J, Fletcher DJ. Updates in the Management of the Small Animal Patient with Neurologic Trauma. *Vet Clin North Am Small Anim Pract*. 2013;43(3):915-940.
8. Platt SR, Radaelli ST, McDonnell JJ. The prognostic value of the modified Glasgow Coma Scale in head trauma in dogs. *JVIM*. 2001;15(6):581-584.
9. Roberts I, Yates D, Sandercock P. Effect of intravenous corticosteroids on death within 14 days in 10,008 adults with clinical significant head injury (MRC CRASH trial): Randomized placebo-controlled trial. *Lancet*. 2004;364(9442):1321-1328.
10. Sturges B, LeCouteur R. Intracranial Hypertension. In: Silverstein DC, Hopper K, eds. *Small Animal Critical Care Medicine*. 2nd ed. Philadelphia, PA: Elsevier Saunders; 2015:436-442.