BRAIN INJURY

BASICS

OVERVIEW

- Primary brain injury—direct result of initial insult to the brain; cannot be altered
- Secondary brain injury—alteration of brain tissue (such as bleeding or swelling) that occurs after the primary injury; can be prevented or improved with optimal supportive care

SIGNALMENT/DESCRIPTION of ANIMAL

Species

- Dogs and cats

SIGNS/OBSERVED CHANGES in the ANIMAL

- Decline in the level of consciousness—implies progression of secondary brain injury from bleeding in the skull (known as "intracranial bleeding"), lack of blood flow to the brain (known as "ischemia"), or fluid build-up within the brain (known as "cerebral edema")
- Seizure activity
- Evidence of trauma (to the head or other parts of the body)
- Bluish discoloration of the skin and moist tissues (known as "mucous membranes") of the body caused by inadequate oxygen levels in the red-blood cells (known as "cyanosis")
- Bruising; bleeding into tissues of the eyes
- Blood from the ears or nose—trauma with bleeding into the skull (intracranial bleeding)
- Separation of the back part of the eye (retina) from the underlying, vascular part of the eyeball (known as the "choroid;" condition known as "retinal detachment")
- Heart or breathing abnormalities
- Abnormalities of the skull—skull fractures
- Constricted or dilated pupils—may involve one or both eyes; pupils may be uneven in size; response of the pupils to light may be altered
- Abnormalities of the nervous system; abnormalities can change over time

CAUSES

- Head trauma
- Prolonged low levels of oxygen (known as "hypoxia") or decreased or lack of blood flow (ischemia) to tissues in the brain
- Severe low levels of glucose (sugar) in the blood (known as "severe hypoglycemia")
- Prolonged seizures
- Severe increase in body temperature (known as "hyperthermia") or decrease in body temperature (known as "hypothermia")
- Changes in concentrations of chemicals in the blood (such as sodium or glucose)
- Prolonged shock
- Increased blood pressure (known as "hypertension")
- Migration of parasites through brain tissue
- Infectious diseases
- Immune-mediated diseases
- Thiamine (a B vitamin) deficiency
- Poisons
- Brain tumor
- Stoppage of the heart (known as "cardiac arrest")
- Severe heart failure
- Blood clots to the brain
- Blood-clotting disorders, leading to bleeding in the brain
- Prolonged breathing compromise

RISK FACTORS

- Free-roaming animal—trauma, exposure to poisons
- Coexisting heart and lung disease
- Uncontrolled high levels of glucose (sugar) in blood (known as "hyperglycemia")

TREATMENT

HEALTH CARE

- Goals of therapy: maximize oxygen levels in the brain; support blood pressure and blood flow to the brain; decrease pressure within the skull (known as "intracranial pressure"); decrease metabolism of the brain

• Avoid cough or sneeze reflex during passage of an endotracheal tube into the windpipe or trachea (known as "tracheal intubation") or oxygen supplementation into the nose—cough or sneeze reflex may elevate pressure within the skull (intracranial pressure)
• Do not block blood flow in the jugular veins
• Carefully administer fluids; excessive administration of fluids can contribute to fluid build-up in the brain (cerebral edema)
• If suspect bleeding, administer crystalloids alone (normal saline or isotonic balanced solution); "crystalloids" are fluids that contain electrolytes (chemical compounds, such as sodium, potassium, chloride) necessary for the body to function, crystalloids generally are similar to the fluid content (plasma) of the blood and move easily between the blood and body tissues, example is lactated Ringer's solution
• If low blood pressure (hypotension) or significant inflammation of blood vessels (known as "vasculitis") is present, a combination of crystalloids with large-molecular-weight colloids may be administered; colloids are fluids that contain larger molecules that stay within the circulating blood to help maintain circulating blood volume, examples are hetastarch and Oxyglobin®
• Avoid high blood pressure (hypertension)
• Keep head level with body or elevate to a 20° angle; head should never be lower than the body
• Maintain unobstructed airways; use suction and humidify air, if the animal is intubated
• Lubricate the eyes
• Position recumbent animal on its breastbone (sternum); if lying on its side, turn the patient every 2 hours to avoid lung congestion
• Meticulous nursing care prevents secondary complications of recumbency
• Prevent fecal/urine soiling
• Maintain body temperature at normal temperature or mildly decreased temperature (slight hypothermia); avoid increased body temperature (hyperthermia)
• Maintain hydration with balanced fluid solutions

ACTIVITY
• Restricted

DIET
• Initiate nutritional support to meet increased metabolic demands
• Tube-feeding may be required for early nutritional support

SURGERY
• Surgery may be necessary for depressed skull fracture, computed tomography (CT or CAT scan) or magnetic resonance imaging (MRI) evidence of surgical problem, or penetrating foreign body

MEDICATIONS

Medications presented in this section are intended to provide general information about possible treatment. The treatment for a particular condition may evolve as medical advances are made; therefore, the medications should not be considered as all inclusive.

Elevated Intracranial Pressure
• Lower intracranial pressure by increased breathing rate to decrease carbon dioxide levels (known as "hyperventilation"), drug therapy, drainage of cerebrospinal fluid, or surgical decompression
• Mannitol—improves brain blood flow and lowers intracranial pressure; may worsen bleeding in the brain
• Hypertonic saline (7%)—decreases intracranial pressure; may be used instead of mannitol; may worsen fluid build-up in the brain (cerebral edema) if it gets outside of the blood vessels
• Medication to remove excess fluid from the body (known as a "diuretic"), such as furosemide—decreases cerebrospinal fluid production; lowers intracranial pressure; used in patients with bleeding, congestive heart failure, and kidney failure characterized by the lack of production of urine (known as "anuric kidney failure"); use before mannitol or as sole diuretic
• Steroids (high-dose methylprednisolone)—no benefit in acute management of brain injury in people; no improvement on long-term outcome
• Provide analgesia/sedatives, as indicated
• Prevent thrashing, seizures, or uncontrolled motor activity—such activity may elevate intracranial pressure; diazepam may be required
• Consider loading dosage of phenobarbital, if seizure activity is present
• Desmopressin (DDAVP) for cases with high levels of sodium in the blood that does not respond to medical treatment (known as "refractory hypernatremia"); desmopressin is a synthetic antidiuretic hormone (ADH), the hormone that decreases the amount of water in the urine and thus, maintains hydration of the body
• Medically induced (barbiturate) coma—for increased intracranial pressure that does not respond to treatment to lower metabolism in the brain; must pass an endotracheal tube into the windpipe or trachea (intubate) and support blood pressure, oxygenation, and breathing

Other

• Cooling the patient down to 32º to 33° C (89º to 91° F) may provide brain protection, when done within 6 hours of severe brain injury
• Glucose supplementation—as required for low levels of glucose (sugar) in the blood (hypoglycemia)
• Insulin—as required for high levels of glucose (sugar) in the blood (hyperglycemia); requires close monitoring of blood glucose
• Cisapride may be necessary to promote gastrointestinal motility; cisapride is a drug that improves the movement of contents through the stomach and intestines (known as a "gastrointestinal prokinetic agent")

FOLLOW-UP CARE

PATIENT MONITORING

• Repeated nervous system examinations—to detect deterioration of function that warrants aggressive therapeutic intervention
• Blood pressure—to keep fluid therapy adequate for blood flow to the brain, but avoid high blood pressure (hypertension)
• Blood gases (measurements of oxygen and carbon dioxide levels in arterial blood)—to assess need for oxygen supplementation or ventilation
• Blood glucose—maintain at 80 to 120 mg/dl
• Electrocardiogram ("ECG," a recording of the electrical activity of the heart)—to detect irregular heartbeats (known as "arrhythmias") that may affect blood flow and oxygen levels in the brain
• Intracranial pressure—to detect significant elevations; monitor success of treatment

PREVENTIONS AND AVOIDANCE

• Keep pets in a confined area with supervised activity (avoid trauma and exposure to poisons)

POSSIBLE COMPLICATIONS

• Increasing intracranial pressure
• Brain pushes downward in the skull and herniates through the opening that leads to the neck (known as "tentorial herniation" or "brain herniation"), leading to death
• Bleeding into the skull (intracranial hemorrhage)
• Progression of signs, indicating deterioration of brain injury
• Seizures
• Malnutrition
• Lung congestion (secondary to lying down)
• Drying of the corneas (the clear outer layer of the front of the eye)
• Skin lesions that develop due to contact with urine, when the hair and skin remain damp (known as "urine scald")
• Airway blockage from accumulation of mucus
• Irregular heartbeats (arrhythmias)—usually involves a slow heart rate (known as "bradyarrhythmias")
• Low blood pressure (hypotension)
• Increased levels of sodium in the blood (hypernatremia)
• Decreased levels of potassium in the blood (known as "hypokalemia")
• Breathing failure
• Death

EXPECTED COURSE AND PROGNOSIS

• Minimal primary brain injury and secondary injury consisting of fluid build-up in the brain (cerebral edema)—best prognosis
• No deterioration of nervous system status for 48 hours—better prognosis
• Rapid resuscitation of systolic blood pressure to greater than 90 mmHg—better outcome
• Maintenance of blood glucose at 80 to 120 mg/dl associated with better outcome in people

KEY POINTS

• The extent of brain recovery may not be evident for several days; and may be more than 6 months for residual nervous system deficits
• Serious generalized (systemic) abnormalities may contribute to the instability of the nervous system