

Bradycardia

- 1** Communicate with surgeon & team
 - Stop surgical manipulation
 - Consider requesting addl help
- 2** Check the patient:
 - Pulse quality, capillary refill time
 - If no pulse/hr, go to *cardiac arrest flow sheet*
 - Assess ECG - verify sinus bradycardia
 - (vs 3rd degree AV block, idioventricular rhythm)
 - Verify adequate oxygenation & ventilation
- 3** Decrease or discontinue inhalant delivery
 - Consider reversal of alpha-2 agonists +/- opioids
- 4** Administer atropine:
 - Start with 0.05 mg/kg if bradycardia is severe & affecting perfusion
- 5** If atropine ineffective:
 - Consider epinephrine, dobutamine, or isoproterenol infusion
 - Consider possibility of hyperkalemia
 - Consider cardiology consult
 - Consider transcutaneous pacing

Bradycardia:

Large dog: HR <60 bpm with hypotension or HR <50 bpm

Small dog/cat: HR <80 bpm with hypotension or HR <60 bpm

Drug doses:

Atipamazole 90 - 400 mcg/kg IM or IV

Atropine 0.015 - 0.05 mg/kg IV

Epinephrine bolus 0.005 mg/kg IV

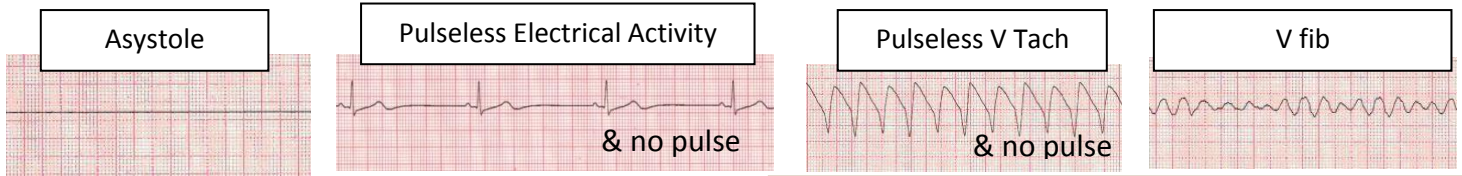
Epinephrine 0.01 - 0.2 mcg/kg/min IV

Dobutamine 10 - 20 mcg/kg/min IV

Isoproterenol 0.04 - 0.09 mcg/kg/min IV

Naloxone 0.01 - 0.05 mg/kg IV

Cardiac Arrest



- 1** Call for help
Check airway and IV access
- 2** Start compressions 100 – 120 bpm
Allow full recoil between compressions
Continue uninterrupted for 2 minutes following drugs/defib
Consider open chest compressions through diaphragm (surgeon)
- 3** Discontinue inhalant delivery, flush circuit with O₂
Consider reversal of alpha-2 agonists, opioids, and benzodiazepines
- 4** Ventilate 8 -12 bpm with 100% O₂
Do not overventilate
- 5** Give low dose epinephrine and atropine IV
- 6** If shockable rhythm (VT/VF), defibrillate @ 3-5 J/kg
- 7** Monitor ETCO₂
If < 10 mmHg, re-assess CPR technique
If >30 mmHg, may indicate ROSC
- 8** Assess every 2 minutes
Switch personnel providing compressions
Check rhythm
If rhythm acceptable, check pulse
If arrest rhythm continues, go to step 2
- 9** Repeat drug administration every 3-5 minutes
Give high dose epinephrine on 3rd round of drug delivery

Drug doses:

Atipamazole 200 mcg/kg IV
Atropine 0.05 mg/kg IV
Epinephrine (Low Dose) 0.01 mg/kg IV
Epinephrine (High Dose) 0.1 mg/kg IV
Flumazenil 0.01 mg/kg IV
Naloxone 0.01 - 0.05 mg/kg IV

Reversible Causes (H's & Ts):

Hypovolemia	Toxins (including anesthetic overdose)
Hypoxia	Tamponade
Hydrogen ion (acidosis)	Tension pneumothorax
Hyper/hypokalemia	Thrombosis (pulmonary)
Hypo/hyperthermia	Trauma (including surgical)
Hypoglycemia	

Delayed Emergence

1 Check the patient

Heart rate and rhythm, pulse quality, respiratory rate and character, mm color and CRT.

Is the airway adequately protected?

Ensure all inhalant and injectable anesthetics are discontinued

Stimulate the patient (rubbing vigorously, flipping recumbency)

2 Check for hypothermia, hypotension, hypoxemia, hypercarbia

3 Review anesthetic record

Check for medication error (dose or wrong drug)

Profound physiologic disturbance during anesthesia?

4 Check for hypoglycemia, anemia, electrolyte, or acid-base abnormality

5 Consider reversal of alpha-2 agonists, opioids, and benzodiazepines

Consider reversal of neuromuscular blockers

6 Consider pre-existing disease (severe liver disease, Addison's, intracranial disease) or new neurologic disorder (ischemia/↑ICP)

Delayed Emergence:

Most patients can be extubated within **15 to 20 minutes**

Following long procedures, stable patients should be extubated **within 45 minutes**

Drug doses:

Atipamezole 90 – 300 mcg/kg IM

Edrophonium 0.2 mg/kg IV & atropine 0.02 mg/kg

Flumazenil 0.01 – 0.02 mg/kg IV

Naloxone 0.01 - 0.05 mg/kg IV (start low, dilute dose, and administer ¼ of the final volume every few minutes)

Hemorrhage

- 1 Communicate** with surgeon & team; get help.
- 2 Check the patient**, including color, CRT, pulse quality and BP
Consider **decreasing inhalant delivery; keep patient warm**
- 3 Estimate blood loss**
Check floor and table
Weigh sponges (1 mL blood = 1 gram)
Measure volume of blood in suction canister
- 4 Bolus crystalloid fluids** (balanced isotonic or hypertonic), +/- artificial colloids
- 5 Consider transfusion** with >20% loss of blood volume & signs of systemic perfusion deficit (persistent hypotension, incr BE, lactate), PCV/TS approaching 20/4.0, or if estimated blood loss exceeds calculated maximum allowable blood loss.
Consider pretx with diphenhydramine
Blood typing recommended for cats
Universal donor blood can be administered to dogs if first transfusion
- 6 Submit CBC, PT/PTT, arterial blood gas** with electrolytes, lactate
- 7 Consider administration of aminocaproic acid**
- 8 Monitor** for development of hypocalcemia and hyperkalemia
Transfusion reaction may be masked during general anesthesia
- 10 Massive transfusion**
> 50% of blood volume in 3h, full blood volume in 24h
Administer 1:1 ratio FFP:unit of pRBCs

Allowable Blood Loss (ABL):

$$ABL = EBV \times (HCT_i - HCT_f / HCT_{avg})$$

HCT_i = initial HCT

HCT_f = lowest allowable HCT

HCT_{avg} = average of initial and final HCT

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Estimated blood volume

(EBV):

Dogs ~ 90 mL/kg

Cats ~50 mL/kg

Drug Doses:

Balanced crystalloids

3:1 vol:vol with estimated blood loss

Hypertonic crystalloids 4 mL/kg/15 minutes

Artificial colloids

1:1 vol:vol with estimated blood loss

Aminocaproic acid 50 – 100 mg/kg for 1 hour,
then 15 mg/kg/hr for 6 -8 hours

Diphenhydramine 2 mg/kg IM

Volume to transfuse:

Whole blood mL =

$$BW_{kg} \times \text{blood volume} \times \frac{[(\text{desired PCV} - \text{recipient PCV})]}{\text{Donor PCV}}$$

Or Whole blood ~20 mL/kg

PRBC (mL) = 1.5 × desired rise in PCV × BW_{kg} (dogs)

Or PRBCs ~ 10 mL/kg

Hyperkalemia

1 Check the patient:

Heart rate/rhythm, pulse quality, capillary refill time,
& anesthetic depth

If no pulse/hr, go to *cardiac arrest flow sheet*

2 Stop IV solutions containing potassium, including blood products

3 Hyperventilate patient to 30 mmHg ET CO_2 to induce alkalosis

4 Administer calcium gluconate to restore membrane potential difference

5 Administer regular insulin with dextrose to drive K^+ into cells

6 Consider sodium bicarbonate and β_2 agonists

7 Correct underlying cause

Hyperkalemia: $\text{K}^+ > 5.5 \text{ mEq/L}$

Do not anesthetize a patient with $\text{K}^+ > 6 \text{ mEq/L}$

Associated ECG changes:

tall peaked T waves

bradycardia

loss of P waves

wide QRS complexes



Possible: tachyarrhythmias

ventricular rhythms

asystole

Drug Doses:

Calcium gluconate 50 – 100 mg/kg (0.5 – 1.0 mL/kg)

Regular insulin 0.25 – 0.5 U/kg IV with
dextrose 1 mL/kg

Sodium bicarbonate 1- 2 mEq/kg (1 – 2 mL/kg)

Inhaled albuterol 20 – 100 mcg/kg

Terbutaline 0.01 mg/kg

Possible Causes:

Acute renal insufficiency

Addisonian crisis

Iatrogenic

Malignant hyperthermia

Severe burns and crushing injuries

Transfusion of “old” blood, massive transfusion

Tumor lysis syndrome

Urethral obstruction

Uroabdomen

Greyhounds & large exotic cats?

Hypotension

1 Communicate with surgeon & team

Surgical hemorrhage? Vascular compression?
Consider requesting addl help

2 Check the patient:

Heart rate/rhythm, pulse quality, capillary refill time,
oxygenation, ventilation, & anesthetic depth
If bradycardia, go to *bradycardia flow sheet*
If no pulse/hr, go to *cardiac arrest flow sheet*

3 Decrease inhalant delivery

Consider partial injectable technique

4 Consider equipment error

Assess integrity of anesthetic circuit
Check BP cuff placement
Obtain BP reading with another machine

5 Administer IV fluid bolus

Balanced crystalloids
Hypertonic saline
+/- artificial colloids

6 Administer pressors and/or inotropes

Ephedrine bolus to temporize
Dopamine or dobutamine infusion
Norepinephrine infusion
Severe refractory hypotension: epinephrine bolus or infusion

Hypotension:

Systolic Arterial Pressure <80 mmHg

Mean Arterial Pressure <60 mmHg

Diastolic Arterial Pressure <40 mmHg

<30% reduction from awake baseline

Drug doses:

Balanced crystalloids

5–10 mL/kg over 5-10 minutes

(~20-30 mL/kg total volume)

Hypertonic saline

4 mL/kg over 15 minutes

Artificial colloids

3-5 mL/kg over 10 minutes

Ephedrine bolus 0.03 – 0.1 mg/kg IV

Dopamine infusion 2-20 mcg/kg/min

Dobutamine infusion 2-20 mcg/kg/min

Norepinephrine infusion 0.1–2 mcg/kg/min

Epinephrine bolus 0.005 mg/kg

Epinephrine infusion 0.005-0.2 mcg/kg/min

Vasopressin 0.5 – 5 mU/kg/min

Hypoxemia

1 Call for additional help

2 Check the patient:

Heart rate/rhythm, pulse quality, capillary refill time,
& anesthetic depth

Consider decreasing anesthetic depth

If no pulse/hr, go to *cardiac arrest flow sheet*

3 Assess **oxygen supply**

Check supply pressure and flow meter

Assess integrity of the anesthetic machine,
anesthesia circuit, and connection to the ETT

Check FiO₂ (gas analyzer), increase to 100%

4 Confirm presence of **ETCO₂** & **assess waveform**

5 **Ventilate** by hand

Assess compliance

Confirm presence of ETCO₂ & assess waveform

Listen to breath sounds on both sides of chest

6 Consider:

suctioning airway

discontinuing anesthetic event

obtaining thoracic radiographs

performing an alveolar recruitment maneuver/PEEP

submitting an arterial blood gas

Hypoxemia:

Low arterial oxygen concentration

Pulse oximetry reading $\leq 94\%$

Think: Equipment or Patient?

Equipment:

Oxygen supply failure

Mis- or disconnection
of circuit

Airway obstruction

Endobronchial
Intubation

Extubation

Patient

Respiratory:

Apnea, anaphylaxis, aspiration,
asthma/bronchospasm,
diaphragmatic hernia,
hypoventilation, obesity,
pleural fluid, pneumothorax,
pneumonia, pulmonary edema

Cardiovascular:

Anatomical shunt, congestive
heart failure, pulmonary
embolus, reduced pulmonary
perfusion/low cardiac output

{Abnormal hemoglobin
– low SpO₂, normal PaO₂}

Local Anesthetic Systemic Toxicity

1 Call for additional help

Stop local anesthetic injection, if possible

2 Check the patient

If no pulse/hr, go to *Cardiac Arrest Checklist*

Verify adequate **oxygenation & ventilation**

3 Discontinue inhalant delivery

Consider reversal of alpha-2 agonists and opioids

4 If severe hypotension, administer **low dose epinephrine**

5 Administer **Intralipid**

6 Treat seizures with diazepam

7 Avoid local anesthetics, β blockers, & Ca^{++} channel blockers

Clinical Signs:

Seizures (when conscious), hypotension,
bradycardia, ventricular arrhythmias,
cardiovascular collapse

Drug doses:

Atipamezole 300 mcg/kg IV slowly

Diazepam 0.5 mg/kg IV

Epinephrine 0.01 mg/kg IV

Naloxone 0.01 - 0.05 mg/kg IV

Intralipid Dosing:

Bolus 1.5 mL/kg over 1-5 minutes

Follow with **continuous infusion 0.25 mL/kg/min**

Repeat bolus once or twice for persistent cardiovascular collapse

Double the infusion rate to 0.5 mL/kg/min if hypotension persists

Continue infusion at least 10 minutes beyond attaining cardiovascular stability

Reflux (Witnessed)

1 Check the endotracheal tube seal

Minimum no-leak volume to 25 cmH₂O

Assess with cuff manometer

2 Check pH of reflux

3 Flush esophagus with warm tap water

Red rubber urinary catheter

Catheter tip 35 – 60 mL syringe

Source of active suction

Do not cross LES with catheter (9th rib)

Flush until suctioned water is clear

4 Consider:

Systemic H₂ blocker or proton pump inhibitor

Localized bicarbonate infusion

Oral sucralfate once awake

5 Monitor for cough, increased respiratory rate, & regurgitation

Reflux:

*Passive movement of stomach contents across
the lower esophageal sphincter (LES)*

Possible Sequelae:

Aspiration pneumonia

Esophageal stricture

Rhinitis

Drug doses:

Bicarbonate 10 – 30 mL of 4.2% soln

Famotidine 0.5 – 1 mg/kg IV q12h

Sucralfate 0.5 - 1 gram PO q8h

Supraventricular Tachycardia

1 Check the patient

Auscult chest, palpate pulse

If no pulse, go to Cardiac Arrest Checklist

Assess hemodynamic results – poor perfusion/hypotension?

2 Decrease or discontinue inhalant delivery

Confirm adequate oxygenation and ventilation

3 Consider carotid sinus massage

4 Control rate

Diltiazem slowly IV

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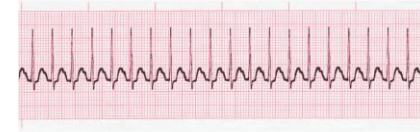
Esmolol slowly IV

5 Primary differential is sinus tachycardia (d/t sympathetic stimulation)

More likely SVT if rate > 250 bpm, irregular, sudden onset/offset

Supraventricular Tachycardia:

Narrow complex tachycardia, HR > 200



Drug doses:

Diltiazem 0.05 mg/kg IV administered in increments over 2 – 5 minutes, can repeat cautiously up to 0.25 mg/kg

Esmolol 0.25 mg/kg IV administered in increments over 2 – 5 minutes followed by 10 – 200 mcg/kg/min

Ventricular Tachycardia

1 Check the patient

Auscult chest, palpate pulse

If no pulse, go to Cardiac Arrest Checklist

Assess hemodynamic results – poor perfusion/hypotension?

2 Decrease or discontinue inhalant delivery

Confirm adequate oxygenation and ventilation

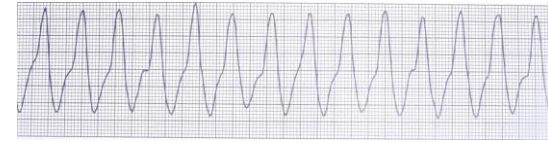
3 Administer lidocaine

4 Consider procainamide or esmolol

5 Primary differential is an SVT with a bundle branch block (consider diltiazem – go to SVT checklist)

Ventricular Tachycardia:

Wide complex tachycardia, HR > 200



Drug doses:

Esmolol 0.25 mg/kg IV administered in increments over 2 – 5 minutes followed by 10 – 200 mcg/kg/min

Lidocaine (dogs) 2 mg/kg IV, can repeat once or twice. Follow with 50 – 100 mcg/kg/min

Procainamide 2 – 4 mg/kg slowly over 2 minutes. Follow with 10 – 40 mcg/kg/min