# Anesthesia in the High Volume Spay/Neuter Environment

*What's Different??*

Lydia Love DVM DACVAA

May 2018

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FOUNDED IN 1975

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THE AMERICAN SOCIETY FOR THE PREVENTION OF CRUELTY TO ANIMALS

# Anesthesia in the High Volume Spay/Neuter Environment

- Mortality data
- Patient Differences
- Systems Differences
- Differences in Drug Administration

# Anesthesia-Related Mortality

- Confidential Enquiry into Perioperative Small Animal Fatalities
  - Prospective
  - UK 2002 – 2004, 117 facilities
  - 98k dogs, 79k cats, 8k rabbits
  - Healthy dogs 1:1849
  - Healthy cats 1:895
  - Healthy rabbits 1:137

ASA I & II

# Anesthesia-Related Mortality

- Banfield Retrospective (2017)
  - 273,684 cats
  - 1,269,582 dogs

  - Cats 1:909
  - Dogs 1:2000

ASA I - V

# HVSN Mortality

- Stationary HVSN clinic in FL (2017)
- Retrospective
- 71,557 cats
- 42,349 dogs

- Cats 1:2000
- Dogs < 1:10,000

ASA ?

# Anesthesia-Related Mortality

- Difficult to directly compare studies
  - Patient populations, statistics, definitions vary widely
  - A well run HVSN clinic may even exhibit better mortality data than some other clinical settings

- Anesthesia-related death in humans ~1:200,000

# Anesthesia in the High Volume Spay/Neuter Environment

- Mortality data
- Patient Differences
- Systems Differences
- Differences in Drug Administration

# Patient Differences

- Owned dogs and cats

- Community trapped cats

- Pediatrics

- Pregnant and lactating

# Owned Dogs & Cats

- May not have full history
  - Vaccines?
  - Parasitism?
  - Co-existing disease?

- May not have contact with the owner
- Preanesthetic bloodwork usually not available
- May not know fasting status

# Fasting Recomendations

- Healthy adults
  - Light meal 4 - 6 hours prior
  - Water is fine until premedication

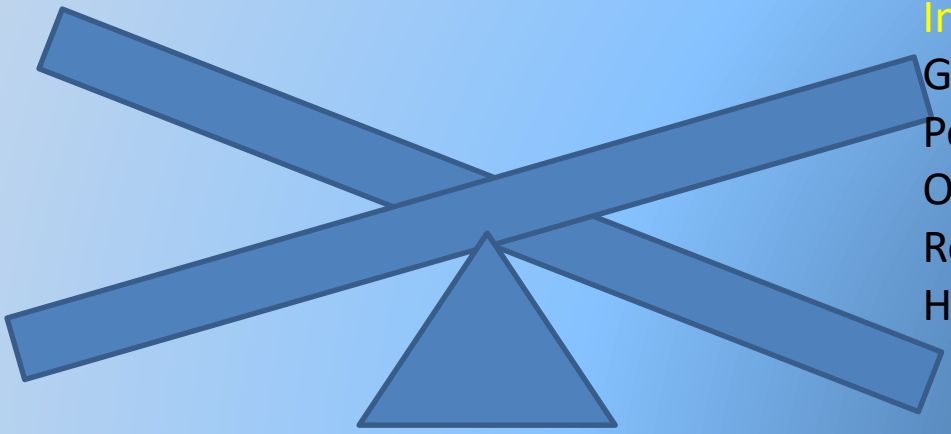
# Patient Assessment

Focused on cardiorespiratory systems

^

and urogenital

Fertile Patient Population



Increased Perianesthetic Risk

Geriatric

Pediatric

Obese

Respiratory Infection

Heart murmur

# ASA Physical Status

- ASA I — Healthy, exercise tolerant
- ASA II — Mild compensated disease, exercise tolerant
- ASA III — Severe systemic disease but not incapacitating
- ASA IV — Uncompensated systemic disease
- ASA V — Moribund

Healthy exercise tolerant patient is best anesthetic candidate!

# Feral Cats

- Staff safety
- Examine may take place after chemical restraint
- Weight and health status may be estimated

# Pediatrics

- 6 – 12 weeks

- Major issues:

  Warmth & Sugar

# Pediatrics: Thermoregulation

- Higher body surface area:mass
- Minimal fat reserves
- Hypothermia
  - Decreases MAC
  - Prolongs recovery
  - Stresses the cardiovascular system
  - Delays clotting
  - Increases risk of surgical site infection
  - Causes shivering, increasing metabolic $O_2$ requirements
  - Unpleasant

# Preventing Hypothermia

- Pre-emptive warming
- Avoid unnecessary hair removal
- Use warmed surgical prep solutions
  - Avoid alcohol
- Warmed IV fluids

# Managing Hypothermia

- Passive Surface Warming
  - Insulate from metal
  - Baby socks/bubble wrap/space blankets/plastic sheeting
- Active Surface Warming
  - Warm water blankets, forced warm air, resistive blankets
- Active Core Warming
  - Irrigate abdomen with sterile saline ~104°F/40°C

# First, Do No Harm

# Pediatrics

- Do not fast for more than 4 hours maximum
- Nursing pediatrics should stay with mother and be returned as soon as possible
- Monitor BG if possible
- Karo syrup on gums
- IV dextrose should be available
- Return to eating quickly

# Pediatrics

- Pharmacokinetic differences from adults
  - More total body water
    - Larger volumes of distribution for water soluble drugs
  - Hypoalbuminemic
    - Highly protein bound drugs maybe more available
  - BBB not as well developed
  - Metabolic and excretory pathways may not be developed

Titrate drugs to effect

# Pediatric Cardiorespiratory Systems

- Cardiac output = HR x stroke volume
- Pediatric patients cannot increase contractility or manage vasomotor tone
  - Blood pressure (organ perfusion pressure) almost entirely dependent on cardiac output
  - Avoid bradycardia

- Respiratory
  - High metabolic $O_2$ demand
  - Fixed tidal volume so dependent on high RR
  - Supplement $O_2$ & be prepared to ventilate

# Pediatrics - Blood Loss

- Healthy adult dogs/cats
  - What is allowable blood loss (ABL)?
  - ~20%
  - How about for pediatrics??
  - ~4%

- Estimated blood volume = $BW_{kg}$ * 75 mL/kg
- 1kg = 75 mL EBV = 3 mL ABL

# Pregnant & Lactating

- Pregnancy
  - Increased plasma volume
  - Decreased PCV & TP
  - Increased cardiac output & decreased SVR

  Changes in VD and protein binding

  May require IV fluids

  - Increased abdominal pressures
  - Hyperventilation

  May require ventilation to maintain $O_2$ saturation

Longer analgesic coverage

# Patients Requiring Other Procedures

- Enucleations
- Wound management
- Tail amputations
- Pyometra
- Leg amputations
  - Beyond analgesic strategies….

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# Anesthetic Systems

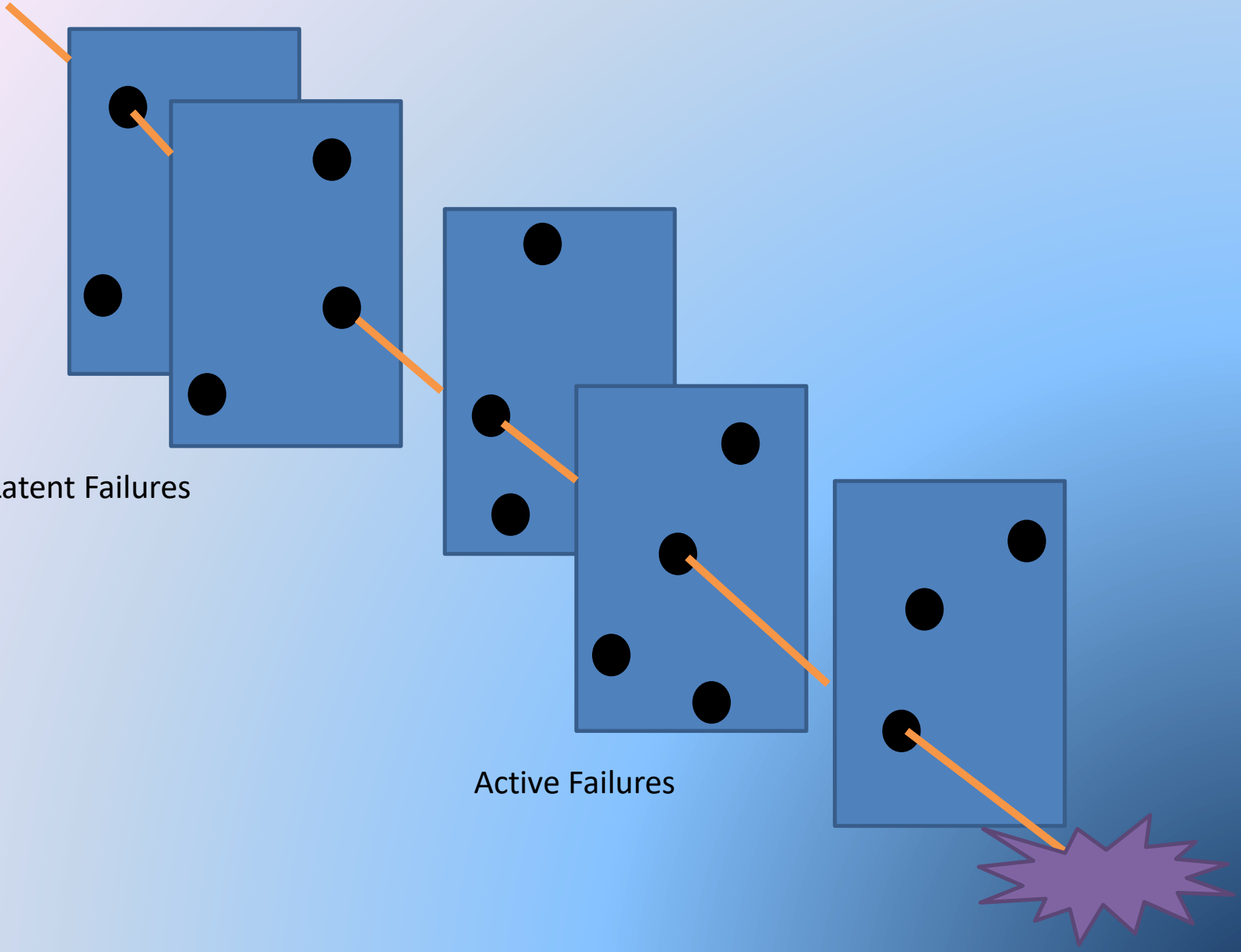
- Systems/processes
  - "Normal Accident" theory
  - Thoughtfully designed environments
  - Morbidity/mortality in anesthesia is due to the way it is delivered
  - Rigorous systems reduce opportunity for and impact of *unavoidable human error*

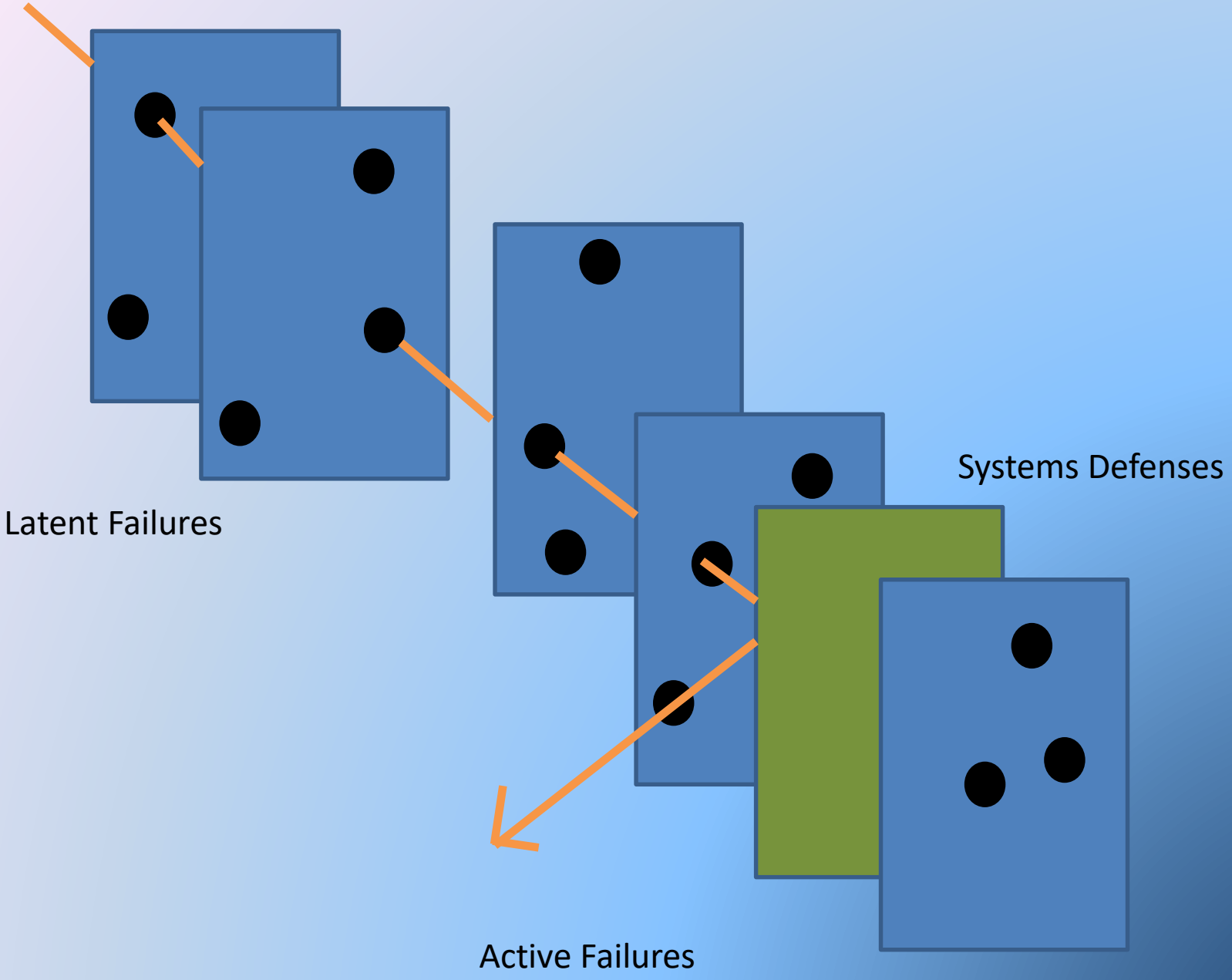
# Factors that Contribute to Error

- Human factors = Active errors
  - Inadequate knowledge
  - Improper technique
  - Equipment misuse
  - Dismissal of data
  - Fatigue, physical/mental stress

# Factors that Contribute to Error

- System factors = Latent Errors
  - Communication failure
  - Resource limitations
  - Training and supervisory limitations
  - Equipment failure
  - Diagnostic/treatment limitations


Latent Failures
Active Failures

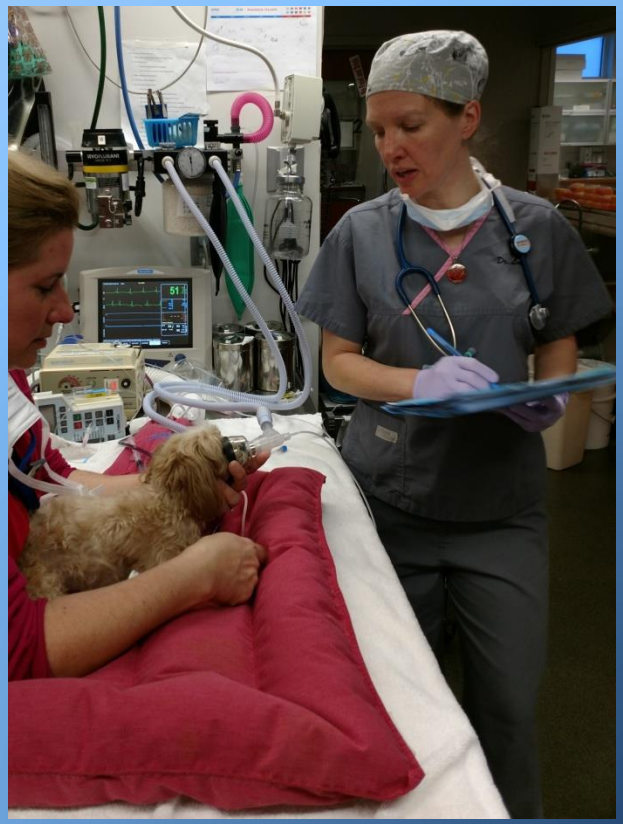

Latent Failures
Systems Defenses
Active Failures

# Anesthesia Systems

- Checklists
- Drug Dosing Charts
- Monitoring & Supportive Care
- Anesthesia Equipment Management
- Emergency Preparedness

# Anesthesia Systems

- Checklists
  - Cognitive aids that reduce error and improve communication
  - Organize essential steps
  - Impose structure
  - Ensure implementation
  - Surgical Safety Checklist
  - Patient hand-off checklists



# Surgical Safety Checklist

World Health Organization | Patient Safety
A World Alliance for Safer Health Care

## Before induction of anaesthesia

(with at least nurse and anaesthetist)

**Has the patient confirmed his/her identity, site, procedure, and consent?**
- ☐ Yes

**Is the site marked?**
- ☐ Yes
- ☐ Not applicable

**Is the anaesthesia machine and medication check complete?**
- ☐ Yes

**Is the pulse oximeter on the patient and functioning?**
- ☐ Yes

**Does the patient have a:**

**Known allergy?**
- ☐ No
- ☐ Yes

**Difficult airway or aspiration risk?**
- ☐ No
- ☐ Yes, and equipment/assistance available

**Risk of >500ml blood loss (7ml/kg in children)?**
- ☐ No
- ☐ Yes, and two IVs/central access and fluids planned

## Before skin incision

(with nurse, anaesthetist and surgeon)

- ☐ **Confirm all team members have introduced themselves by name and role.**
- ☐ **Confirm the patient's name, procedure, and where the incision will be made.**

**Has antibiotic prophylaxis been given within the last 60 minutes?**
- ☐ Yes
- ☐ Not applicable

**Anticipated Critical Events**

**To Surgeon:**
- ☐ What are the critical or non-routine steps?
- ☐ How long will the case take?
- ☐ What is the anticipated blood loss?

**To Anaesthetist:**
- ☐ Are there any patient-specific concerns?

**To Nursing Team:**
- ☐ Has sterility (including indicator results) been confirmed?
- ☐ Are there equipment issues or any concerns?

**Is essential imaging displayed?**
- ☐ Yes
- ☐ Not applicable

## Before patient leaves operating room

(with nurse, anaesthetist and surgeon)

**Nurse Verbally Confirms:**
- ☐ The name of the procedure
- ☐ Completion of instrument, sponge and needle counts
- ☐ Specimen labelling (read specimen labels aloud, including patient name)
- ☐ Whether there are any equipment problems to be addressed

**To Surgeon, Anaesthetist and Nurse:**
- ☐ What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.

Revised 1 / 2009

| Pathway | Phase in surgical pathway | Completed by | Number of items | Examples of items |
|---|---|---|---|---|
| Admission to ward | A Preoperative on ward | Ward doctor: | 9 | Imaging present, laboratory checks done, anticoagulants checked, orders concerning preoperative medication/consultations executed |
| | | Surgeon: | 4 | Informed consent registered, operation side marked |
| | | Anaesthesiologist: | 6 | Actual condition of patient assessed, blood products ordered |
| | | Nurse: | 6 | Operation protocol present, premedication administered, decubitus protocol executed |
| Operating room | B Preoperative time-out in operating room (discussion using checklist) | General (all): | 3 | Correct patient/procedure/side |
| | | Surgeon: | 3 | Positioning, antibiotics/other peroperative medication |
| | | Anaesthesiologist: | 5 | Premedication, comorbidities/ allergies, equipment checked |
| | | OR-assistant: | 1 | Equipment/ instruments/ material (specific and standard) present and functioning |
| Recovery/ICU | C Postoperative in recovery room or ICU | Surgeon: | 5 | Operation report in medical record, instructions about drains, diet, medication |
| | | Anaesthesiologist: | 4 | Instructions about ventilation/oxygenation, drip, medication |
| Ward | D At transfer from recovery or ICU to ward | Anaesthesiologist or intensivist: | 5 | Changes in postoperative instructions |
| Discharge | E At discharge | Ward doctor: | 9 | Pathology and follow-up discussed, medication checked, outpatient appointments, other instructions, discharge letter written |

| Weight (Kgs) | TTDEX VOLUME<br>mL (IM)<br>0.035 mL/kg<br>N/A | MELOXICAM<br>mL (SQ)<br>0.1 mg/kg<br>5 mg/mL | ANTISEDAN (if necessary)<br>mL (IM)<br>1/3 Volume of TTDex<br>5 mg/mL | Weight (Lbs) |
|---|---|---|---|---|
| 1.0 - 1.1 | 0.04 | 0.02 | 0.01 | 2.2 - 2.4 |
| 1.2 - 1.3 | 0.04 | 0.03 | 0.01 | 2.6 - 2.9 |
| 1.4 - 1.5 | 0.05 | 0.03 | 0.02 | 3.1 - 3.3 |
| 1.6 - 1.7 | 0.06 | 0.03 | 0.02 | 3.5 - 3.7 |
| 1.8 - 2.0 | 0.07 | 0.04 | 0.02 | 4.0 - 4.4 |
| 2.1 - 2.2 | 0.08 | 0.04 | 0.03 | 4.6 - 4.8 |
| 2.3 - 2.4 | 0.08 | 0.05 | 0.03 | 5.1 - 5.3 |
| 2.5 - 2.7 | 0.09 | 0.05 | 0.03 | 5.5 - 5.9 |
| 2.8 - 2.9 | 0.10 | 0.06 | 0.03 | 6.2 - 6.4 |
| 3.0 - 3.1 | 0.11 | 0.06 | 0.04 | 6.6 - 6.8 |
| 3.2 - 3.4 | 0.12 | 0.07 | 0.04 | 7.0 - 7.5 |
| 3.5 - 3.6 | 0.12 | 0.07 | 0.04 | 7.7 - 7.9 |
| 3.7 - 3.8 | 0.13 | 0.08 | 0.04 | 8.1 - 8.4 |
| 3.9 - 4.0 | 0.14 | 0.08 | 0.05 | 8.6 - 8.8 |
| 4.1 - 4.3 | 0.15 | 0.08 | 0.05 | 9.0 - 9.5 |
| 4.4 - 4.5 | 0.16 | 0.09 | 0.05 | 9.7 - 9.9 |
| 4.6 - 4.7 | 0.16 | 0.09 | 0.05 | 10.1 - 10.3 |
| 4.8 - 5.0 | 0.17 | 0.10 | 0.06 | 10.6 - 11.0 |
| 5.1 - 5.2 | 0.18 | 0.10 | 0.06 | 11.2 - 11.4 |
| 5.3 - 5.4 | 0.19 | 0.11 | 0.06 | 11.7 - 11.9 |
| 5.5 - 5.6 | 0.19 | 0.11 | 0.06 | 12.1 - 12.3 |
| 5.7 - 5.9 | 0.20 | 0.12 | 0.07 | 12.5 - 13.0 |
| 6.0 - 6.1 | 0.21 | 0.12 | 0.07 | 13.2 - 13.4 |
| 6.2 - 6.4 | 0.22 | 0.13 | 0.07 | 13.6 - 14.1 |

Add 0.2 mL of saline to each dose of Antisedan for reversal
Meloxicam 0.1 mg/kg administered SQ at prep
TTDex dosed at 0.035 mL/kg

| | |
|---|---|
| Torbugesic | 10 mg/mL |
| Telazol (when reconstituted) | 100 mg/mL |
| Dexdomitor | 0.5 mg/mL |

Purchase unconstituted Telazol vials, and reconstitute with 2.5 mL of Dexdomitor (500 mcg per mL) and 2.5 mL of Torbugesic (10 mg per mL). Give 0.035 mL/kg IM for total injectable anesthesia.

If feline reversal is necessary after greater than 60 minutes (patient not showing signs of recovery), Antisedan may be administered IM. The patient must be warm and hydrated, and also adding 0.2 mL of saline to the reversal (in same syringe) will help to circulate the drug to the patient.

# Monitoring

- Anesthesia reliably upsets homeostasis

- Technician with hands, eyes, & ears on the patient at all times
- Temperature
- Pulse oximetry
- Doppler BP
- Capnography
- ECG

# Supportive Care

- Oxygenation
  - Supplement oxygen
- Organ perfusion
  - Volume status – IVF?
  - Avoid deep anesthesia
- Thermoregulation
  - Manage heat loss
- Ventilation
  - Manually ventilate
  - Intubating cats?

# Intubation

- CEPSAF study
  - Intubating cats correlated with increased risk of death
  - Trending towards more so in short procedures and less so in procedures of longer duration

- It is ALWAYS best to control the airway and be able to ventilate for an animal
- For short procedures in cats, intubation may not be required, depending on the abilities of nursing staff
- Waste gas exposure!

# Endotracheal Intubation

- Preoxygenate and monitor throughout
- Ensure good visualization
  - Laryngoscope
- Lidocaine 2% 0.05 – 0.1 mL
- Wait 30 seconds
- 3.5 – 5 mmID high volume, low pressure ETT
  - +/- stylet
- Tip at thoracic inlet
- Minimum no-leak volume

# Anesthesia Equipment

- Nonrebreathing circuit >250 mL/kg/min
  - < ~ 5 -7 kg
- Rebreathing circuit ~20 – 40 mL/kg/min
  - >~5-7 kg
- Reservoir bag ~50 mL/kg

# Anesthesia Equipment

- Different patients require different anesthesia machine setups
- CHECK THE MACHINE BETWEEN EVERY PATIENT

Daily Anesthesia Machine Checklist

- Check oxygen supply pressure (should be around 50 psi)
- Turn on flowmeter
  - Flowmeter knob should turn smoothly
  - Bobbin should move through tube easily and spin
- Check inhalant level in vaporizer
- Check color of CO2 absorbent
- Pressure check machine/circuit
  - Close pop-off valve
  - Attach small rebreathing bag to patient end of circuit
  - Pressurize circuit to 25 $cmH_2O$ by turning on flow meter
  - Turn off flow meter and watch manometer for drop in pressure
  - If pressure in circuit decreases slowly turn on flowmeter until pressure loss stops
    - Flow at which pressure loss stops is = rate of leak
    - Leak < 250 mL/min is acceptable
  - Squeeze rebreathing bag to evaluate for normal movement of one way valves
  - One-way valves should be clean and dry
  - **Open pop-off valve to release pressure in circuit**
- Scavenger system
  - Collection tubing connected to the pop-off valve and the scavenger interface
  - Inspect reservoir bag for holes/dry rot
  - Turn scavenger on ½ turn (adjust as necessary during anesthesia)

# Emergency Preparedness

- If not intubating, be prepared to do so
  - Ambu bag
- If not placing IVC, be prepared to do so
- Close monitoring allows you to avert disaster
- Know emergency drug doses in mL/kg or mL/#

# Anesthesia-Related Death

- Most deaths occur in the recovery period

- But vigilance is required throughout

# Anesthesia in the High Volume Spay/Neuter Environment

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- Patient Differences
- Systems Differences
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# Anesthetics & Sedatives

- Least interesting part
- They are ALL bad
- Dose-dependent cardiorespiratory depression
- It’s not the drugs, it’s how you use them

# Anesthetics & Sedatives

- **Balanced Anesthetic Protocol:**

- Opioid +/- sedative +/- anticholinergic IM or IV
- IV induction to effect
- Inhalant (+/- IV infusions)
- Local anesthesia + NSAID

# Differences in Drug Administration

- May premedicate several patients at once
  - May compound drug cocktails
- May use heavy IM premedication or IM induction
- May require total injectable anesthetic protocols

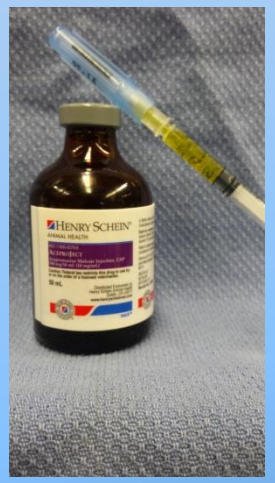
# Total IM Induction

- Dissociative & alpha-2 agonist  +/- opioid

- Drugs not titrated to effect
- Monitoring & supportive care minimal during induction


- Anesthesia can be extended by “topping up” with IV administration ¼ of the original volume

# Sedatives




- Acepromazine
  - Vasodilation, hypotension, tachycardia
  - Not reversible, not analgesic


- Dexmedetomidine
  - Vasoconstriction and reflex bradycardia
  - Transitions to central sympatholysis
  - Reversible, analgesic


- Midazolam
  - Minimal cardiorespiratory effects
  - Reversible

# Induction Agents


- Dissociatives
  - Increase sympathetic outflow
  - Analgesic and antihyperalgesic
- Propofol
  - Profound vasodilation and apnea
  - Smooth induction and recovery
- Alfaxalone
  - Vasodilation and some ventilatory depression
  - Controlled, expensive
- Fentanyl/Midazolam
  - Hemodynamic stability
- Thiopental?
  - Availability?


## Dogs

### Balanced Anesthetic Protocol:

Opioid/sedative IM; IV induction to effect, Inhalant, local anesthetic splash block, NSAID

**Opioid choices:**

Morphine 0.5 - 1 mg/kg (full mu agonists are most effective for invasive procedures)

Hydromorphone 0.1 -0.2mg/kg

Methadone 0.3 -0.5 mg/kg

Buprenorphine 0.02 – 0.04 mg/kg (moderate soft tissue pain)

Butorphanol 0.2 mg/kg (good sedative, poor analgesic)

**Sedative Choices**:

Acepromazine 0.02 – 0.05 mg/kg

Dexmedetomidine 3 – 8 mcg/kg

**IV Induction choices:**

Ketamine 5 mg/kg and midazolam 0.25 mg/kg

Ketamine 2 mg/kg and propofol 3 mg/kg

Midazolam 0.5 mg/kg and propofol 3 mg/kg

Propofol 4 -6 mg/kg

### Total IM Induction

-Monitor patient closely from time of administration; be ready to supply heat support, $O_2$, and intubate; may need to add inhalant for longer procedures.

- If inhalant unavailable, "top up" with ¼ of the original dose IV

Telazol/dexmedetomidine/butorphanol (marginal lasting analgesia, add an opioid such as buprenorphine in recovery)

-Reconstitute 1 vial of Telazol with 2.5 mL dexmedetomidine (0.5 mg/mL) and 2.5 mL butorphanol (10 mg/mL)

- 0.1 – 0.3 mL/9.1 kg (20 lbs)

Telazol/ketamine/xylazine (marginal lasting analgesia, add an opioid such as buprenorphine in recovery)

- Reconstitute 1 vial of Telazol with 4 mL of ketamine (100 mg/mL) & 1 mL xylazine (100 mg/mL)

- 0.25 mL/4.5 kg (10 lbs)

## Cats

### Balanced Anesthetic Protocol:

Opioid/sedative IM; IV induction to effect, Inhalant, local anesthetic splash block, NSAID

**Opioid choices:**
Morphine 0.5 - 1 mg/kg (full mu agonists are most effective for invasive procedures)
Hydromorphone 0.1 -0.2mg/kg
Methadone 0.3 -0.5 mg/kg

Buprenorphine 0.02 – 0.04 mg/kg (moderate soft tissue pain)

Butorphanol 0.2 mg/kg (good sedative, poor analgesic)

**Sedative Choices**:

Acepromazine 0.02 – 0.05 mg/kg
Dexmedetomidine 3 – 8 mcg/kg

**IV Induction choices:**
Ketamine 5 mg/kg and midazolam 0.25 mg/kg
Ketamine 2 mg/kg and propofol 3 mg/kg
Midazolam 0.5 mg/kg and propofol 3 mg/kg
Propofol 4 -6 mg/kg

### Total IM Induction

-Monitor patient closely from time of administration; be ready to supply heat support, $O_2$, and intubate; may need to add inhalant for longer procedures.

-If inhalant unavailable, "top up" with ¼ of the original dose IV

Dexmedetomidine/ketamine/butorphanol marginal lasting analgesia, add an opioid such as buprenorphine in recovery)
- -2 mL dexmedetomidine/3.3 mL ketamine/ 2 mL butorphanol, 2.7 mL saline
- - 0.5 mL/4.1 kg (9 lbs)

Dexmedetomidine/ketamine/midazolam/ buprenorphine OR methadone
("Quad protocol" Hint: there's an app for that!)
- Convert weight to BSA = $(10.4 \times BW^{0.67})/100$
- Multiply BSA by 0.06 for volume of each agent

Telazol/dexmedetomidine/butorphanol (marginal lasting analgesia, add an opioid such as buprenorphine in recovery)
- -Reconstitute 1 vial of Telazol with 2.5 mL dexmedetomidine (0.5 mg/mL) and 2.5 mL butorphanol (10 mg/mL)
- - 0.1 – 0.3 mL/9.1 kg (20 lbs)

Telazol/ketamine/xylazine (marginal lasting analgesia, add an opioid such as buprenorphine in recovery)
- - Reconstitute 1 vial of Telazol with 4 mL of ketamine (100 mg/mL) & 1 mL xylazine (100 mg/mL)
- - 0.25 mL/4.5 kg (10 lbs)

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