Breathing and anesthesia involves a lot more than oxygen, it’s all about carbon dioxide. Monitoring it, equipment options and goals for the patient will be discussed. Surgical cases where this is especially important will be discussed and well as suggestions for pre and postop care of “at risk” cases.

- Several patient considerations make it more difficult or less likely for a patient to ventilate well enough on their own
  - Mucous membrane color and SPO2 are not sensitive enough to indicate issues until they are critical
  - Respiratory rate gives no indication for the quality of breath (depth of breath) they are taking
  - Gas exchange is the critical component for breathing
- Obese patients are less likely to breathe well on their own
  - Extra weight on rib cage
  - Weaker muscle strength, even before they are asleep
- Dorsal recumbency – most common position for surgery (electives, exploratory, knees etc)
  - Unnatural breathing position
  - Puts more weight on diaphragm
- Pregnant animals or laparoscopic procedures
  - Extra pressure from babies or insufflation on diaphragm
  - Relies more heavily on intercostal muscles to breath – negligible when anesthetized
    - C-section
- Geriatric patients have weaker muscles, more sensitive to drugs and can have secondary lung disease making ventilation more troublesome
  - “old dog lungs”
- “At risk breeds”
  - Cavalier king Charles – syringomyelia, CSF flow issues, Chiari Malformation
    - Increasing intracranial pressure can result in herniation of the brain
  - Brachycephalic breeds
    - Increased oropharynx soft tissues
    - Obesity
    - Increased vagal tone
    - Hypoplastic trachea 1” compromise to airflow
    - Postoperative breathing is also vital during recovery period in these patients
- Trauma case
  - Need to keep CO2 low to assure cerebral pressure does not climb
  - Pain from trauma can further decrease thoracic compliance to breathing
    - Pain with ribs or intercostal muscles
    - Pulmonary contusion pain or lack of lung compliance for air movement
- Preoperative bloodwork should be performed for general anesthesia health
- Spo2 and oxygen used for preoperative prepping
  - Many will preoxygenated BAOS patients and pregnant animals 5-10 minutes before induction
- Have capnography hooked up in the prep area
  - One of the most critical times for anesthesia risks
  - Drugs in full effect and most common time to be “too deep” and have breathing compromise
- Under normal physiological conditions the primary indication for mechanical ventilation during general anesthesia is patient PCO2. Patient oxygenation does NOT define ventilation.
- There are two ways to monitor patient PCO2: arterial blood gas analysis and/or end-tidal PCO2 (PETCO2, capnography).
- Although arterial blood gas analysis is more accurate, it is also expensive and impractical. Capnography provides a useful, and practical, means to monitor patient PCO2, and is recommended for all anesthetized patients undergoing mechanical ventilation under general anesthesia. There are two categories of capnographs: main-stream, which analyzes the patient’s
exhaled breath adjacent to the endotracheal tube, and side-stream, which removes a sample of the patient’s breath and delivers it to an analyzer away from the patient.

- Capnography is based on the principle that end-tidal exhaled PCO2 (PACO2) is roughly equal to pulmonary arterial PCO2 (PaCO2)
- Graphical illustration of the PETCO2 over time is called a capnogram. Capnograms are useful for visually monitoring an anesthetized patient’s PCO2 and other problems that can develop, such as a leak in the breathing system.
- Several capnograms will be demonstrated with discussion regarding their interpretation and how to mitigate associated issues.
In this seminar Dr. Landsberg will collaborate with a colleague to discuss real cases of canine aggression cases and the selection and use of drugs and natural supplements for these cases. Therefore the summary below provides a brief overview of drug selection and use.

**Pharmacotherapy and canine aggression**

When a dog is excessively aroused, fearful, anxious, overly reactive lacking impulse control or “behaviorally abnormal”, psychotropic medications are indicated to improve the problem as well as address the dog’s well-being. However, drugs do not change the relationship with the stimulus; therefore, concurrent behavior modification is needed to desensitize, countercondition and train desirable.

Selective serotonin reuptake inhibitors might be most effective for hyperactivity, aggression, social anxiety, generalized fear and anxiety and panic disorders. Four weeks or longer is generally required to achieve full therapeutic effects. Starting the medication at the time of the consultation allows time for the drug to reach optimal therapeutic effect when the exposure program begins. Medication might not be required for dogs that can be effectively kept away from fear-evoking situations, provided the dog is sufficiently settled and relaxed. Adjunctive medication to further reduce anxiety especially prior to stimulus exposure might include benzodiazepines, trazodone, clonidine or propranolol, alone or in combination. If effective these drugs might be used several times a day.

**Psychotropic drugs**

Selective serotonin reuptake inhibitors (SSRI) are most commonly used in dogs that are behaviorally abnormal, to control reactivity and impulsivity, reduce fear and anxiety and improve trainability as well as address the dog’s behavioral well-being. SSRI’s are selective in blocking the reuptake of 5HT1A into the presynaptic neurons. Fluoxetine and paroxetine might be useful for general anxiety disorders, stabilizing mood, reducing impulsivity and behaviorally pathologic aggression. Fluvoxamine and sertraline are other options for social and irritable aggression.

The primary mechanism of action of TCA’s is to block the reuptake of serotonin and to a lesser extent noradrenaline. They also have anticholinergic and antihistaminic effects which may contribute to varying levels of sedation, urine and stool retention. Clomipramine and amitriptyline may be useful in controlling underlying anxiety and impulsivity in aggressive dogs. However, studies have shown no effect of amitriptyline or clomipramine on canine aggression.

While antidepressants reach peak plasma levels within hours, reuptake inhibition may induce down-regulation of postsynaptic receptors that are responsible for clinical effects. Therefore, 4 weeks or longer is generally recommended to fully assess therapeutic effects.

Buspirone is a serotonin (5HT1A) receptor agonist and a dopamine (D2) agonist. It is used for mild fear and anxiety. It is non-sedating, does not stimulate appetite, and does not inhibit memory. It takes a week or more to reach effect. Adding buspirone to an SSRI might add to the serotonin pool.

Benzodiazepines potentiate the effects of (GABA), an inhibitory neurotransmitter. They cause a decrease in anxiety, hyperphagia, and muscle relaxation. Most have a rapid onset and short duration in dogs. They can be used alone or adjunctively primarily on an as needed basis but may be considered in select cases on an ongoing basis with multiple daily dosing. They may cause paradoxical excitability, increased activity, and an amnesic effect. Buspirone and benzodiazepines can disinhibit fearful and inhibited pets which may result in aggression.

Beta blockers such as propranolol reduce physiologic signs of anxiety (heart rate, respiratory rate, trembling). Therefore they might be most useful if combined with drugs that reduce behavioral anxiety. Clonidine a selective alpha-2 agonist that blocks noradrenaline, might be used together with SSRI’s for situational use in fear or territorial aggression, separation anxiety, or noise phobias.

Trazodone, a serotonin 2A antagonist-reuptake inhibitor, may be useful in dogs for generalized anxiety, separation anxiety, storm phobias, and some forms of aggression including interdog aggression and impulse control disorders. Trazodone can be used on as needed basis alone or in conjunction with a TCA or SSRI or 2 to 3 times daily.

Focal seizures of the temporal lobe may present with mood alterations or hallucinatory and self-traumatic behaviors. Generalized seizures may be associated with aggression e.g. in the post-ictal phase. Therefore anticonvulsants may be a consideration in diagnosis and treatment. Levetiracetam may be effective for focal seizures, and for anxiety, panic, and mood disorders which may have comorbidity with epilepsy. Gabapentin might be combined with SSRI’s for the treatment of impulse control disorders, noise phobias.
and to reduce reactivity. Carbamazepine is also a mood stabilizer that may be a useful adjunct to SSRI’s for irritable and impulsive aggression.

Neuroleptics decrease motor function at the level of the basal ganglia in the brain, elevate prolactin levels and may reduce aggression as dopamine antagonists. Phenothiazines such as acepromazine are sedatives but do not reduce anxiety.

Selegiline is an MAOB inhibitor licensed for CDS in North America, and emotional disorders in Europe. Chronic stress associated with stereotypic and displacement behaviors, fear aggression, and autonomic signs, may have elevated prolactin levels, which might improve with selegiline, while lower prolactin levels are seen with acute onset fears and phobias which might improve with fluoxetine.9

Complementary and alternative medications are another option; however, few have been assessed in evidence based studies. Products that might be useful in reducing anxiety and improving trainability include Adaptil, alpha-casozepine, l-theanine, melatonin, Hormonease and aromatherapy. Each of these might be used concurrently with drug therapy. Aggression might be reduced by supplementing tryptophan to a reduced protein diet (to optimize entry through the blood brain barrier). In addition, adding tryptophan to an SSRI or TCA may increase the available serotonin pool. Royal Canin Calm diet contains both alpha-casozepine and l-tryptophan. There have been no studies to demonstrate efficacy of other natural products including Bach flower remedies or homeopathy.

Abnormal aggressive dogs

For most cases of behaviorally abnormal dogs an SSRI such as fluoxetine or paroxetine would be the first choice for managing underlying anxiety and impulsivity. Immediate acting medications might be needed concurrently prior to specific events including benzodiazepines (e.g. alprazolam, lorazepam, diazepam), trazodone, clonidine, or propranolol. Drug combinations may be a consideration but safety and potential for reaeficacy must be weighed against potential adverse effects. Natural products might also be used concurrently. In some cases drug combinations will need to be considered such as a combination of SSRI with carbamazepine, gabapentin, clonidine, trazodone, buspirone or even a TCA (with cautious monitoring for serotonin syndrome).

### Drug doses for behavior therapy

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alprazolam</td>
<td>0.02-0.1 mg/kg bid to qid</td>
</tr>
<tr>
<td>Clonazepam</td>
<td>0.1-1.0 mg/kg bid to prn</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.5-2 mg/kg prn to q6h</td>
</tr>
<tr>
<td>Lorazepam</td>
<td>0.25-0.2 mg/kg sid to prn</td>
</tr>
<tr>
<td>Amitriptyline</td>
<td>2.0-4.0mg/kg bid</td>
</tr>
<tr>
<td>Clomipramine</td>
<td>1-3 mg/kg bid</td>
</tr>
<tr>
<td>Citalopram</td>
<td>0.5-2.0 mg/kg sid</td>
</tr>
<tr>
<td>Fluoxetine</td>
<td>1.0 – 2.0 mg/kg sid</td>
</tr>
<tr>
<td>Fluvoxamine</td>
<td>1.0 -2.0 mg/kg sid – bid</td>
</tr>
<tr>
<td>Paroxetine</td>
<td>0.5-2.0 mg/kg sid</td>
</tr>
<tr>
<td>Sertraline</td>
<td>1-5 mg/kg sid or divided bid</td>
</tr>
<tr>
<td>Clonidine</td>
<td>0.01-0.05mg/kg prn to tid</td>
</tr>
<tr>
<td>Propranolol</td>
<td>0.5-3.0 mg/kg bid or prn</td>
</tr>
<tr>
<td>Buspirone</td>
<td>0.5-2.0 mg/kg sid-tid</td>
</tr>
<tr>
<td>Trazodone</td>
<td>2 to 8 mg/kg prn to tid (up to 15 mg/kg prn)</td>
</tr>
<tr>
<td>Gabapentin</td>
<td>10-30 mg/kg bid to tid</td>
</tr>
<tr>
<td>Carbamazepine</td>
<td>4-8 mg/kg bid to tid</td>
</tr>
<tr>
<td>Levetiracetam</td>
<td>20 mg/kg tid</td>
</tr>
<tr>
<td>Selegiline</td>
<td>0.5-1 mg/kg sid in am</td>
</tr>
</tbody>
</table>

References


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