Economics of pain management in terminally ill pets

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ABSTRACT

Pain management in terminally ill pets is an important and complex issue. Physical therapy, acupuncture, non-steroidal anti-inflammatory drugs, steroids, muscle relaxers, holistic herbs, nutraceuticals, cannabinoids, and opioids are all commonly used to manage their pain. Often, they are used in combination with each other to better control the pain level. Animal owners have the option of humane euthanasia which can be considered, when time, cost, or emotional toll goes beyond the benefit-cost value to a family.

This research demonstrates how to use a pain scale to facilitate decision making when managing chronic pain. Some background on pain medications and other pain management modalities are discussed. Normally more medications, higher doses, and opioids are added when pets are in a terminal decline. The research uses a terminally ill canine with cancer in the final six weeks of his life. We employ a benefit-cost analysis using pecuniary and non-pecuniary risks and benefits to facilitate a decision guide. The pecuniary variables are cost of medications and veterinary services. The non-pecuniary costs include separation anxiety and emotional cost. The satisfaction the pet owner gets from the companionship of the pet is captured as the principal benefit in the model.

The model explores alternative values for the different variables and simulates the potential decision outcomes. The decision rule using the benefit-cost ratio analysis is the traditional economic decision rule: When the benefit cost ratio is greater than unity, the pet owner may choose to continue treatment. However, a benefit-cost ratio of less than unity would require the pet owner to consider the

pet's quality of life and discuss euthanasia as an effective economic and emotional option.

The benefit cost model developed in this study provides a useful tool for veterinarians to discuss the difficult subject of euthanasia with their clients when the quality of life of their terminally-ill pet does not justify sustaining life even if the pet owner's separation anxiety seems to ignore this. The model relieves the veterinarian from making the decision for the client, and allows the client to explore the relative weights they place on the different dimensions of the model to arrive at a decision that both humane and economical.

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I thank my KSU major professor, Dr. Vincent Amanor-Boadu. He has pushed my boundaries of veterinary care into some emotional spaces with economic principles that challenged me to explore their quantification. For example, what is the emotional value of a pet the pet owner and their families? I am deeply indebted to him for the many hours of thought and guidance he has spent helping me complete this thesis and the potential it presents to help my peers in the veterinary profession solve one of the major challenges in companion animal medicine.

My devoted wife Ginger, and children, Adam and Karis, who have been very supportive of the long hours and many challenges encountered on a graduate school program. I have enjoyed hosting many international exchange students who have opened my eyes to the many economic joys and problems encountered around the world. I hope to be able to address these issues in the years ahead. Opioids are a current issue the leaders must address and the social ramifications the world must better balance.

I am very blessed to be able to tackle graduate school at the time in life when many of my friends are declining with heart disease, arthritis and dementia. I thank God for the chance to still make a difference, learn and contribute to the areas of animal science, agricultural economics and veterinary medicine that I feel I can improve and contribute.

CHAPTER I: INTRODUCTION

The veterinary medicine profession may be organized into two broad specialties: Livestock medicine; and Companion animal medicine. Dealing with livestock is easy compared to dealing with companion animals because livestock have clear economic value that allows their treatment costs to be judged against that value. For example, when the cost of a treatment of pig is determined to be greater than the value it can provide its owner, the decision to not treat is often easily made by the farmer. However, when the same pig is a pet, the decision becomes very complex. Now, the pet owner, not a farmer, is considering the emotional comfort the pet provides, and the pricelessness of the relationship.

The emotional relationship between a pet and it owner can sometimes make the treatment of terminal diseases in the pet difficult. The complexity emerges when the desire for keeping the pet alive because of its emotional value to the pet owner causes the pet owner to have difficulty making decisions about the pet's quality of life. Often, pet owners believe that spending any amount of treatment is an indicator of their value for the pet. This can make the veterinarian's work difficult when the quality of life effect of treatment is actually negative. It is a known challenge in the companion animal veterinary practice that conversations with pet owners about end of life questions for their pets are some of the most difficult.

1.1 Research Problem and Research Question

The focus of this research is to develop a means of easing the end of life conversations for pets between pet owner and the veterinarian. It is premised on the assumption that the emotions and other cognitive issues related to the relationship with pets often obscure their owner's ability to focus on the health and quality of life components of

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the pet's life during terminal illness. Searching for a means to make the conversation between veterinarians and pet owners easier through the employment of some objective analysis is the problem motivating this research. An objective approach often overlooked in these conversation is an assessment of the pecuniary and non-pecuniary net benefits of the pet in the owner's life during those terminal stages of an illness. For example, when the pet is unable to provide the same joy for the owner, the quality of the pet's life becomes a cost consideration that must be included in the conversation. Unfortunately, without any tools for valuing these non-pecuniary aspects of the pet in the owner's life, the decision becomes difficult and often intractable.

The motivating research question is defined as follows: What economic tools may be used to help pet parents minimize their treatment costs and enhance the benefits they get from their pet, when a terminal problem develops. This paper explores a benefit-cost model that veterinarians and clients may use to ensure terminally ill pets are offered the best quality of life with the minimum cost and maximum benefit to pet owners. Veterinarians strive to contribute by minimizing the use of opioids and address any contribution the veterinary industry might make towards the opioid epidemic.

Pain is a major factor in helping owner decide when to allow a pet to give up on the struggles of life. Conditions such as chronic arthritis are very painful. The pet may have significant difficulty moving or even sleeping when these conditions become very severe. Also, chronic heart and kidney disease and respiratory conditions, such as asthma, certainly can cause major distress during the final stages of a terminal illness. The pain often "cripples" the animal and prevents it from having a good quality of life. For example, it might have difficulty going about its business as it always has. This can be distressful for

the owner, but it is also very disconcerting for the animal. Combining the pain

management challenges and the declining quality of life issues is important for

veterinarians and pet owners to develop the best solutions for managing terminally ill pets,

including the consideration of euthanasia.

1.2 Objectives

The overall research objectives is to develop a decision support tool to enable an

easier conversation between veterinarians and pet owners during conversations about

terminal illness treatment protocols for the patter's pets. It seeks to provide a "metric" that

allows for the subjective to become "objective" in these conversations and help both the pet

owner and veterinarian provide the best care for a terminally ill pet, care that recognizes the

pet's quality of life as integral to the decision equation, even as it recognizes the owner's

psychological needs and responsibilities to the pet.

The specific objectives are as follows:

a. Describe the economics of pain management in companion animals.

b. Simulate the pecuniary and non-pecuniary costs and benefits associated

with treating a hypothetical terminally ill canine pet and the potential

decision options a pet owner might make.

c. Evaluate the potential effects of pet owners' evaluation of pet comfort,

owner's separation anxiety and medical treatment costs on pet owner's

decision about euthanasia.

1.3 Outline of Thesis

The foregoing chapter has presented the background, research problem, research

question and objectives framing this research. Chapter 2 presents a brief literature review of

the opioid crisis in more detail, tracing its origin and the factors contributing to the crisis. It

also explores the real or perceived contribution of the veterinary industry to the human opioid crisis and the challenges that present to the profession. Chapter 2 also covers regulations being proposed and imposed, and possible problems that they present to veterinarians and veterinary clinics. It explores non-pharmaceutical and non-traditional pain management options available for veterinarians and assesses their effectiveness based on the literature assessments. It reviews the value of a pet to an owner, and how the value may change if separation anxiety factors and emotional costs change. Chapter 3 presents the data and conceptual models for assessing the economics of pain management using a hypothetical canine pet with terminal cancer as the reference for simulating the potential outcomes under alternative therapies. It also evaluates the potential effect of pet owner socio-economic characteristics on pain management options. Chapter 4 presents the simulation results for the hypothetical canine pet with terminal cancer. It assesses the alternative benefit-cost outcomes for the different therapies, recognizing the factors or separation anxiety and emotional costs on the model. Chapter 5 develops a process that veterinarians might use with these results to engage their clients in conversations to facilitate the best humane decisions for pets and determining the best cost benefit ratio for pet owners. The conclusions and recommendations for future research are in the final segment.

CHAPTER II: PAIN MANAGEMENT IN VETERINARY MEDICINE

The literature on pain and pain management in the veterinary industry is critically explored in this chapter. The chapter is organized in five sections. The first provides a review of pain among animals and how veterinarians have addressed this through time. It also explores the use of opioids by veterinarians and the associated costs of alternative therapies. Section 2.2 presents a review of state and federal regulations guiding veterinarians' use opioids and other therapies as well as potential regulatory actions being considered for veterinarians, including collecting information about their clients' addiction and drug use profiles. The review explores veterinary industry's responses to these proposals, arguing that their implementation would increase the cost profile of all clinics and practices, as well as increase the potential insurance costs facing veterinarians. Sections 2.3 and 2.4 discusses guidelines for veterinary opioid use and why veterinarian should consider limiting opioid for pain management. Section 2.5 reviews the processes used by veterinarians to develop veterinary treatment plans under alternative presentations, and evaluates how to deal with chronic pain under terminal disease conditions. It discusses how to manage chronic or cancer pain in a veterinary setting. Section 2.6 explores the literature on companion animals and the prevalence of diseases among companion animals. It then develops the "model" of a canine companion animal with a terminal disease situation, and discusses the decision choices within the context of treatment plan and related cost considerations. It also discusses the measurement challenges associated with non-pecuniary metrics, such as emotional attachment, and animal comfort and pain level. The final section 2.7 goes over the value of a pet over its life time.

2.1 Pain and Pain Management in Animals

Most veterinarians do not want to see an animal in pain. Some veterinarians have learned in the past 10-15 years that the newer opioids seem to have the best pain control opportunities. Some pharmaceutical companies have been developing longer acting products such as fentanyl patches which could be applied before surgery and give the patient several days of post-operative pain reductions. Pharmaceutical companies find the human market for these products was much more lucrative than the veterinary market so most companies did not get veterinary classification. Some research indicates opioid analgesics may not be as well tolerated and metabolized by the animal patients, blood plasma concentrations are not as high in dogs as in people and show more patient variation. More pharmacy testing of opioids in animals is still needed (Benitez 2014). For example, Tramadol is not considered effective at alleviating pain in canine patients, especially when used alone. Veterinarians can still use theses human drugs if

a. there was not an animal drug approved for this intended use

b. the animal drug did not come in the required concentration or dose needed

c. the veterinary product was not effective

These drugs must be used in the context of a client patient relationship. Veterinarians could then try a human extra label drug (such as an opioid that has not been approved for animals). There are only two opioids specifically approved for use in animals, and only two are currently being marketed (buprenorphine for use in cats and Butorphanol@ for use in cats, dogs, and horses). Wildlife Laboratories, the maker of a potent analog of fentanyl called carfentanil (Wildnil@), voluntarily relinquished the approval for this product March 2018 (Federal Drug Administration 2018). The company probably wanted to avoid the possibility of diversion of the drug (roughly 10,000 times that

of heroin) (Illinois College of Veterinary Medicine - Ashley Mitek, McMichael, and Schlosser 2017) and limit its possibility of increasing the human opioid epidemic. In a valid veterinary-client-patient relationship the veterinarian makes the medical judgment on the health of an animal, and the need for medical treatment. In turn, the client (owner, caretaker, or employee) has agreed to follow veterinarian's instructions. A general or preliminary diagnosis of the medical condition is obtained and availability for after care (emergency) is provided. Currently telemedicine is not considered a viable option for control drug dispensing. A relationship can only exist when you have recently seen and are personally acquainted with the keeping and care of the animal or animals. You must have recently examined the patient, and made "medically appropriate and timely visits" to the premises or them to a veterinary hospital (Federal Drug Administration 2017).

Opioids are among the most effective analgesics in medicine, and commonly used to treat terminally declining pets. They are used to manage acute pain in companion animals, either alone or in combination with other analgesics. The euphoric effect of narcotics (mainly mu agonists), dependency, and the adverse conditions of withdrawal in humans has led to the current epidemic of opioids in humans. We usually expect some of the same effects to be found in animals. Some pharmacokinetic studies indicate they may not work as well in animals as they seem to in human patients (Benitez 2014).

Medical staff were encouraged by experts and pharmacy representatives to manage pain with opioids in the 1990s and early 2000s without realizing the addictive properties of these drugs. According to the CDC web site an average of 130 human deaths a day are due to Opioids. It is alarming to see the number of these deaths in this country. Most of these are illegal drugs (heroin and synthetic opioids) that are sold on the streets, but some are

prescribed by well-meaning medical providers. The drug problem is very complex involving products such as cocaine, fentanyl, heroin, home derived synthetic drugs and medicinal opioids. Many people get good pain control initially and then seem to require higher doses with more side effects as time on the medication persists. All seem to be culminating in a human epidemic in this country, we will look at Veterinary Medicine to see if it is contributing to the problem. As human doctors are more reluctant to prescribe opioids, human addicts may consider veterinarians as a source of their opioids. Veterinarians as well as other health care professionals may feel pressure to prescribe them for people's animals which could be subverted to a human with an addiction.

Veterinarians are trained on the best ways to control pain in animal patients, and this often includes the use of opioid medication. Acute pain of surgery and often end of life care of chronically ill and debilitated animal patients usually involves a form of a narcotic pain medication. Many veterinarians felt at "arm's length" from the opioid epidemic because the patients could not open a pill vial or randomly increase their doses of medication. Owners are required to refill and administer the medication, but subsequently serve as a possible source of misuse and diversion. Some owners allege to invent symptoms and exploit the older or injured animal in order to get opioid medication for human use.

According to the National Institutes of Drug Abuse 2019, the opioid epidemic began in the late 1990s largely as a result of the perception that "patients in pain should not be denied opiates" and that patients pain communities were exploited by the pharmaceutical industry in the aggressive marketing of opioid based products. The unrestricted doctor prescribing, misuse and widespread diversion has resulted in a marked

and continuing increase in substance abuse, diversion and lethal death toll. The United States is now seeing this epidemic have taken a frightening human death and economic toll (Muir, et al. 2018).

2.2 Review of State and Federal Regulations Guiding Veterinary Use of Opioids

Opioid prescriptions in the United States have increased from 76 million in 1991 to 207 million in 2013 (Schuchat, Houry and Guy 2017). The human medical community had a significant increase of use in the 1990s. Once used primarily for the treatment of acute pain or pain due to cancer, physicians began using opioids for anyone experiencing chronic pain. This has been accompanied by rising rates of accidental addiction and many overdoses leading to death. Some states are enacting new laws or strengthening existing ones in an effort to limit access to opioid medication. According to the American Veterinary Medical Association, 17 states and Washington DC have regulations requiring veterinarians to report, though Prescription Monitoring Programs, when they dispense opioids and other controlled substances to patients (Alaska, Arkansas, California, Colorado, Connecticut, Illinois, Indiana, Maine, Michigan, New Hampshire, New York, North Dakota, Oklahoma, South Carolina, Vermont, Washington, and West Virginia). However, some of these mandates are on hold while legislatures decide how to implement this regulation. It is important for all practitioners to check with their state veterinary medical and pharmacy boards to ensure compliance with current laws and regulations. If a controlled substance is ever stolen or missing from a veterinary hospital inventory it needs to be reported to the Drug Enforcement Administration and local police department (AVMA 2018).

In a recent town hall meeting with the Colorado PDMP (Prescription Drug Monitoring Program) Veterinary Advisory group it was stressed that all practitioners

licensed to practice in Colorado should register and have access to check patient and owner

narcotics use on any client they feel may be at risk for diversion or misuse before an opioid

prescription is used (Adams, Meola and Newman 2019).

Illinois law was to have required all opioid prescribing veterinarian to be registered for

client access by January 1, 2018, but has been slow at implementing the PMP information

and confidentiality information. On October 13, 2019 the Illinois Legislature exempted

veterinarians from the PDMP requirements, and requires three hours of controlled

substances training on "Safe Opioid Prescribing".

2.3 Veterinary Guidelines to avoid Veterinary Clients Addiction Issues

Veterinarians try to identify, deter and report customers shopping for controlled

drugs or trying to divert them for human use:

2.3.1 Companion Animal Facilities

In companion animal facilities, things to watch for include:

• New clients bringing in seriously injured animals with strange or vague histories

(These cases should be hospitalized and treated not just sent home on opioid medication

  In some cases people have been known to harm a pet to get narcotic medication!)

• Old, incomplete, or non-verifiable veterinary care records

• Describing clinical signs that are inconsistent with findings on examination of the patient

• Describing clinical signs that require specific medications (seizures or chronic pain)

• Requesting medications by name (e.g., Tramadol or Xanax) for the pet's issues

• Refusing medications as prescribed and suggesting alternatives in the opioid class

• Requesting early refills of medication, or large amount for long vacations

• Claiming medications were lost, stolen or not given to them at check out (consider

surveillance video at checkout area)

• Requesting refills, while missing appointments (client too busy working to bring pet in, but he needs more meds now)

• Uncooperative and aggressive owner behavior when discussing pain medication

  Make sure to document on patient chart, dosage administered, treatment duration

2.3.2 Large Animal for Food Production

The concern is large animal veterinarians less commonly prescribe opioids but if used dosages could be much higher than in small animal patients. (follow general guidelines)

- Carefully diagnose and evaluate the condition for which you are prescribing drug.

- Make sure clients can maintain the identity of the treated animals or animals

- Establish adequate withdrawal periods so no illegal drug residue in treated animal reaches the food chain.

The vast majority of veterinarians whether they work in a small rural veterinary clinics or a large specialty clinic with thousands of clients all went into veterinary medicine to help animals and take the Hippocratic oath seriously, to provide the best quality medicine that the client can afford. Opioids have always been an option for those patients that are in severe pain. The altruistic value to the client and practitioner would be similar, (for all practice types), however in larger practices when clients do not see the same doctor each visit, the risk of opioid abuse may increase. It is best for doctors and staff to have uniform policies in place for dealing with controlled drugs and treat all clients with respect but caution in this area. When the animal dies or is euthanized, proper disposal of remaining pain medication should be encouraged.

2.4 Treatment Plan

Veterinarians should try to follow recommended guidelines for dosage (some listed Table 2.1). For example, cats who are experiencing geriatric arthritis often show improved

mobility and corresponding improvements in quality of life at 2 mg/kg of Tramadol dosed twice daily. Side effects often increase at 4 mg/kg twice daily (Alonso, et al. 2018). Many veterinary reference formularies have a limited dosages of pain medication, because most are not approved for animals. It is important for veterinarians to have a guideline for doses and have alternatives to consider when addressing chronic pain in patients.

Although the Federal Drug Administration and Drug Enforcement Administration do not intend to directly limit availability of opioid drugs to the veterinary market, there may be some interruptions and restrictions of full mu agonists including morphine, hydromorphone and fentanyl. Some of the pharmacy production facilities in Puerto Rico were damaged in Hurricane Maria and are not fully functional yet. The demand for many of these drugs is expected to decrease by 20% per year. Pfizer does not anticipate resuming sales of some veterinary injectable opioids, and the federal government has directed a decrease in production of certain highly abusive Schedule II drugs. The trend to no longer make multi-vial bottles, will greatly decrease use in veterinary medicine as single use/ preservative free human doses are much more expensive (Pfizer 2019). Veterinarians have a lot of variation on size of pets treated and single dose and discard vials are much more expensive to inventory and use in veterinary medicine.

2.5 Canine Cancer Pain Management

Pain medications are commonly used to treat animals undergoing cancer treatments. Not all tumors are painful and not all pets with arthritis need to take an opioid or cannabis products to control their pain. The flow chart presented in Figure 2.1 may help in assessing the decision to adopt certain treatments based on the pain experienced by the animal. It suggests that all aspects of pain be considered including any relevant side effect of the treatment regime. Stronger drugs or combinations of drugs are to be considered only

when the pain level becomes unbearable. And beyond that, euthanasia must be considered

for humane reasons.

Figure 2.1: Evaluating Animals With Pain

Assessment of cancer patient

Functional assessment | Behavioral assessment | Palpation assessment | Reassess at regular intervals

Pain unrelated to cancer

Pain

No pain

Treat as appropriate

Analgesic Ladder or Reverse Pyramid approach

Switch base

Initiate base (NSAID; steroid; acetaminophen) adjunctive

Side effects

Reassessment

Pain persists

Initiate multiple adjunctive treatments

Reassessment

Pain persists

Adjunctive drugs and therapies to consider *adding in* to the therapy (if response is poor, consider increasing dose where possible):
Cannabis
NMDA antagonists
Antidepressants
Gabapentin
Tramadol
Steroids (not with NSAIDs)
Acetaminophen
Transdermal opioids
Oral opioids
Bisphosphonates
Nutraceuticals
Acupuncture
Multiple drug "wind-down" therapy
Radiation
Topical capsaicin

Other treatments to consider:
Cannabis, Acupuncture or "Wind-down therapy"
Radiation treatment
Palliative surgical resection
Epidural catheter

Neurolytic procedures

Pain persists or side effects unacceptable when relief obtained

Consider Euthanasia

Source: Adapted from (Lascelles 2015, 250)

Pain may be organized into a number of classes (Atkinson Smith and Hambleton 2014, 76):

1. Neuropathic pain, which humans feel, is poorly controlled by opioids, is typically described as shooting pain, burning, radiating, tingling, and numbness.

2. Somatic pain is typically a throbbing, dull, achy in addition to being localized in nature, and pet is usually requiring multi drug treatment approach.

3. Visceral pain is usually post-surgery of the abdomen or thoracic areas. This type of pain may also be present as a secondary result of liver cancer metastases. Visceral pain will usually require opioids and multimodal therapy as well to control all the pain (Atkinson Smith and Hambleton 2014).

Pain is difficult to communicate in humans and much more difficult in animals. Various pain scales have been developed to help people in pain discuss or communicate their pain to caregivers. Pain Doctor (https://paindoctor.com/pain-scales/), a website organized by a group of pain management professionals, including physicians and chiropractors, delimits no less than 15 of these pain description scales and charts. For example, there is the Wong-Baker FACES, the Global Pain Scale, and the McGill Pain Scale. The Color Scale of Pain describes the severity of pain being experienced on the basis of color and a number, ranging from 0 to 10 and blue to red (Figure 2.2). Using this Color Scale of Pain, humans are asked how much pain they are experiencing based and a

response of 0 implies no pain. Levels 1 and 2 present hardly noticeable pain and awareness of pain only when attention is drawn to it. The color changes from blue to increasing darker shades of green. By the time the pain is rated a 7 or higher, the color changes to deep crimson from dark orange. At these levels, the human patient would describe their pain as unmanageable, implying they are in pain all the time, and the pain keeps them from doing most activities, to they are unable to move (10), they are laying down all the time, unable to move because of the pain. In one commentary, 10 on the color scale was described as willing to choose death if pain cannot be reduced. But pets cannot provide this feedback.

Figure 2.2: The Color Scale of Pain

Severity		Description of Experience
10	Unable to Move	I am in bed and can't move due to my pain. I need someone to take me to the emergency room to get help for my pain.
9	Severe	My pain is all that I can think about. I can barely talk or move because of the pain.
8	Intense	My pain is so severe that it is hard to think of anything else. Talking and listening are difficult.
7	Unmanageable	I am in pain all the time. It keeps me from doing most activities.
6	Distressing	I think about my pain all of the time. I give up many activities because of my pain.
5	Distracting	I think about my pain most of the time. I cannot do some of the activities I need to do each day because of the pain.
4	Moderate	I am constantly aware of my pain but I can continue most activities.
3	Uncomfortable	My pain bothers me but I can ignore it most of the time.
2	Mild	I have a low level of pain. I am aware of my pain only when I pay attention to it.
1	Minimal	My pain is hardly noticeable.
0	No Pain	I have no pain.

Source: https://paindoctor.com/pain-scales/ (Pain Doctor 2018).

Colorado State University Veterinary Teaching Hospital (CSUVTH) has developed the Canine Acute Pain Scale to help describe the pain level in dogs. Like the human scale above, it uses colors. However, it includes poses, numbers and description of psychological and behavioral state. It also uses the dog's response to palpation and the body tension it exhibits (Figure 2.3). For example, pain score of 0 on the CSUVTH is described as comfortable when resting, looking happy and content and not bothering their wound or surgery site. Body tension is zero and the surgery site is non-tender to palpation. By scale level 2, the dog visibly uncomfortable when resting and may whimper and does not respond when beckoned. The dog expresses no interest in people. A score of 4 on the CSUVTH pain scale would have the dog constantly groaning or screaming when unattended and may bite or chew at pain site. It is difficult to distract the dog from its pain (Colorado State University Veterinary Teaching Hospital 2016).

Figure 2.3: Colorado State University Veterinary Teaching Hospital Canine Acute Pain Scale

CANINE ACUTE PAIN SCALE
Colorado State University Veterinary Teaching Hospital

PAIN SCORE FOR DOGS	PSYCHOLOGICAL & BEHAVIORAL	RESPONSE TO PALPATION	BODY TENSION
0	☐ **Comfortable** when resting ☐ **Happy, content** ☐ Not bothering wound or surgery site ☐ Interested in or curious about surroundings	☐ **Nontender** to palpation of wound or surgery site, or to palpation elsewhere	**MINIMAL** — 0
1	☐ **Content to slightly unsettled** or restless ☐ **Distracted easily** by surroundings	☐ **Reacts to palpation** of wound, surgery site, or other body part by looking around, flinching, or whimpering	**MILD** — 1
2	☐ Looks **uncomfortable** when resting ☐ May **whimper or cry** and may **lick or rub wound** or surgery site when unattended ☐ Droopy ears, **worried facial expression** (arched eye brows, darting eyes) ☐ **Reluctant to respond** when beckoned ☐ **Not eager to interact** with people or surroundings but will look around to see what is going on	☐ Flinches, whimpers cries, or guards/pulls away	**MODERATE** Reassess analgesic plan — 2
3	☐ **Unsettled, crying, groaning, biting or chewing** wound when unattended ☐ **Guards or protects wound** or surgery site by altering weight distribution (i.e., limping, shifting body position) ☐ **May be unwilling to move** all or part of body	☐ May be subtle (shifting eyes or increased respiratory rate) if dog is too painful to move or is stoic ☐ May be dramatic, such as a sharp cry, growl, bite or bite threat, and/or pulling away	**MODERATE** Reassess analgesic plan — 3
4	☐ **Constantly groaning or screaming** when unattended ☐ May bite or chew at wound, but unlikely to move ☐ **Potentially unresponsive** to surroundings ☐ **Difficult to distract** from pain	☐ Cries at non-painful palpation (may be experiencing allodynia, wind-up, or fearful that pain could be made worse) ☐ May react aggressively to palpation	**MODERATE TO SEVERE** May be rigid to avoid painful movement Reassess analgesic plan — 4

REASSESS PAIN MANGAEMENT IF PET FALLS WITHIN THIS RANGE

(Colorado State University Veterinary Teaching Hospital 2016)

The pain management chart (Figure 2.1 above) showed that opioids are used for non-responsive pain. Short-term pain medicine is used after surgery or illness but rarely is used longer than 3 to 14 days for most pets. Owners would often assist with physical therapy, range of motion exercises and encourage pets to return to normal function as soon as possible, rather than relying on pain medication in non-chronic conditions. Table 2.1 describes the recommended dosage for pain medicines in canines and the issues that need to be assessed when using them.

Table 2.1: Dosage of Canine Medication

Drug	Dose for Dogs	Comments
Paracetamol–Tylenol (acetaminophen)@	10-15 mg/kg PO q12 hours.	Associated with fewer GI side effects than regular NSAIDs. Monitor liver and kidney values. Toxicity has not been evaluated clinically in dogs. Could be combined with regular NSAIDs in severe cancer pain, but this combination has not been evaluated for toxicity.
Paracetamol (acetaminophen) + codeine (30 or 60 mg)	10-15 mg/kg of acetaminophen	Sedation can be seen as a side effect with doses at or above 2 mg/kg of codeine.
Amantadine-Symmetrel@	4.0-5.0 mg/kg PO q24 hours.	Used to treat Influenza A, can cause loose stools and excess GI gas can be seen for a few days. Should not be combined with drugs such as selegiline or sertraline possible drug interactions. Should not be used in seizure patients or patients in heart failure.
Amitriptyline-Elavil@	0.5-2.0 mg/kg PO q24 hours	Antidepressant, has not been evaluated for clinical toxicity in the dog. Should be used cautiously in combination with tramadol.
Butorphanol-Torbutol@, Torbugesic@	0.2-0.5 mg/kg PO up to q8 hours	May produce sedation at higher doses. Not a very predictable analgesic, and best when used in combination with other analgesics.
Codeine	0.5-2.0 mg/kg PO q8-12 hours	Sedation can be seen at higher doses. Like all oral opioids, it is subject to liver metabolism before reaching circulation, limiting some of its analgesic effect.
Fentanyl, transdermal	2-5 mcg/kg/hr	Can be very useful in the short-term control of pain. For long-term therapy, usefulness is limited due to need to change the patch every 4 to 7 days.
Gabapentin	3-10 mg/kg PO q6-12 hours	Has not been evaluated in dogs as an analgesic. The most likely side effect is sedation.

Drug	Dose for Dogs	Comments
Glucosamine,and chondroitin sulfate	13-15 mg/kg chondroitin sulfate PO q24 hours	Can be useful in a variety of chronic pains due to its mild anti-inflammatory and analgesic effects.
Morphine, liquid	0.2-0.5 mg/kg PO q 6-8 hours	Can be useful for dosing smaller dogs. Sedation and particularly constipation are side effects that are seen as the dose is increased. Like all oral opioids, it is metabolized by liver early.
Morphine, sustained release	0.5-3.0 mg/kg PO q 8-12 hours	Doses higher than 0.5-1.0 mg/kg are often associated with unacceptable constipation according to owners, so suggest using 0.5 mg/kg several times a day. With oral opioids bioavailability may be limited by liver metabolism.
Pamidronate	1-1.5 mg/kg slowly IV diluted in 4 mL/kg normal saline, administered over 2 hours; repeat every 4-6 weeks	Inhibits osteoclast activity and thus only provides analgesia in cases suffering from a primary or metastatic bone tumor that is causing osteolysis. Effect may be delayed days-weeks.
Prednisolone	0.25-1 mg/kg PO q12-24 hours; taper to q48 hours if possible after 14 days	Do NOT use concurrently with NSAIDs. Can be particularly useful in providing analgesia when there is a significant inflammatory component associated with the tumor and for CNS or nerve tumors.
Tramadol	4-5 mg/kg PO q6-12 hours Orally	This drug has not been evaluated for efficacy or toxicity in dogs. Currently felt to have very limited efficacy in dogs

The basic doses primarily come from Oncology of Small Animals, the author's experience and the experience of others working in small animal medicine (Lascelles 2015, 251).

None of these drugs have been evaluated for efficacy in the treatment of chronic pain or cancer pain.

None of these drugs in table 1 or appendix B are approved or licensed for use in chronic or cancer pain. The NSAIDs have not been included in this table.

Normally NSAIDs should be used as a first line of pain relief, if it is clinically appropriate and should be used at their approved dose on bottle, whenever possible.

- There is currently no information (evaluations or efficacy) on the long-term use of oral opioids for chronic pain or cancer in cats.

- None of these drugs are approved or licensed for use in chronic or cancer pain. Some drugs are approved for inflammatory or painful conditions in the cat in certain countries, and doses for the control of chronic pain or cancer pain are extrapolated from these (Lascelles 2015, 252-253).

- Most veterinarian will utilize their training and knowledge of pharmacology to only stock the best products and will write a prescription to an outside pharmacy for any that would not be cost effective to inventory. It costs a lot to inventory drugs that are rarely used and often outdate before another animal will use that medication or dosage of medication. When patients are in a terminal decline, they may not require refills before death or euthanasia.

2.6 Prevalence of Different Types of Companion Animal Diseases

A common trend noted in veterinary practice in the past 10 years is obesity in cats and dogs. As pets become more intimate parts of the family and daily life, many humans spoil their pets with higher calorie food, treats and less exercise.

Obesity changes are often subtle, and owners do not get worried until a friend or veterinarian explains that a couple pound increase on a 10-pound pet is equivalent to a 10 to 20% increase in weight. As with humans, it takes several months of concentrated effort to get a weight loss program to work, and rarely is easy.

Chronic kidney disease is more common in cats; however, it can affect dogs as well. Geriatric animals are more at risk than younger pets. Normally about half of the pets with early kidney disease are asymptomatic (i.e. owners do not know they have a problem). Animals with kidney disease, critical processes become impaired and affect the body in many ways such as urination problems, nausea or high blood pressure, depending on the nature of the disease. Dogs and cats may be born with unhealthy kidneys, or they may develop kidney problems as they age.

Chronic kidney disease is usually progressive and permanent, so early diagnosis is critical. Veterinarians should do blood and urine testing to diagnose problems early. Most animals are not showing symptoms initially, but early detection and treatment can increase longevity by several years. Dogs and cats that are diagnosed early can be placed on special diets and receive other veterinary-prescribed treatments. The following charts depict the most common veterinary diseases seen in 2011 in Banfield Hospitals and are similar to conditions observed in practice in Illinois and Florida (Banfield Veteriary 2012).

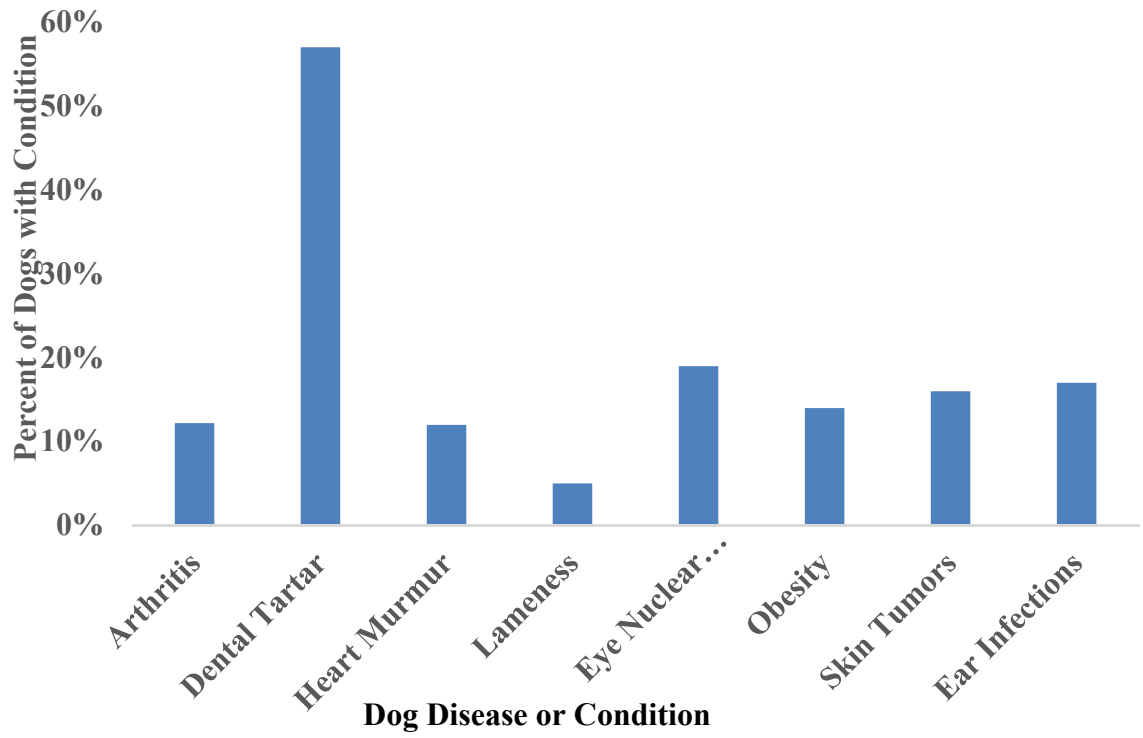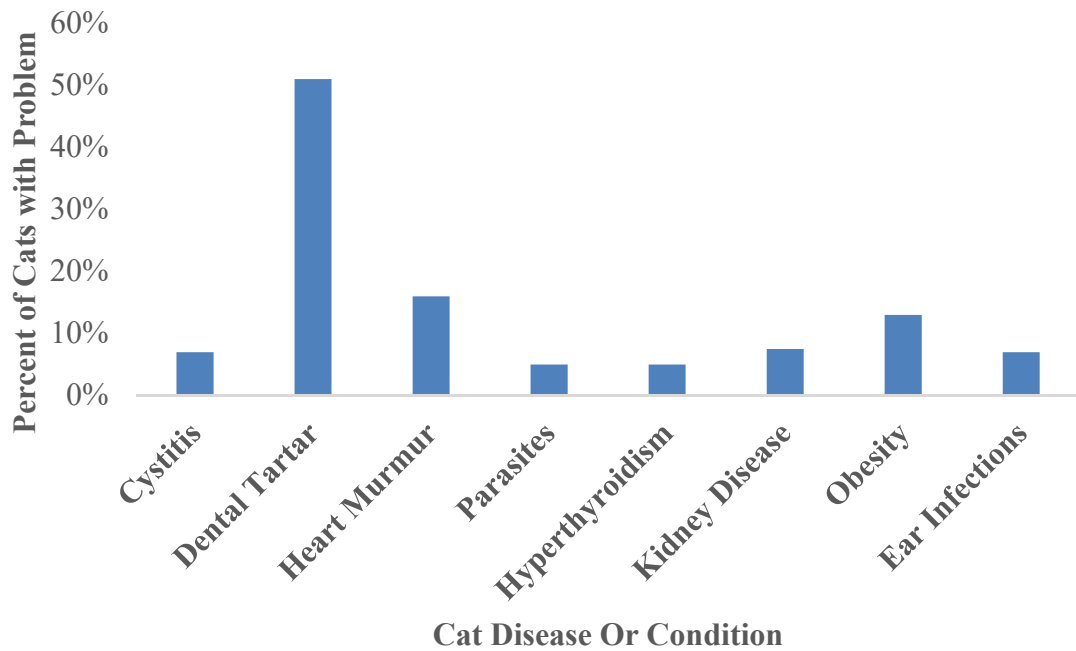**Figure 2.4 Geriatric Canine Disease Prevalence**

Figure 2.5 Geriatric Feline Disease Prevalence

2.7 Pet Value to Pet Owners

Most Americans feel the pet is a member of the family and the animal-human bond increases over time. Many clients cannot go on vacation or attend family gatherings unless the pets are able to attend also. In a recent discussion at an agribusiness social, most people indicated that a pet is more caring and compassionate than a spouse. From the anecdotal information obtained from discussions with friends (most of whom have pets at home) an estimated value of a pet to its owner is about $1000. The discussion in Chapter 4 will use the benefit-cost ratio to help guide owners and veterinarian to determine when the topic of humane euthanasia should be entering into the discussion. Understanding these dialogs are very challenging at times, and the veterinarians will be guided by the family's feedback of the patient's terminal care.

CHAPTER III – DATA AND CONCEPTUAL MODEL FOR TREATING
TERMINAL DISEASE IN VETERINARY MEDICINE

Beyond a certain point of the progression of a terminal illness, such as cancer, the treatment focus moves from curing to alleviating pain and ensuring patient comfort. This chapter presents a conceptual model for assessing the potential economic implications of managing pain in pets during a terminal decline. Companion animals are the primary focus because food animals and livestock are often driven in a more straight-forward economic way. If treatment cost exceeds the market value of the animal, owners do not treat. However, with companion animals, the decision is often complicated by emotional attachment. For some pet owners, the animal takes on a family member position, making them consider treatment for any terminal disease at the same par as treatment for similar diseases for their human children or relatives. This section shows how the conversations about treatment decisions might be influenced by the economics of such decisions.

The chapter is divided into three main sections. The first section presents the conceptual model for treating terminally-ill companion animals. Section 3.2 describes the conceptual model developed to explore the decision making process under alternative scenarios. It also describes the different scenarios that are considered. The final section presents the data and their sources employed in the analyses.

3.1 Treatment Models

In this research, we have represented the final six-week treatment profile for a terminally-ill canine. The treatment profile reflects the treatment plan used for a hypothetical 80-pound canine with terminal cancer beginning six weeks before its demise. Because both the pet owner and the veterinarian know that the pet cannot be treated at this stage of its disease progression, the focus of the treatment profile is to ensure maximum pet

comfort during this time and make the necessary economic and emotional decisions related to care.

Treatment plans in terminally ill cancer pets focus on pain management aimed at increasing pet comfort after chemotherapy. This is because patients in this stage of their disease are unlikely to get better. However, some pet owners are unwilling to accept that finality and the veterinarian has to manage their expectations by focusing on the comfort of the pet, which is the patient. Veterinarians would use Rimadyl@ or similar nonsteroidal anti-inflammatory drug at the start of this and adjust the pain management regime usually with more powerful pain management therapies over time. Additionally, medical evaluations by the veterinarian and blood work to monitor internal organs, electrolytes and complete blood count are routinely done, at least on a weekly basis, to make sure the chemotherapy does not need to be adjusted.

The following weeks Cannabinoids (CBD) and Gabapentin may be added to adjust for increasing pain noticed by owner (table 3.1). Based on the pain situation, the care team and the owner might elect to try some narcotic by the end of Week T-3, where T is the end date. By then most of these cases are not likely to get better and pet comfort requires more aggressive pain management. By Week T-5, signs of pet discomfort become more visible, manifested in howling and crying, whining and painful looks. At this point, an opioid, such as Fentanyl patches, could be applied to manage the pain, given that it is more potent than Tramadol. Conversations with pet owners at this time explains that this medical care will not make the pet better, but only manage its pain. The administration of pain management medication in increasing dosage will continue until the pet dies naturally or the pet owner elects euthanasia.

3.2 Conceptual Treatment Models

Owners faced with a terminally ill pet must evaluate how much they spend on the treatment of the pet (pecuniary expenses). That assessment, unlike that of production livestock, is complicated by how attached pet owners are to their pets. It is also influenced by the emotional cost (non-pecuniary cost) of the illness on the pet owner. A very sick animal could extract a very high emotional cost on its owner by constraining the owner's movement and disrupting their normal routines. For example, a pet that is unable to walk due to a terminal illness may have to be carried outside for its bodily functions, restricting its owner's ability to leave her for a long period. If the owner has to leave, then they have to hire the services of someone who can help the pet with these needs it is unable to undertake on its own. The assessment also includes the medical costs associated with the treatment. These are the medications and professional services that are provided to care for the animal. The final consideration in the assessment is the value of the pet to the pet owner.

Let us explore the conceptual relationships among these variables (value of pet, separation anxiety, emotional cost factor and benefit cost ratio) we are using to assess the treatment decision about a terminally ill companion animal. Let the value of the animal to the pet owner be V. Assuming that this value is independent of the pet's disease but dependent on how long the pet has been with the owner. The relationship between V and duration of the pet-owner relationship is positive and increasing but at a decreasing rate after some time. This implies that beyond a certain period, the value of the pet is constant to the pet owner most of its mature adult life. It is also assumed that this value towards the end of the pet's life can change, depending on the pet owner's disposition and perceived bond with the pet.

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The potential change in the value of the pet to the pet owner is dependent on the separation anxiety the pet owner experiences with the imminent death of the pet. If the pet owner does not experience any separation anxiety, then the value remains unchanged. If the pet owner does experience some separation anxiety towards the end of the pet's life, then that will increase the perceived value of the pet to the pet owner as the inevitable date gets closer. The separation anxiety model, therefore is a function of time and its impact is transferred through the pet owner's value for the pet.

Emotional cost of the pet's illness is modeled as a rate of increase in the cost of pet's care directly attributable to changes in the pet owner's life. It could be the cost of missing work, sleepless nights, or new nursing skills to take care of a pet that is increasingly unable to take care of itself. In this conceptual development, the model simply shows an increase in the medical cost of care over time. Medical cost of care is the cumulative cost of drugs, diagnostics and professional fees related to the treatment of the pet. The model is assumed to focus on the last six weeks of the pet's life. This is the period where deterioration in the quality of life of the sick pet can be rapid and also visible.

Conceptually, the total cost of care at any point in time, C, is defined as follows:

$$C = \sum (MC + EC) \tag{3.1}$$

When MC is the medical cost and EC is the emotional cost. Emotional cost has been modeled as a growth function of medical treatment cost and time. The emotional cost factor, e, is the adverse effect of care on the owner; it is assumed dependent on the medical care cost. These adverse effects include the increased time for care giving and loss of time available for other activities. Specifically, the emotional cost is defined as:

$$EC_t = MC_t e^t \qquad (3.2)$$

Value of the pet, in this research, is defined as an integer that is influenced by the separation anxiety factor at any point in time. Therefore, it is modelled as follows:

$$V_t = s_t V_{t-1} \qquad (3.3)$$

Where "s" is the separation anxiety factor and "t" is time. The relationship between "s" and "t" is dependent on value in the prior time period. The separation anxiety factor could go up or down each week, but would correspond to the value of pet now divided by value of pet in prior time period (here one-week interval). An owner with a lower separation anxiety level who understands that either they cannot extend the pet's quality life or cannot afford the time and monetary needs beyond a certain point of their pet value estimate would be more likely to consider euthanasia.

We use the benefit-cost decision framework to facilitate the decision making by the pet owner on when to stop treatment. The decision guide for the BCR (benefit-cost ratio) framework is as follows:

$$BCR = \frac{V_t}{C_t} \begin{cases} >1: Continue\ treatment \\ =1: Indecision \\ <1: Discontinue\ treatment \end{cases} \qquad (3.4)$$

The decision point for consideration of euthanasia is defined as when the benefit cost ratio is less than unity.

3.3 Data Sources

The foregoing analysis is based on the treatment of a terminally ill canine, who started treatment at about 80 pounds. It focuses on the last six weeks of treatment, assuming the decision to continue treatment will be evaluated weekly using the above model. The example cited uses routine medication and hospital costs were obtained from

Novak Brainard Veterinary Clinic in Illinois and the retail cash price of medication (in US dollars) from a large national pharmacy. The treatment regime is assumed to begin after the pet has undergone chemotherapy for cancer treatment and remission has been ruled out. The owner has been left with a terminally declining pet with an expected 6 weeks prognosis. The sample treatment model presented in Section 3.1 is reflected to show possible medications and cost presented in Table 3.1. We have excluded the specific dosage applied to protect potential use of this information by non-professionals in the treatment of a terminally ill canine.

Table 3.1 shows that at the beginning of treatment (Week 0), we recommended treatment with only a non-steroidal anti-inflammatory (NSAID) medication. We also assume diagnostic blood tests are conducted and the veterinary services are provided. The total cost for medical services and medication in this initial week is estimated at $122.81. The table shows the inclusion of Gabapentin and CBD in Week 1 and 2. An oral opioid such as Tramadol is added in week 3 and 4. A description of treatment plan is in Section 3.1 above.

Table 3.1: Weekly Medical Treatment Cost Assumptions

Week	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total
NSAID	$17.81	$17.81	$17.81	$17.81	$17.81	$17.81	$15.26	$122.11
Gabapentin		$78.79	$78.79	$78.79	$78.79	$78.79	$67.53	$461.48
CBD		$24.99	$24.99	$24.99	$24.99	$24.99	$21.42	$146.37
Tramadol				$71.12	$71.12			$142.24
Fentanyl						$72.00	$72.00	$144.00
Blood Test	$85.00	$85.00	$85.00	$85.00	$85.00	$85.00		$510.00
Vet services	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$140.00
Euthanasia							$100.00	$100.00
Total Medical Cost	$122.81	$226.59	$226.59	$297.71	$297.71	$298.59	$296.22	$1,766.21

In Table 3.2, we show the emotional cost factor and the separation anxiety factor parameters for the scenarios considered in this research. In total, we consider six scenarios, including the Base Scenario. The separation anxiety factor under the Base Scenario was 0, suggesting that we are considering a situation where the pet owner does not exhibit any separation anxiety about the imminent demise of the pet. Based on the Value equation, this results in a constant pet value over time. As the separation anxiety increases, the ability of the owner to part with the pet becomes more difficult. Thus, under Scenario 1, the separation anxiety factor is assumed at 0.1, leading to a base value of $1,000 being $1,772 by terminal time period (table 3.2 and figure 3.2). Similarly, the emotional cost factor in the Base Scenario is assumed to be 0.15, because sick pets always disrupt the lifestyles of caring pet owners. They either incur the cost of these changes directly through loss of time or they do so indirectly by paying someone to undertake their increased pet care duties.

Table 3.2: Scenarios and their Alternative Parameters

Scenarios	Separation Anxiety Factor	Emotional Cost Factor
Base Scenario	0	0.15
Scenario 1	0.1	0.3
Scenario 2	0.2	0.6
Scenario 3	0.3	0.9
Scenario 4	0.4	1.2
Scenario 5	0.5	1.5

The trend in the emotional cost and medical treatment costs for the last six weeks plus the initial week for the Base Scenario is presented in Figure 3.1. The figure shows that emotional cost factor of 0.15, the emotional cost exceeds the medical treatment cost in Week 5, when all other things are held constant.

Figure 3.2 illustrates the trend in value of the pet to the pet owner under the Base Scenario and Scenario 1 parameters of separation anxiety. From Equation 3.2, the

implication of the separation anxiety parameter is that the value increases linearly at 10%

per week in the terminal stages of the pet's life. This is explained by the fact that the

recognition that they would lose their pet in the near future fosters a desire to hold onto the

pet more dearly by inflating its value. The other scenario is a pet owner who does not

exhibit any separation anxiety, i.e., the separation anxiety factor is zero.

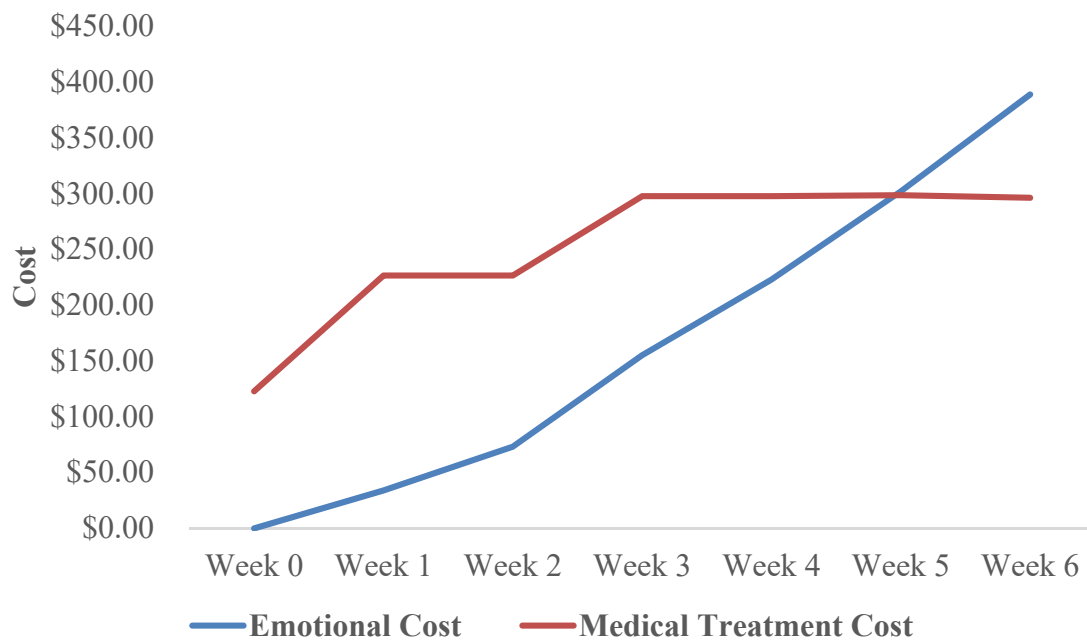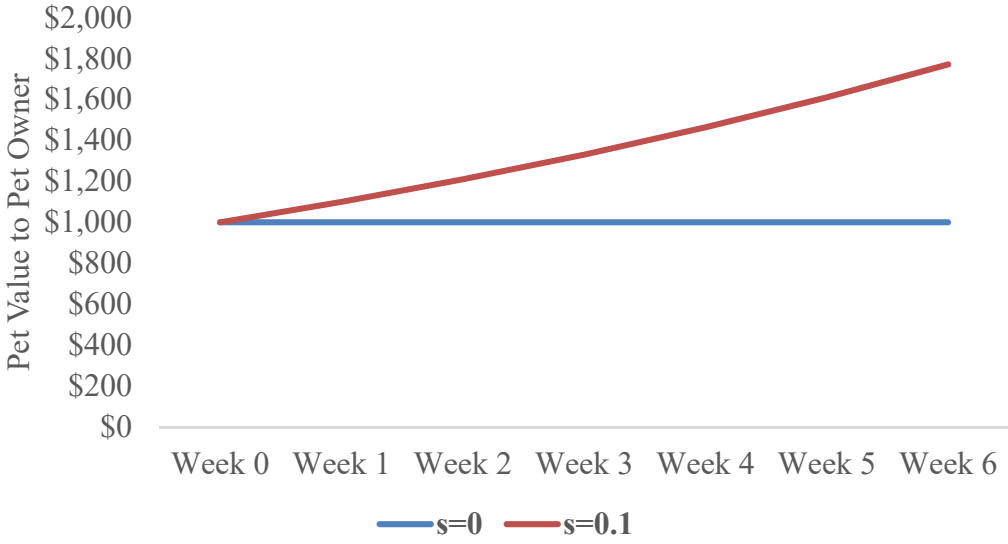**Figure 3.1: Emotional and Medical Treat Cost Data Used in the Analysis with Emotional Cost Factor = 0.15**

Figure 3.2: Pet Value to Pet Owner Under Alternative Assumptions about Separation Anxiety Factor (s)

CHAPTER IV: SIMULATION ANALYSIS AND RESULTS

In this chapter, the results of our models are discussed and the implication of the analyses and how the analytical tool we used in this research may be used by veterinarians to help their clients in their decisions about terminally ill pets. The first section of the chapter provides a recap of the scenario characteristics. The second section presents the Base Scenario results, positioning them as a reference point from which the rest of the analyses take off. Section 4.3 presents the results of the simulation of the separation anxiety factor while Section 4.4 presents those of the emotional cost factor. Section 4.5 organizes the results as a way of engaging pet owners who have high separation anxiety, and would like to treat their pets "forever", to have humane conversations about their choices.

4.1 Pain, Humane Treatment and Love

Treating a pet with chronic pain can be expensive and emotional. In other medical conditions of terminal pet decline, veterinarians' will focus on other quality of life factors in addition to pain. Recall that this research is about managing the pain of an 80-pound canine with terminal cancer. The treatment in Week $T-6 = 0$, when it is assumed the dog has completed a section of chemotherapy for the cancer. T is the terminal stage, defined here to mean six weeks after the terminal chemotherapy treatment.

Chemotherapy always induces significant pain that can cause massive discomfort for the dog, which can disturb the pet owner immensely. This interaction between the dog's pain and the pet owner's discomfort connects the latter's decisions and options to their own utility function. In other words, the choices pet owners make for their pets may not be altruistic since they are, through those actions, dealing with their own utility. The pet

owner recognizes the deteriorating state of the pet and the increasing difficulty of managing

the pain with increasing dosage of more potent medications. The pet owner begins to

balance their love for their animals and the emotional torment of its demise on them, the

pet owner, with the humane treatment of the animal. Euthanasia becomes an option, but

when? This is the decision support tool that this research developed. The decision point for

considering euthanasia is defined as when the benefit-cost ratio is less than unity.

4.2 Base Scenario Analysis

It is assumed that separation anxiety is 0 and emotional cost factor is 0.15 under the

Base Scenario. Based on the medical care cost presented in Table 3.1, total medical costs

over the terminal six weeks is $1,766.21 while emotional cost would be expected to be

double that. Thus, the emotional cost (sleepless night, missed work, nursing duties if pet is

home etc.) associated with the dog reaching Pain Level 4 on the CSUVTH (Colorado State

University Veterinary Teaching Hospital) scale is higher than cash expenses on medication

and veterinary services. Thus, when not recognized, the cost of treating the pet in these last

days is underestimated. Since the Base Scenario does not assume changes in separation

anxiety, the value of the dog to its owner does not change. This leads to a benefit-cost ratio

profile that decreases from 4.1 in Week 0 to 0.2 in Week 6. The benefit-cost ratio is 0.8 in

Week 2, suggesting that the pet owner may euthanize the dog in that week to present the

most economical decision in terms of out of pocket expenses on treatment and emotional

cost of care experienced by the pet owner. Since that emotional care of cost is connected to

the pain level of the dog, this decision also becomes a humane choice. The foregoing is

summarized in Figure 4.1. It is observed from this figure that emotional cost is a

significantly and increasing share of total cost of care for the terminally-ill pet.

Figure 4.1: Value of Pet, Medical and Emotional Cost and Benefit-Cost Ratio in the Last Six Weeks of Life
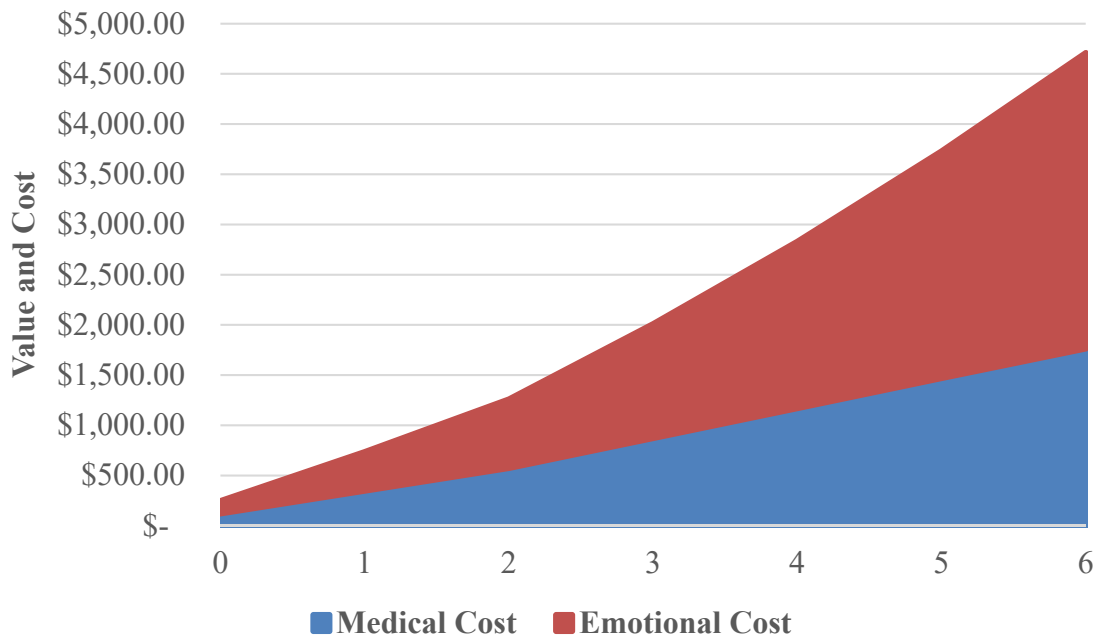
4.3 Separation Anxiety Scenarios

The separation anxiety scenarios assumed separation anxiety factor increasing from 0 in the Base Scenario to 0.5 in Scenario 5, while holding all other parameters constant. The trends in value for the different scenarios are presented in Figure 4.2. For example, when separation anxiety factor is 0.2 (Scenario 2), the terminal value of the pet in week 6 is $2,985.98. This compares to the terminal value of the pet under Scenario 5 (s = 0.5) of $11,390. The high value the pet owner places on the pet as she contemplates the separation from the pet through the pet's demise distorts the relative expenditure on treatment and pet comfort. Indeed, this high value would suggest a "selfishness" on the pet owner's part, where their pain of losing the pet is placed ahead of the humane treatment of the pet.

Figure 4.2: Pet Value Under Alternative Separation Anxiety Scenarios
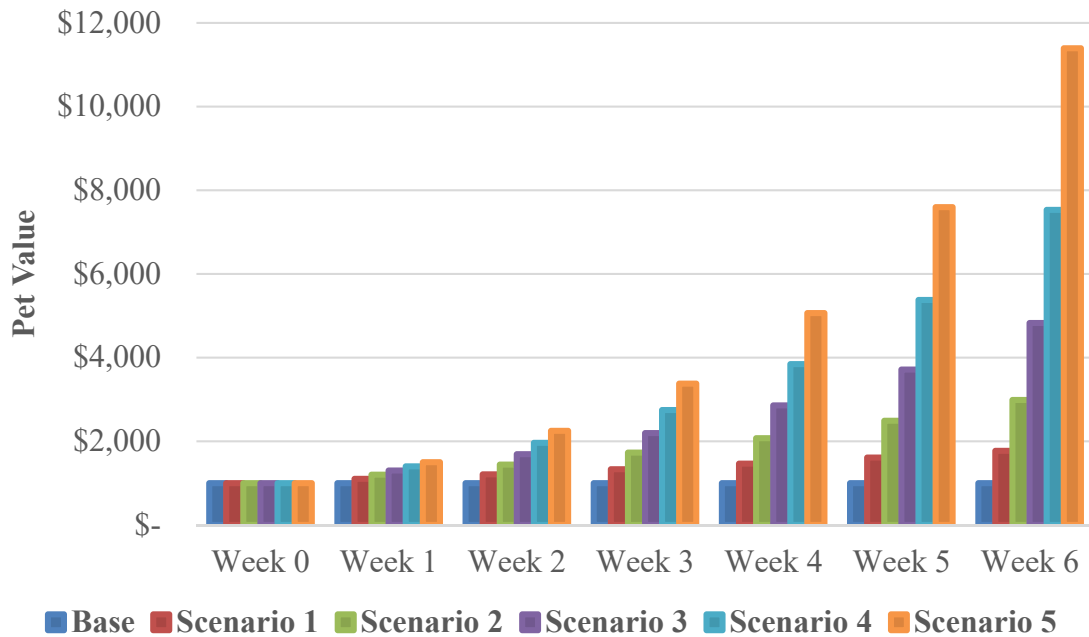
The benefit-cost ratio results are presented in Table 4.1. The table shows the reference Base Scenario results compared to the five separation anxiety scenarios, where the separation anxiety factor increases from 0.1 to 0.5 in 0.1 increments across the scenarios, starting at 0.1 in Scenario 1. The benefit-cost ratio is 0.99 in Week 2 in Scenario 1, suggesting consideration of euthanasia in Week 2, just as it was determined under the Base Scenario. The results also show that euthanasia is not a feasible option in Scenario 3, Scenario 4 and Scenario 5 because the benefit-cost ratios under those scenarios never fall below unity, given the conditions under which the simulations are conducted. This means that holding all other things constant, separation anxiety reduces the likelihood of a pet owner considering euthanasia. The "selfishness" effect of separation anxiety is revealed in the results, with the pet owner placing their own "comfort" ahead of the pet's comfort, and hence choosing to ignore the humane treatment of ending the pet's pain by continuing to

treat with higher doses of more potent medications, e.g., opioids, even when the

contribution to comfort is minimal or nonexistent.

Table 4.1: Benefit-Cost Ratio Results Under Alternative Separation Anxiety Factors

Week	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Week 0	4.07	4.07	4.07	4.07	4.07	4.07
Week 1	1.36	1.50	1.64	1.77	1.91	2.05
Week 2	0.82	0.99	1.18	1.39	1.61	1.84
Week 3	0.54	0.72	0.93	1.18	1.48	1.81
Week 4	0.40	0.59	0.83	1.14	1.54	2.02
Week 5	0.32	0.51	0.79	1.18	1.71	2.42
Week 6	0.26	0.47	0.79	1.28	1.99	3.01

4.4 Emotional Cost Factor Scenarios

Emotional cost factor is assumed to increase by 0.15 in each Scenario, from

0.15 under the Base Scenario to 1.5 under Scenario 5. The effect of these changes on total

cost is presented in the trends in total cost (medical care cost and emotional cost) in Figure

4.3. It shows that the terminal total cost (medical and emotional) is in excess of $120,000

because of the perceived emotional costs the pet's sickness and pain imposes on the pet

owner. These parameters were chosen to show the range of the decision support tool,

allowing the veterinarian and the pet owner to explore alternative parameters that are

realistic and relevant to the pet owner.

The effect of these emotional cost factors on the feasibility of euthanasia is

presented in Table 4.2. Despite the seemingly outrageous assumptions about the emotional

cost factor, the table shows that euthanasia is feasible only in Week 1 under Scenario 5 and

not feasible until Week 2 under the remaining scenarios. For example, the benefit-cost

ratio was estimated at 0.73 under Scenario 1, 0.61 under Scenario 2, 0.51 under Scenario 3

and 0.44 under Scenario 4 in Week 2, the same as the Base Scenario.   Scenario 2,

Scenario 3 and Scenario 4. Scenario 1 is the same as the Base Scenario, when euthanasia is

feasible only in Week 4.

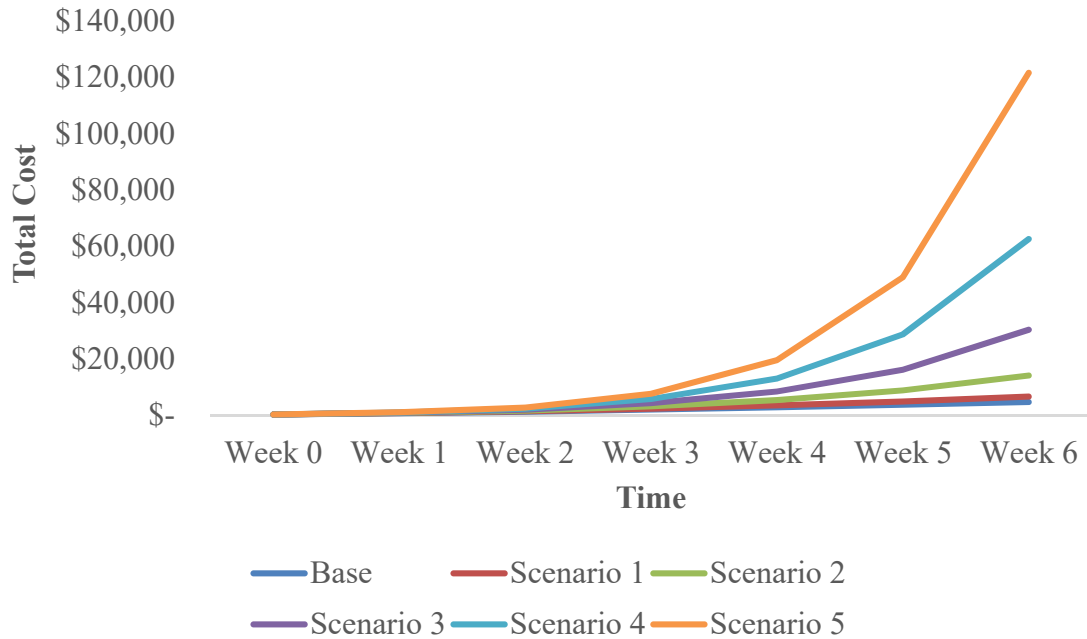**Figure 4.3: Total Cost Trends under Alternative Emotional Cost Factor Assumptions**

Table 4.2: Benefit-Cost Ratio Under Alternative Emotional Cost Factor Assumptions

Week	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Week 0	4.07	4.07	4.07	4.07	4.07	4.07
Week 1	1.36	1.30	1.20	1.11	1.03	0.96
Week 2	0.79	0.73	0.61	0.51	0.44	0.37
Week 3	0.50	0.43	0.32	0.23	0.17	0.13
Week 4	0.35	0.29	0.18	0.12	0.08	0.05
Week 5	0.27	0.20	0.11	0.06	0.03	0.02
Week 6	0.21	0.15	0.07	0.03	0.02	0.01

What if the separation anxiety factor is assumed to be 0.2 in these scenarios? The results

show that euthanasia becomes feasible in Week 2. Thus, the separation anxiety factor

tempers the effect of emotional cost factor but not too much, changing as it were, the

results only in under Scenario 5, from Week 1 to Week 2. The results are presented in

Table 4.3.

Table 4.3: Benefit-Cost Ratio for Emotional Cost Factor Scenarios under Separation Anxiety Factor = 0.2

Week	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Week 0	4.07	4.07	4.07	4.07	4.07	4.07
Week 1	1.36	1.57	1.44	1.33	1.24	1.16
Week 2	0.79	1.05	0.88	0.74	0.63	0.54
Week 3	0.50	0.74	0.55	0.40	0.30	0.23
Week 4	0.35	0.60	0.38	0.24	0.16	0.11
Week 5	0.27	0.51	0.28	0.15	0.09	0.05
Week 6	0.21	0.45	0.21	0.10	0.05	0.02

CHAPTER V: SUMMARY AND CONCLUSIONS

In this chapter, we present the summary and conclusions from the research. It is organized in three parts. The first part provides the summary of the study. The second part the study's conclusions and lessons learned. The final part presents recommendations for future research on the subject.

5.1 Summary

The problem this research focus was on assessing the economics of pain management in a terminally ill pet. The importance of the problem rests on the challenges veterinarians face when dealing with pet owners whose pets have terminal illnesses. Because of their relationships with their pets, there are often difficulties in making objective decisions about treatment programs that are in the pet's best interest. It is not uncommon for pet owners to put their emotional pain of the impending death of their pet ahead of the humane treatment of the pet, which may in the case of terminally ill pets, be euthanasia. The research sought, then, to develop a process to help veterinarians work with their clients to make these end-of-life decisions in the most economically sound manner, taking into consideration the medical costs of treatment and the emotional and subjective costs and values of the pet to the pet owner.

The research used a benefit-cost ratio analysis as the economic decision support mechanism. Benefit from owning a pet was defined as the monetary value the pet owner places on the pet. There are numerous ways in which this value may be discovered "truthfully" from the pet owner. However, in this research it was assumed to be $1,000. Conceptually, this value was seen as a function of time: the longer the pet has been with its owner, then higher the value the owner would place on it. Cost comprised two major components: medical care cost, which involves medications and hospital staff services; and

emotional cost, which is a function of the debilitating effects of the pet's sickness on the pet owner and his life. The simulated benefit-cost ratio of managing pet pain in the last six weeks of life used parameterized values of separation anxiety factor and emotional cost factor. The independent simulations of separation anxiety and emotional cost factors showed that euthanasia was feasible as early as the second week and the decision seemed to be more sensitive to emotional cost factor than separation anxiety factor.

The results suggest that the model is effective in helping veterinarians help their clients make more economical and humane choices using this simulation tool. By allowing the clients to select their own parameters, they will be able to assess how their subjective perceptions and feelings translate into computer model results that help them make more *objective* choices. The tool does not prevent them from recognizing their deep and complex relationship with their pet but it helps them to frame those relationships within the context of economic value.

5.2 Conclusion and Suggestions for Future Research

The fact that the non-pecuniary parameters produced similar decisions meant that the idea of parameterization to test model sensitivity was robust. Using the benefit cost analysis and simulations as the methods allowed the data to be transformed from subjective data to objective data.

Although each animal is unique in its medical needs and treatment, the information indicates that most pets are reaching a point where the discussion of euthanasia can be evaluated in the 2 to 5 week range after owner is aware of a condition being terminal. The primary factor of separation anxiety prevents some owners from being able to emotionally make a humane decision, but as the emotional cost of daily nursing care, cost of time and medicine, and emotional cost of seeing pet declining in pain continues, euthanasia maybe

reconsidered. A veterinarian must handle these situations very delicately and try to gage

the families' separation anxiety factors and emotional costs factors from their interactions

with them.

The economic data here suggests the optimal time to discuss euthanasia is 2 to 5

weeks after the pet is diagnosed with a terminal diagnosis, and is in severe pain, and has a

life expectancy of 4-8 weeks. Each case is unique and variables such as severity of

condition, quality of life, emotional cost, and separation anxiety of the owner need

consideration.

In talking to veterinarians around the country about this project, many veterinarians

feel the FDA and pharmacy boards are overly focused on elimination of opioids (even

small amounts for acute pain conditions) and not on better alternatives of pain relief as

options for patients. Veterinarians need to review other modalities of pain relief.

Reviewing alternative treatments and expected costs with clients, especially when limiting

the more highly addictive (full mu agonist) narcotics. Safer options may be needed if

humans cannot stay away from these animal medications. Limiting the chance of human

abuse is important to everyone.

The vast majority of veterinarians went into veterinary medicine to help animals

and take the Hippocratic oath seriously to provide the best quality medicine that their

clients can afford. Opioids have always been an option for those animal patients

experiencing acute and chronic pain (severe arthritis and cancer patients most commonly).

The altruistic value (the value of having patients in less pain) as well as the client's attitude

toward medications and their ability to follow treatment protocols needs to be assessed.

When possible acute pain should be managed with only a short 3-7-day prescription, then

animals should be rechecked and medication only refilled if needed, and if the veterinarian feels the benefits outweigh the risks. Regardless of economic cost (this will include cost of ordering, prescribing, monitoring and complying with regulatory requirements) veterinarians want to provide the animal with the best medical care possible. Veterinarians treating chronic pain issues can discuss options such as non-steroidal medication, holistic products, muscle relaxers, cannabinoids, physical therapy, chiropractic and acupuncture procedures to help manage pain. The cost of these additional therapies will ultimately have to be incurred by the owners or insurance companies.

Further research in the field of pain management should continue. Scientific and medical research must develop safe medications/therapies for both humans and animals to control pain that will be cost effective for the average family. The addictive potential of these products needs to be better evaluated before they are released for wide spread usage. Veterinarians must carefully evaluate all aspect of a pet's medical situation before prescribing chronic pain medication. When the pet's pain goes to a 3 or 4 on the pain scale veterinarians must consider the emotional cost factors and separation anxiety factor to determine the best time to have the discussion about if and when the owner might decide to discontinue treatment and elect euthanasia.

Despite the knowledge and advances in economics and veterinary medicine, each veterinarian must provide empathy and guidance for pet owners. The variables of human nature will make it difficult to obtain perfect understanding and objective decisions in every case.

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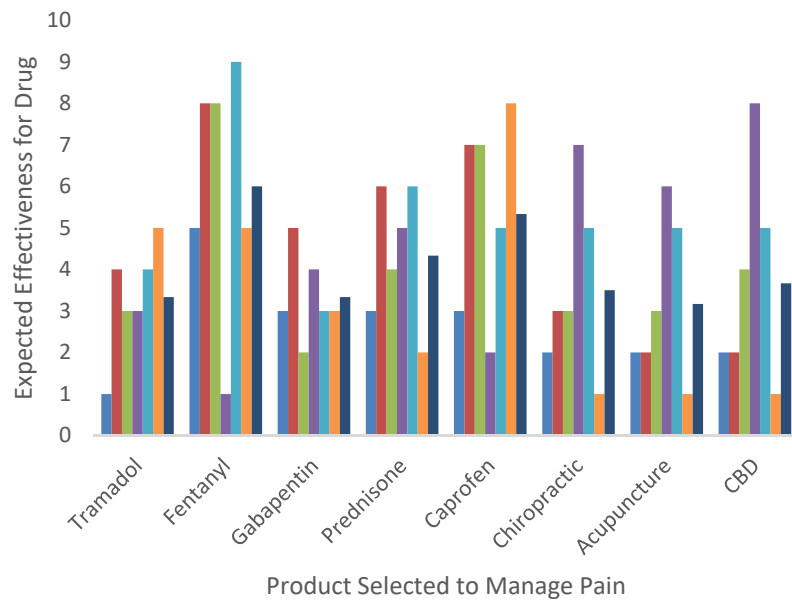Wikopedia. 2019. *Opioids* . August 30. Accessed September 7, 2019. https://en.wikipedia.org/wiki/Opioid_epidemic.

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APPENDIX A

Responses from seven veterinarians about their pain management protocols. The question was:

Please rate the following pain medications for managing the pain of a pet with chronic pain, such as arthritis or cancer. 1 being the least effective, and 10 the most effective at reducing the pain level.

1. Tramadol
2. Fentanyl
3. Gabapentin
4. Prednisone
5. Caprofen
6. Chiropractic
7. Acupuncture
8. CBD - cannabis

Bar chart. Y-axis: Expected Effectiveness for Drug (0–10). X-axis: Product Selected to Manage Pain (Tramadol, Fentanyl, Gabapentin, Prednisone, Caprofen, Chiropractic, Acupuncture, CBD).

APPENDIX B

PAIN MEDICATION FOR CATS

Drug	Cat Dose (mg/kg)	Notes
Acetaminophen-Tylenol@ (Paracetamol)	Contraindicated	Small doses rapidly cause death in cats.
Amantadine-Symmetrel@	3.0-5.0 mg/kg PO q24 hrs	This drug has not been evaluated for toxicity but is well tolerated in dogs and humans, with occasional side effects of agitation and GI irritation. May be a useful addition to NSAIDs in the treatment of chronic cancer pain conditions. Amantadine powder can be formulated to correct dose.
Amitriptyline-Elavil@	0.5-2.0 mg/kg PO q24 hrs	This drug appears to be well tolerated for up to 12 months of daily administration. Can be formulated into a dermal application. May be a useful addition to NSAIDs for treatment of chronic pain conditions.
Aspirin	<u>10 mg/kg PO q48 hrs</u>	Can cause significant GI ulceration. Do not use more that 3 days!
Buprenorphine-Buprinex@	0.02-0.03 mg/kg SL q8-12 hrs	Good way to provide postoperative analgesia at home. Feedback from owners indicates that after 2-3 days dosing at this dose, anorexia develops. Smaller doses (5-10 µg/kg) may be more appropriate for "long-term" administration, especially in combination with other drugs.
Butorphanol-Torbutrol@ Torbugesic@	0.2-1.0 mg/kg PO q6 hrs	Oral form after surgery may be beneficial. Generally considered to be a poor analgesic in cats

except for visceral pain; it to be useful as part of a multimodal approach to cancer pain therapy.

Carprofen- Rimadyl@	Not enough data to enable recommendations for long-term administration.	
Fentanyl patch (transdermal)	2-5 µg/kg/hrs	The patches may provide 5-7 days of analgesia in some cases and should be left on for longer than 3 days. Following removal, the decay in plasma levels following patch removal is slow.
Firocoxib-Previcox@	—	Has not been reported in clinical cases, but it has a half-life of 8-12 hours in the cat, and at 3 mg/kg provided antipyretic effects in a pyrexia model.
Flunixin.meglumine-Banamine@	1 mg/kg PO daily for 7 days	Daily dosing for 7 days results in increased rate of metabolism of the drug but a rise in liver enzymes, suggesting liver toxicity *may* be a problem with prolonged dosing.
Gabapentin-Neurontin@	10 mg/kg q12 hrs	Appears to be particularly effective in chronic pain in cats where an increase in sensitivity has occurred, or where the pain appears to be excessive.
Glucosamine/chondroitin sulphate combinations	15 mg/kg chondroitin sulphate PO q12-24 hrs	May be associated with mild analgesic effects.
Glucosamine/chondroitin sulphate combination with avocado/soya extracts	At labelled dose	May be associated with mild analgesic effects.
Ketoprofen-Orudis@	1 mg/kg PO q24 hrs	Probably well tolerated as pulse therapy for chronic pain, with a few days "rest" between treatments of approximately 5 days. Has also been used by some at 1 mg/kg every 3 days long term. Another approach has been to use 0.5 mg/kg daily

for 5 days (weekdays) followed by no drug over the weekend and repeated.

Meloxicam-Metacam@	0.01 mg/kg PO on day 1, followed by 0.05 mg/kg PO daily for 4 days, then 0.05 mg/kg every other day thereafter.	Well received by cats due to its formulation as a honey syrup. Also, the drop formulation makes it very easy to gradually and accurately decrease the dose. Meloxicam should be dosed accurately using syringes.
Morphine (oral liquid)	0.2-0.5 mg/kg PO every 6 to 8 hours	Best compounded into a palatable, flavored syrup; however, cats usually resent this medication. Morphine may not be as effective in cats as it is in dogs.
Morphine (oral sustained release)	Tablets too large for dosing cats.	—
Piroxicam-Feldene@	1 mg/cat PO daily for a maximum of 7 days. If longer term try EOD	Daily dosing for 7 days results in a slight increase in the half-life.
Prednisolone	0.5-1.0 mg/kg PO q24 hrs	Can be very effective. NOT to be combined with concurrent NSAID administration.
Polysulfated glycosaminoglycans (PSGAGs; Adequan)	5 mg/kg SQ twice weekly for 4 weeks; then once weekly for 4 weeks; then once monthly (other suggested regimens call for once weekly injections for 4 weeks, then once monthly).	There is no evidence-based medicine that it provides any analgesic effect, but anecdotal information suggests improvement can be seen after a few injections.
Robenacoxib-Onsior@	1-2 mg/kg q24 hrs	First NSAID that is a COX-2 inhibitor, has a short half-life, and demonstrates tissue selectivity.

Tepoxalin-Zubrin@	5-10 mg/kg q24 hrs	NSAID used long-term in cats, likely due to its short half-life (5 hours).
Tolfenamic..acid-Clotam@	4 mg/kg PO q24 hrs for 3days maximum	Has not been evaluated for chronic pain, but recent objective measurements demonstrate analgesia in the cat when administered at surgery time
Tramadol-Ultram@	1-2 mg/kg once to twice daily	Main problem is dosing cats—the tablets are very bitter and hard to pill cats.
Vedaprofen-Quadrisol@	0.5 mg/kg q 24 hrs for 3 days	NSAID not been evaluated for chronic pain but was evaluated for controlling pyrexia in upper respiratory infection, and for controlling postoperative pain following ovariohysterectomy.

APPENDIX C

COMMON ABBREVIATIONS USED:

 PO - By mouth;

GI - gastrointestinal;

NSAIDs - nonsteroidal anti-inflammatories;

SL - sublingual;

SQ - subcutaneous;

 tid - three times a day;

qid - four times a day;

COX-2, cyclooxygenase-2.

CSUTH – Colorado State University Teaching Hospital

DEA – Drug Enforcement Agency,

FDA Federal Drug Administration,

PDMP- Prescription Drug Monitoring program