An Endeavor Toward Process Improvement:
An Analysis of the Triage and Caseload in the Emergency Room at the Foster Hospital For Small Animals and the Development of a Modified Emergency Severity Index (mESI)

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Abstract

In 2019, over 17,500 cats, dogs, rabbits, ferrets, birds and other pets came through the emergency room of the Foster Hospital for Small Animals (FHSA), located at Tufts University, Cummings School of Veterinary Medicine in North Grafton, Massachusetts. This enormous caseload, combined with a nationwide shortage of qualified emergency veterinary professionals, necessitates the development of a system to maximize efficiency in the ER to minimize error, wait times, patient suffering, and staff burnout.

Strategies to identify and eliminate the wasteful practices in the ER were devised using the Toyota Production System (TPS) and other efficiency ideologies as models. The Emergency Severity Index was modified using a list of triage discriminators developed by Ruys et al. in a 2012 study of the Manchester Triage System. This modified Emergency Severity Index (mESI) algorithm, consisting of five levels of patient acuity and resource need, was applied to 430 cases in a retrospective study. The purpose of the study was to analyze the caseload at FHSA and to determine any correlation between mESI scores and lengths of stay in the emergency room.

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I would like to thank the originators of the Emergency Severity Index, Dr. David Eitel and the late Dr. Richard Wuerz for inspiring this project and providing its backbone. I would also like to thank Dr. Laura Ruys and her team for their work developing the Veterinary Triage List, which helped to clarify much of the work required for the development of the IQP.

Authorship

As the sole member of this IQP team, I, Alli Butler, wrote and researched all of the following sections myself.

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Introduction

In 2019, over 17,500 cats, dogs, rabbits, ferrets, birds and other pets came through the emergency room of the Foster Hospital for Small Animals (located at Tufts University, Cummings School of Veterinary Medicine in North Grafton, Massachusetts). FHSA is one of just 17 veterinary hospitals in Massachusetts with 24-hour emergency facilities (See Appendix A for map). Of those, it is one of just two that are classified by the Veterinary Emergency and Critical Care Society (VECCS) as Level 1 facilities. FHSA earned this designation because it has a multitude of resources that most veterinary hospitals lack, including mechanical ventilators, hemodialysis, MRI and specialists in cardiology, neurology, and internal medicine. As such, a significant portion of the cases seen in the FHSA ER are referred from other veterinary hospitals.

This enormous caseload, combined with a nationwide shortage of qualified emergency veterinary professionals, necessitates the development of a system to maximize efficiency in the ER to minimize error, wait times, patient suffering, and staff burnout.[1]

The efficiency of any ER begins the art and science of triage – the sorting and prioritizing of patients by urgency of need. Triage methodology is a topic that has been much explored and improved in human healthcare since its advent during the Napoleonic era. However, it is a relatively new topic in veterinary medicine. Although a few systems have been discussed in veterinary medical literature, there is currently no widely accepted system of triage for veterinary hospitals.

The goal of this IQP is to develop such a system. This was achieved in four stages: a pilot study, analysis of process improvement strategies, development of a veterinary triage scoring system based on triage algorithms used in human emergency departments, and a retrospective study applying the triage scoring system.

First, a pilot study was initiated to assess the current triage system and the feasibility of implementing of a new triage protocol. The pilot study failed but provided valuable insight into client interactions and the utility of a triage nurse. Most importantly, this failure illuminated the sources of error and waste in the current system –

These problems were the targets of the second stage: analysis of process improvement in healthcare. The Toyota Production System (TPS) is the quintessence of process improvement in manufacturing. TPS strategies have been implemented in various business sectors to reduce waste, increase profits, and improve customer satisfaction. For healthcare, these improvements translate to better patient care and outcomes.

Strategies to identify and eliminate the wasteful practices in the ER were then devised using TPS and other efficiency ideologies. But waste reduction is only half of the battle. The next step would be to create a triage system of categorization and prioritization to create continuous and efficient patient flow when resources in the ER are limited.

The beginning of the third stage focused on the triage systems most commonly used in human emergency departments and how they might be modified for use in veterinary medicine.

The Emergency Severity Index (ESI) was chosen as a model for this IQP because it is a relatively simple algorithm which can be learned via an online training course. A list of triage discriminators from a 2012 study published in the Journal of Veterinary Emergency and Critical Care was used to create a modified Emergency Severity Index (mESI) with scores from 1 (immediate intervention required) to 5 (non-urgent).

The fourth and final stage was the application of the mESI in a retrospective study of 430 emergency cases at FHSA from eight randomly selected Saturdays in 2019. The data was organized to observe the variability of caseload throughout the day, the typical distribution of cases of each mESI score, and the lengths of stay (LOS).

The ultimate goal of process improvement in healthcare – human or veterinary – is to provide better care to reduce patient suffering. This IQP is just the first step to that end. With further testing and refinement, the mESI has the potential to begin a new movement towards systematic triage that can be implemented in veterinary hospitals everywhere.

Background

An endeavor into process improvement is a process in and of itself. It is no small undertaking to break down and rebuild a system that involves dozens of personnel and the habits of an entire organization. To that end, this chapter will begin with a brief summary of the most successful process improvement method of the 20th century: the Toyota Production System (TPS). Next, the reader will be introduced into the 5-step version of TPS known as Lean and how it is applied to healthcare. This is followed by a brief explanation of triage, including a brief description of the Manchester Triage System, the Veterinary Triage List, and the Emergency Severity Index (which was used as a model for the system used in the retrospective study described in later chapters). Lastly will be a step-by-step outline of the current triage protocol in the FHSA ER.

Toyota Production System (TPS)

In 1950, the managers of the Toyota Motor Corporation traveled to the United States to study the manufacturing processes of the world-renowned Ford Motor Company. At the time, Toyota was a nascent car company, producing a meager 900 units per month, compared to the 90,000 units per month churned out by Ford. Upon returning from the 12-week tour, Eiji Toyoda (president of Toyota Motor Manufacturing and nephew of the company's namesake) assigned his plant manager, Taiichi Ohno, with the mission to make Toyota as productive as the American giant but on the scale of the Japanese market. Ohno's overhaul of Toyota's manufacturing was largely based on Henry Ford's idea of continuous material flow from his book, *Today and Tomorrow*.[2] However, during their tours of the Ford factories, Ohno recognized the production methods were inherently flawed and not wholly *continuous*. The specialization of machines and workers that allowed for Ford's mass production resulted in a large back-up of work-in-progress inventory that were later moved on to the next step in production. This emphasis on gross productivity – rather than quality and efficiency – would often lead to accumulation of defective components. To Ohno, this clearly did not adhere to Ford's tenet of the elimination of waste.

Toyota did not have the advantage of warehouse space to keep such a back-up of inventory, nor the capital to risk mass production of defective parts. Ohno recognized that Toyota must adapt Ford's continuous material flow system to a product-driven, one-piece flow system that could be adjusted based on consumer preference and demand. The focus needed to be shifted from the individual machines and their places in the assembly line to the flow of the product from beginning to end. Over the following two decades, the work toward this objective would result in a manufacturing philosophy known as the Toyota Production System (TPS).

<u>*Jidoka* and JIT – The Two Pillars of TPS</u>

To fully understand the Toyota Production System (and its progeny like *Lean*), it is necessary to appreciate the origins of its two pillars: *jidoka* and just-in-time (JIT).

The founder of the Toyota Motor Company, Kiichiro Toyoda was the son of a man named Sakichi Toyoda, the inventor of an automated loom that would stop if a thread snapped during production. This concept of "mistake proofing" is known as *jidoka.* It is the praxis of adding quality and value to the product as it is being produced, eliminating defects and their causes as they occur – thus eliminating waste.

Later in Toyota's evolution, Ohno also implemented the novel idea of "just-in-time" (JIT) supply, based on the way American supermarkets restock shelves. To maintain continuity on the assembly line, each step in the process would be supplied with its required parts as they are needed, thus *pulling* the product through. JIT effectively eliminated the waste of waiting and of excess inventory.

> "Toyota's focus…was designed to address the same conditions most companies face today: *the need for fast, flexible processes that give customers what they want, when they want it, at the highest quality and affordable cost."*
>
> - Jeffrey K. Liker, *The Toyota Way*

Lean – TPS Outside of Manufacturing

In the late 1980s, Dr. Jim Womack and his research team at MIT's International Motor Vehicle Program coined the term "lean" to describe Toyota's business model and its emphasis on the elimination of waste.[3]
Later, he and his co-writer Daniel Jones codified Lean into a five-step process[4]:

1. Specify Value

Womack and Jones state that value should be specified from the customers' point of view, and in healthcare, the customer is the patient. In veterinary medicine, the customer is both the patient and the paying client (the pet's owner). Either way, the interpretation is essentially the same: value is any way to change a treatment or process or tool with the goal of alleviating pain and suffering. If it does not add value, it does not help the patient, and should therefore be eliminated.

2. Map the Value Stream

In the simplest of terms, the value steam is an assembly line that includes all steps and parts that deliver the product to the consumer. How do you get from point A to point B most efficiently? The answer lies in the culling of wasteful processes, any steps that may cause a divergence from the primary goal: customer satisfaction. These wastes include defects, overproduction, transportation, waiting, inventory, motion, over-processing, and human potential (see Table 1 for examples).

3. Create Flow

Once wasteful practices have been eliminated, flow must be established by creating a structured, continuous process through which the product can travel from beginning to end. In manufacturing, this is the assembly from raw materials to final product. In healthcare, this is the time between triage and discharge or admission.

4. Establish Pull

To ensure the continuation of the value stream, protocols are introduced to pull the product (or patient) through the system. Ohno implemented this concept with his "just-in-time" practice in Toyota factories. In a hospital or emergency department setting, pull is most clearly observed when the appropriate number of staff are available to treat the incoming patients. A high ratio of patients-to-medical staff can only result in decreased quality of care and increase in mistakes.

5. Seek Perfection

Perfection in Lean production is the complete elimination of waste and ideal value. In manufacturing, this perfection is reached when every customer is served and completely satisfied. It is achieved when there is no waste and maximum profit. Unfortunately, this cannot be completely translated for application in healthcare because not all patient outcomes can be ideal. Humans are mortal. Perfection, in this regard is rarely achieved in veterinary medicine because all costs are out-of-pocket, with the exception of the few pet owners who have pet insurance. Nonetheless, veterinary medical institutions should still strive for perfection, because the value does not change.

Table 3.4 The Eight Types of Waste

Type of Waste	*Brief Description*	*Hospital Examples*
Defects	Time spent doing something incorrectly, inspecting for errors, or fixing errors	Surgical case cart missing an item; wrong medicine or wrong dose administered to patient
Overproduction	Doing more than what is needed by the customer or doing it sooner than needed	Doing unnecessary diagnostic procedures
Transportation	Unnecessary movement of the "product" (patients, specimens, materials) in a system	Poor layout, such as the catheter lab being located a long distance from the ED
Waiting	Waiting for the next event to occur or next work activity	Employees waiting because workloads are not level; patients waiting for an appointment
Inventory	Excess inventory cost through financial costs, storage and movement costs, spoilage, wastage	Expired supplies that must be disposed of, such as out-of-date medications
Motion	Unnecessary movement by employees in the system	Lab employees walking miles per day due to poor layout
Overprocessing	Doing work that is not valued by the customer or caused by definitions of quality that are not aligned with patient needs	Time/date stamps put onto forms, but the data are never used
Human potential	Waste and loss due to not engaging employees, listening to their ideas, or supporting their careers	Employees get burned out and quit giving suggestions for improvement

Table 1: The Eight Types of Waste

Graban, Mark. Lean Hospitals : Third ed. 2016. Web. Improving Quality, Patient Safety, and Employee Engagement.

"To be a lean manufacturer requires a way of thinking that focuses on making the product flow through value-adding processes without interruption (one-piece flow), a 'pull' system that cascades back from customer demand by replenishing only what the next operation takes away at short intervals, and a culture in which everyone is striving continuously to improve."

- Jeffrey K. Liker, *The Toyota Way*

Triage, 42nd Division, near Suippes, France, July 17, 1918
http://www.kumc.edu/wwi/index-of-essays/triage-field-hospital-section.html

Triage

Not surprisingly, the systematic sorting of patients has is origins on the battlefield – specifically during the times of mass casualties in the Napoleonic Wars in France in the early 19th century.[5] In fact, the term triage is derived from the French word, *trier*, meaning "to sort," but its use as a medical term began during World War I.[6] The Manchester Triage Group defines triage as "a system of clinical risk management employed in Emergency Departments worldwide to manage patient flow safely when clinical need exceeds capacity."[7] Prior to the development of systems such as the Emergency Severity Index (ESI) and the Manchester Triage System (MTS), triage in an emergency department (ED) was a primarily intuitive procedure. It was not until the mid-2000s when EDs began experiencing overcrowding and excessive wait times. Today, veterinary hospitals like Tufts University's Foster Hospital for Small Animals are in a similar situation. Americans spent over $18 billion on their pets' veterinary care in 2018, and that number continues to grow.

The research for this IQP is focused on one triage system in particular: the Emergency Severity Index (ESI).

Emergency Severity Index (ESI)[8]

In 1998, two emergency physicians, Richard Wuerz and David Eitel, developed the first version of the Emergency Severity Index (ESI).[8] The most recent version (4th), consists of five levels to categorize patients based on urgency of medical need and the number of resources each would require for diagnosis and treatment. The ESI algorithm can be broken down into four decision points that categorize patient into five levels of increasing (See Fig. 1). If the patient requires immediate, life-saving intervention he or she is categorized as a level 1. If the patient is not actively dying but should not wait to be seen (due to a high-risk situation, disoriented mental state, or severe pain or distress), he or she is categorized as a level 2. If the patient does not fit the criteria for the first two ESI levels, the triage nurse assesses the patient's condition to determine the number of resources he or she will require. If more than one resource (including bloodwork, radiographs, and specialty consultations) is required and the patient has normal vitals (heart rate, respiratory rate and blood oxygen saturation), he or she is classified as a level 3. The assessing nurse may consider "up-triaging" the patient to a level 2 if any of these vitals are outside normal parameters. Non-urgent cases are classified as level 4 or 5 if they require one or no resources, respectively.
ESI could be described as a paradigm of the Toyota or Lean methodology for process improvement in healthcare. The concept of patient-outcomes-as-products may seem dispassionate, but in the context of emergency medicine, efficiency is paramount to patient safety and quality of care. If triage methods and practices can be standardized, as with the ESI algorithm, variation in many aspects of patient care can be minimalized, resulting in fewer mistakes, shorter wait times, and ultimately better patient outcomes.

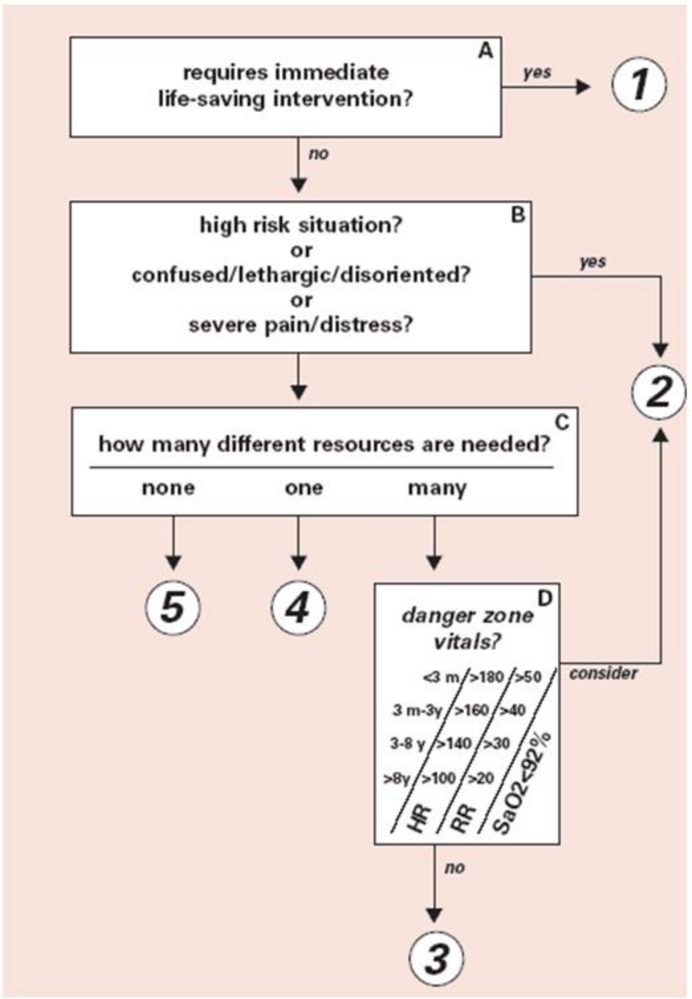


Figure 1: Emergency Severity Index Conceptual Algorithm, v. 4

© ESI Triage Research Team, 2004.

Methodology

The goal of this IQP is to assess the efficiency of the current triage system used at the Foster Hospital for Small Animals (FHSA) at the Tufts University Cummings School of Veterinary Medicine. In doing so, the primary research objectives were to apply the Lean strategy to (1) identify sources of wastes and any processes that do not add value, (2) use methods of process improvement to eliminate those wastes to create better patient flow, and (3) develop a modified Emergency Severity Index to use as a scaffold on which to build a more efficient triage system.

Pilot Study

This initial concept for this IQP was the implantation of an electronic form that clients could fill out upon check-in with the receptionist (see Appendix). The form, which the client would fill out on an iPad, asked for the patient's basic information and presenting complaint (i.e. the pet's symptoms). This information, including a picture of the patient, would automatically upload to a Google Sheet (See Appendix) that could be seen by the doctors, nurses, and students on a monitor in the ER. The information from the form would also be transferred into the patient's electronic medical record. The goal of pilot study was to simply reduce the chaos in the ER by adding the role of a triage nurse to assess non-emergent cases and collect information from the clients before the patient was examined by a doctor. Unfortunately the chaos of the ER overtook my efforts and the pilot study was aborted. However, this failure came with a silver lining. After researching the Toyota Production System, the objective of this IQP shifted from a broad idea of "reducing chaos" to using Lean methods to define the specific customer value in the ER and ways to maximize it.

Identify the Wastes

The following table is adapted from *Table 3.4: The Eight Types of Wastes: Lean Hospitals: Improving Quality, Patient Safety, and Employee Engagement, (Graban, 2016).*

Type of Waste	Brief Description	Examples in FHSA
Defects	Time spent doing something incorrectly, inspecting for errors, or fixing errors.	- Errors made in treatments, prescriptions, or diagnoses due to overload of patients and chaos in the ER. - Untrained staff missing red flags during triage.
Overproduction/over-processing	Doing more than what is needed by the customer or doing it sooner than needed; Doing work that is not valued by the customer	- Immediately bringing every new patient back into the ER to take vitals. This is not necessary for the vast majority of patients and it interrupts procedures happening in the ER. - There is little utility in the receptionists' asking "Is your pet having an emergency?" when clients enter the hospital other than recognizing they are there without an appointment.
Transportation/motion	Unnecessary movement of the "product" (patients, specimens, materials) in a system. Unnecessary movement by employees in the system	Poor layout of the hospital: The ER is two-hallways away from the waiting/reception area. The lab is on the other side of the hospital (see Appendix)
Waiting	Waiting for the next event to occur or next work activity	- Inpatients sit in cages in the ER waiting to be transferred to wards because the technicians in the ER are too busy to move them sooner. - Patients wait for radiographs to be taken because there are no students or radiology technicians to take them, making it the responsibility of the ER staff. - Owners wait while their pets are being assessed after triage. Often pets are put into a cage in the ER after being deemed stable but owners are not updated nor given the opportunity to provide information about their pet's condition in the interim.
Inventory	Excess inventory cost through financial costs, storage, spoilage, wastage	The charges for procedures often are too broad and clients are charged more or less than is appropriate.
Human Potential	Waste and loss due to not engaging employees, listening to their ideas, or supporting their careers	- Unsafe patient-to-technician ratios. - Overstretching (expected to take radiographs, answer phones, transfer patients, etc).

Waste Identification in Current Triage Protocol at FHSA

When an emergency department can meet 100% of clinical need continuously, there is no wait time in any step of the process. Unfortunately, this is simply not reality. The value stream for a patient in an emergency room begins with triage. This means that maximizing the value for one patient may mean prioritizing he/she over another, which inevitably results in a bottleneck. This effect is magnified in a veterinary ER because patient assessment is a longer, more investigative process than that in a human hospital. At FHSA this is compounded again due to a multitude of problems in every step of the process.

To demonstrate this, the following section will outline the current triage protocol at FHSA ER and wastes created in the process:

Step	Description	Problems	Waste
1	A client enters the ER and is greeted by a receptionist who asks, "Is your pet having an emergency?"	- The receptionists have no formal veterinary medical training and therefore are usually unable to distinguish emergent from non-emergent cases. - This question is too broad, and owners usually cannot answer with medical accuracy. Owners often assume that because they are in an emergency room, this qualifies their pet's situation as an emergency.	- Over-processing - Human potential
2	The receptionist calls into the ER and asks, "Can we get a triage for a [dog/cat/etc.] named [patient name]?"	- Someone in the ER must stop what he or she is doing (e.g. assisting with a procedure, assessing a patient, writing discharges, etc.) to answer the phone. This interruption can cause errors and delays.	- Defects - waiting
2a	If the patient is non-ambulatory and over 30 pounds, they will specify that it is a "gurney triage."	- At least two people must stop what they are doing to triage the patient from the parking lot. - The receptionists often incorrectly assume that if the patient needs to be retrieved from the owner's car in the emergency parking area that it requires a gurney.	- Transportation/motion - Defects
2b	If the patient is having a seizure, in obvious respiratory distress, actively and profusely bleeding, etc., the receptionist will call for a "STAT triage."	- Because they are not trained to do so, very often receptionists will call for a STAT triage when it is not an emergent case (e.g. the owner is emotional, etc.) - If the ER is very busy and no one is available to answer the phone immediately, a STAT patient is not triaged as quickly as necessary. - Receptionists often miss STAT triages because the patient (usually a cat or small exotic animal) is in a carrier.	- Defects - Waiting

3	A student, technician, or veterinary assistant walks to the reception area, asks the owner a few basic questions about the pet's reason for coming to the ER, and then brings the patient back to the ER.	- The ER is two hallways away from the reception area. This is particularly problematic during STAT triages that need to be rushed into the ER. - Owners are often anxious about where their pet is being taken because the two areas are so separated.	- transportation/motion - Over-processing
3b	The patient's information is then entered into the electronic triage board on a monitor in the ER. (SEE APPENDIX XXX).	- The triage board does not allow for the categorization between "emergency" and "stable."	- defects
4	The patient's vitals are taken and a student, nurse, or doctor (when available) does a perfunctory assessment to determine the patients stability. ****Critical patients (i.e. STAT triages) are assessed by a doctor immediately.***	- Students are instructed to bring back every patient, regardless of presenting complaint. Learning to triage is an essential part of a veterinary student's ER rotation, but this experience is somewhat problematic when caseload is overwhelming. - Most patients do not require immediate assessment, especially those with superficial wounds, chronic but minor health problems, and those too hyperactive or aggressive to assess safely.	- Over-processing

Map the Value Stream and Create Flow – A Justification for mESI

Currently, the value stream in the FHSA ER is defined by assessing every patient equally as quickly as possible. The reality is, this does not add value for most patients. In fact, it is a disservice because time and resources are wasted on superfluous practices. This is in part due to the structure, or lack thereof, the students' rotation in the ER. An argument can be made that the veterinary students are also consumers in this process and the value from their point of view is their education. Currently, this part of their education is achieved by exposure to as many patients as possible to gain the experience of triaging to learn to recognize both common and uncommon emergencies. The problem lies in the lack of structure to that exposure. Therefore, a triage system in which patients are categorized and prioritized based on acuity could also serve to add value for the students as well.

Photo of the FHSA ER treatment area,
Liz Rozanski, DVM, DACVIM, DACVECC seen at left

Modification of the Emergency Severity Index for Use in Veterinary Medicine

For the purposes of this IQP, the Emergency Severity Index was modified by applying the list of triage discriminators (see Table 3, next page) and their definitions (See Appendix C) as outlined by Ruys, et al. in their 2012 study, *Evaluation of a veterinary triage list modified from a human five-point triage system in 485 dogs and cats.* The same basic flow diagram of the ESI was kept with the addition of the color code of the Manchester Triage System (MTS) as a measure of continuity.

A major distinction of the ESI is that classification of less-urgent cases is based on the number of resources required. The classification of resources vs non-resources (See Table 2, next page) is determined by the hospital implementing the ESI. The ESI Implementation handbook even states that "emergency nurses who use the ESI are cautioned not to become overly concerned about the definitions of individual resources."[8] This is especially true in a veterinary ER where the use of one resource necessitates the use of another (e.g. a patient requires sedation [resource 1] to get an ultrasound [resource 2]). The objective of estimating resource need is mainly to determine if the patient will need several or only a few. For this reason, a level 4 classification in the mESI can need one to two resources (not just one).

A significant addition to the ESI for this modified version is the decision point for those patients presenting for toxin ingestion. Easily one of the most common pet emergencies, especially in dogs, any toxin ingestion has the same initial treatment upon triage: decontamination. The intravenous administration of a drug called apomorphine causes almost immediate emesis. Obviously, there is a time limit for decontamination as stomach content is digested. Additionally, toxins are usually dose-dependent,(e.g. more or darker chocolate will cause different effects in different size dogs). For this variability, it was added as a decision point for immediate triage to decontaminate the patient as soon as possible, followed by reassessment for high-risk situations such as arrhythmias or other secondary effects from the toxin.

Finally, the classification of E was added to the mESI for those patients that have been brought to the ER to be humanely euthanized.

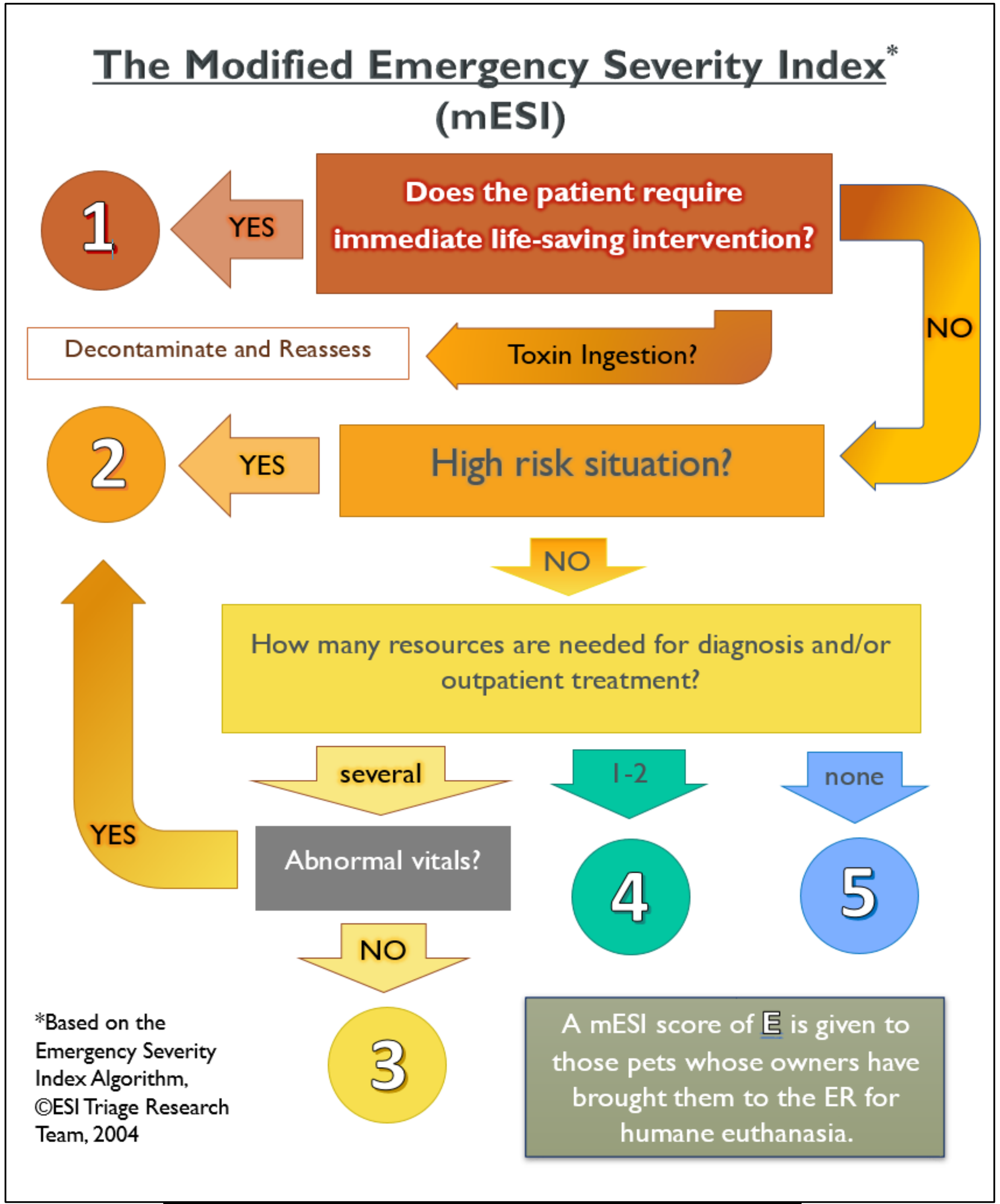


Figure 2: The Modified Emergency Severity Index

Table 2: Resources for the ESI Triage System

Gilboy, et al., 2012

Emergency Severity Index (ESI): A Triage Tool for Emergency Department Care, v.4.

Implementation Handbook 2012 Edition.

Table 4-1. Resources for the ESI Triage System

Resources	Not resources
Labs (blood, urine)	History & physical (including pelvic)
ECG, X rays CT-MRI-ultrasound angiography	Point-of-care testing
IV fluids (hydration)	Saline or heplock
IV, IM or nebulized medications	PO medications Tetanus immunization Prescription refills
Specialty consultation	Phone call to PCP
Simple procedure = 1 (lac repair, Foley cath)	Simple wound care (dressings, recheck)
Complex procedure = 2 (conscious sedation)	Crutches, splints, slings

Table A1: Proposed Veterinary Triage List. Changes made compared with Manchester Triage System are indicated as follows: ↑ raised one triage category; ↓ lowered one triage category; * defined differently; § added.

Triage category	Subcategory	Discriminator
Red	Respiratory	Severe respiratory distress*
	Circulatory	Shock (decompensated)
		Exsanguinating hemorrhage
	Neurological	Currently seizuring
		Unresponsive
	Gastrointestinal	Rapid onset abdominal distension
	Obstetrical	Presenting fetal parts
	Generalized	(Suspicion of) hypoglycemia
		Rectal temperature ≥41°C *↑
		Rectal temperature ≤36.7°C *↑
Orange	Respiratory	Moderate respiratory distress*
		Acute stridor* ↓
		Subcutaneous emphysema
	Circulatory	Uncontrollable major hemorrhage
		Signs of arterial thromboembolism*
		Pale mucous membranes in absence of shock §
		Abdominal fluid thrill §
	Neurological	Altered level of consciousness
		Acute abnormal behavior*
		Acute continuous vocalization §
		Cluster seizures §
		Acute complete loss of vision
	Trauma	Evisceration
		High lethality envenomation
		Proptosis of eye §
		Penetrating or acute chemical ocular injury ↓
	Gastrointestinal	Toxin ingestion
		(Possible) foreign body ingestion >24 hours with anorexia or vomiting
	Obstetrical	Active labor
		History of seizures*
	Urogenital	Rapid onset of testicular swelling and pain §
		Urethral obstruction *↑

Table A1: Continued

Triage category	Subcategory	Discriminator
	Generalized	Petechiae/purpura/ecchymosis *
		(Suspicion of) hyperglycemia with ketosis
		Severe pain
		General weakness*
		Severe dehydration (>8%)*
		Rectal temperature 40.5–40.9°C*↑
Yellow	Respiratory	Mild respiratory distress*
	Circulatory	Uncontrollable minor hemorrhage
	Neurological	Acute spinal/peripheral neurological deficit or acute deterioration *↓
		Head tilt §
		History of unconsciousness (excluding uncomplicated seizures) *
	Trauma	Moderate lethality envenomation
		Oral stick trauma §
		Open fracture/gross deformity
		Medium to large skin wound §
	Gastrointestinal	(Possible) foreign body ingestion §
		Persistent vomiting
		Melena *↓
	Obstetrical	Recent history of trauma
		Abnormal blood loss per vagina in pregnant animal
	Urogenital	Red discoloration of urine without stranguria *
	Generalized	Ventroflexion of the head and neck §
		Facial edema ↓
		Moderate pain *
		Moderate dehydration (5-8%) *
		Severe pruritus *↓
		Anorexia in puppy or kitten §
		Rectal temperature 40.0–40.4°C*↑
Green		Local inflammation
		Stranguria/tenesmus §
		Vomiting
		Recent mild pain or pruritus
		Recent isolated seizure §
		Swelling
		Rectal temperature 39.0–39.9°C*
		Recent problem

Table 3: Veterinary Triage List of Discriminators

L.J. Ruys, et al., 2012

Evaluation of a veterinary triage list modified from a human five-point triage system in 485 dogs and cats.

Journal of Veterinary Emergency and Critical Care

Application of the Modified Emergency Severity Index: A Retrospective Study

A census of emergency patients seen in 2019 was retrieved from the electronic medical record system, StringSoft, used at FHSA. The census data included the check-in times, patient status (inpatient or outpatient), and patient species. This data allowed for the visualization of the total and average caseloads by time of day, day of the week, and month of the year
Eight Saturdays in 2019 were selected as a sample using a random date generator (random.org/calendar-dates). Saturday was chosen because the hospital is open only for emergencies. While the hospital is also open for emergencies only on Sundays, the data was more likely to be skewed for those days due to New England Patriots football games and religious holidays. According to the FHSA Stringsoft electronic medical records, 17,568 emergency cases were seen 2019. 2964 (16.9%) of those were seen on Saturdays (an average of 57 patients per Saturday). The sample included a total of 430 patients once duplicate records were removed.

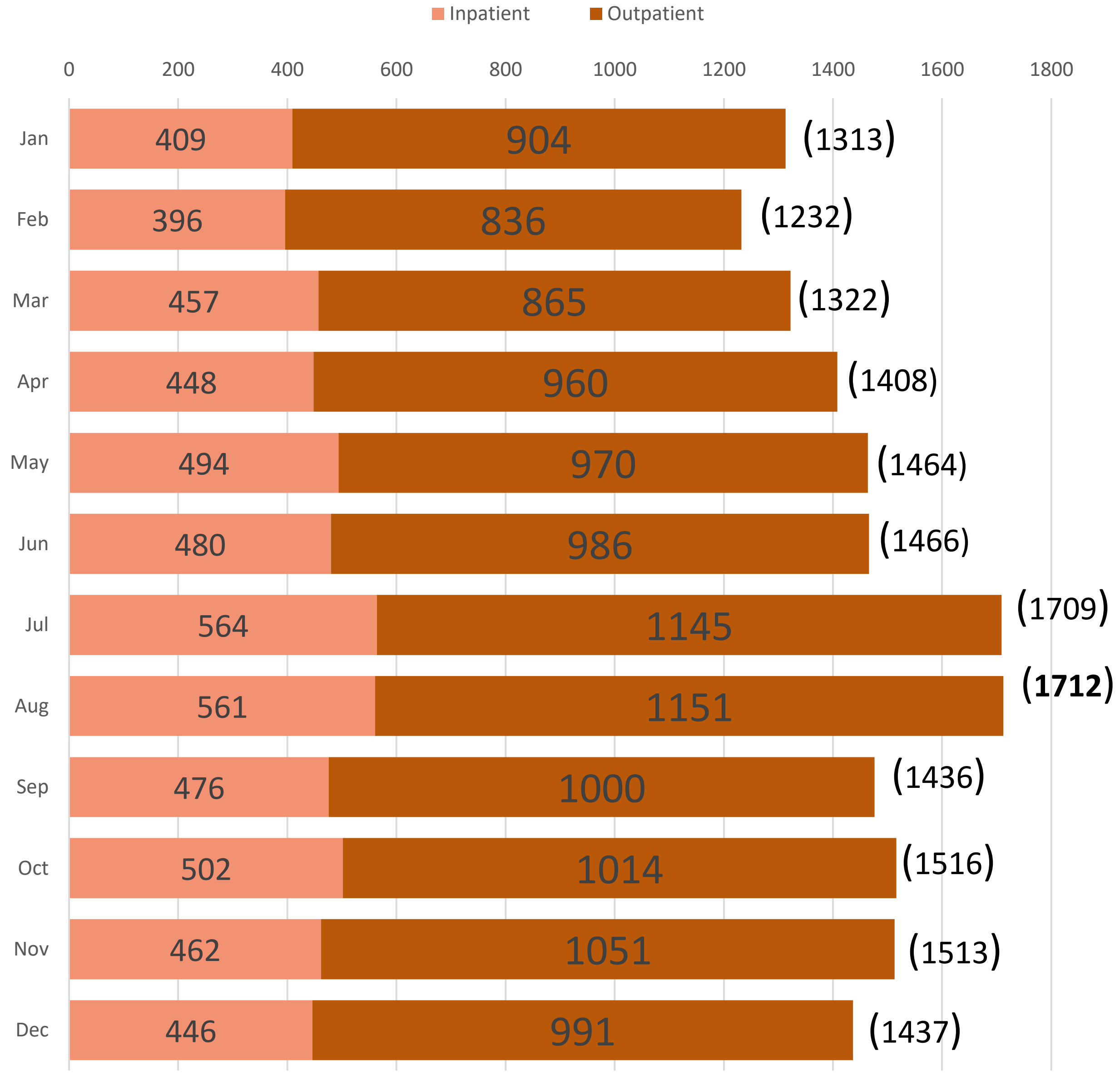
Retro-triage

A mESI score was given to each case upon analysis of the notes written by the doctor in the patient's medical record. These notes, known familiarly as SOAPs, are a synopsis of the subjective and objective (S, O) observations and the diagnostic assessment and plan (A,P) for treatment. mESI scores were given based upon the documented presenting complaint and up-triaged (to higher acuity) or down-triaged (to lesser urgency) based on the assessment and vitals. SOAPs also include information such as the referring hospital's name and actions when applicable, and relative client communications. It should be noted that this method of "retro-triage" may not accurately reflect the mESI scores given in a real triage situation, when details and red flags are not always illuminated immediately.

Outpatient Lengths of Stay and Inpatient Wait Times

Because there was no feasible way to accurately track the wait times for patients (between checking in at reception and when they were assessed by a doctor), the data collection was focused on outpatients' lengths-of-stay (OPLOS) and inpatients' wait times (IPWT). OPLOS were determined by the timestamps for check-in and check-out provided in Stringsoft. IPWT were calculated from the check-in time to the time at which the client approved the estimate outlined by the doctor for the expected cost of hospitalization. The goal of this data collection was to observe any trends in the number of patients seen throughout a Saturday and to compare OPLOS and IPWT with their respective mESI scores and caseload at time of arrival.

FIGURE 3: Total Number of ER Patients, by month (2019)



Findings

<u>Study Sample Summation</u>

- 430 patients
  - 297 dogs, 103 cats, 30 exotics (birds, small mammals, reptiles)
- 79 (18.4%) referrals
  - Average of ~10 per Saturday (min. 5, max. 14)
- 46 patients (10.7%) with mESI score of E
  - 34 (8%) presented for euthanasia
  - 12 (2.8%) were dead on arrival (DOA)
- 29 (6.7%) euthanized after assessment

FIGURE 4: mESI SCORES PERCENTAGES

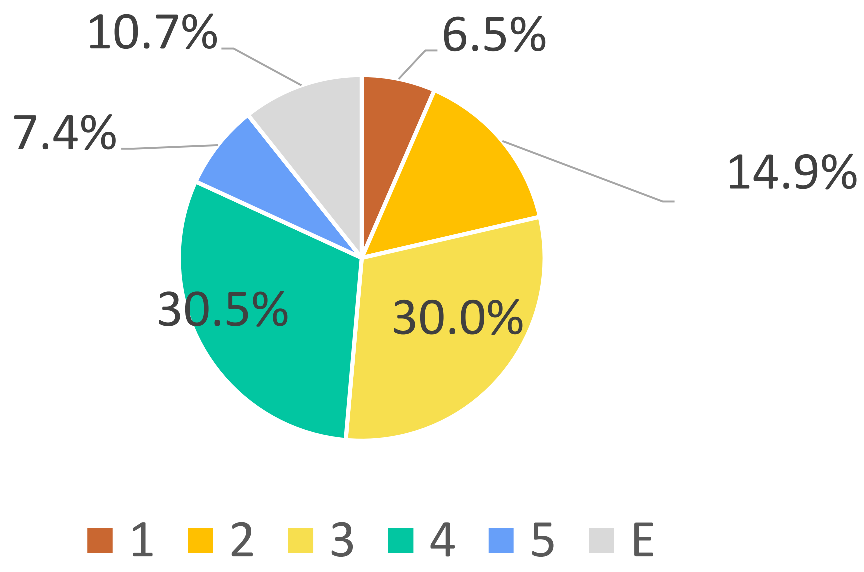


FIGURE 5:DISTRIBUTION OF mESI SCORES PER DAY

total = 430 patients

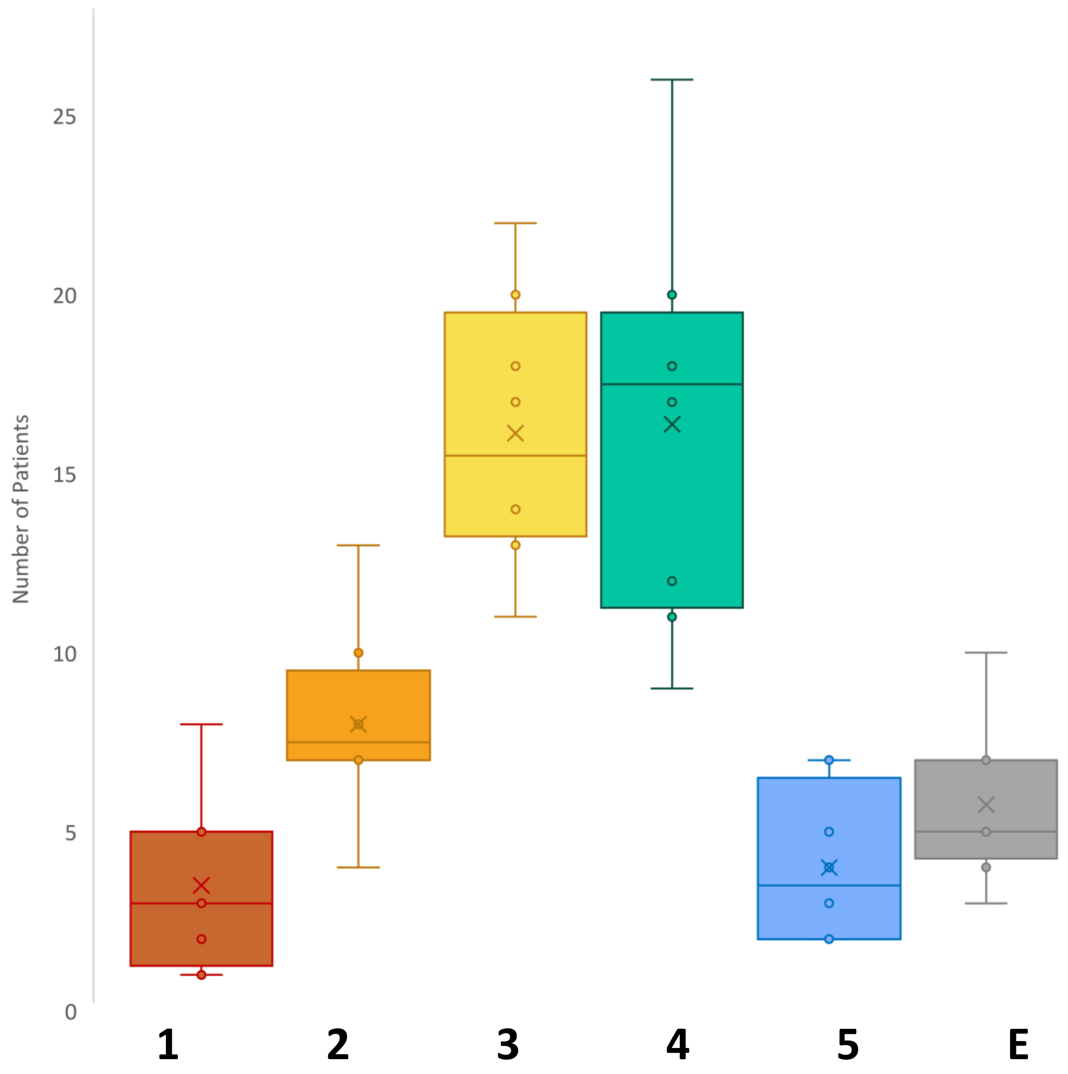
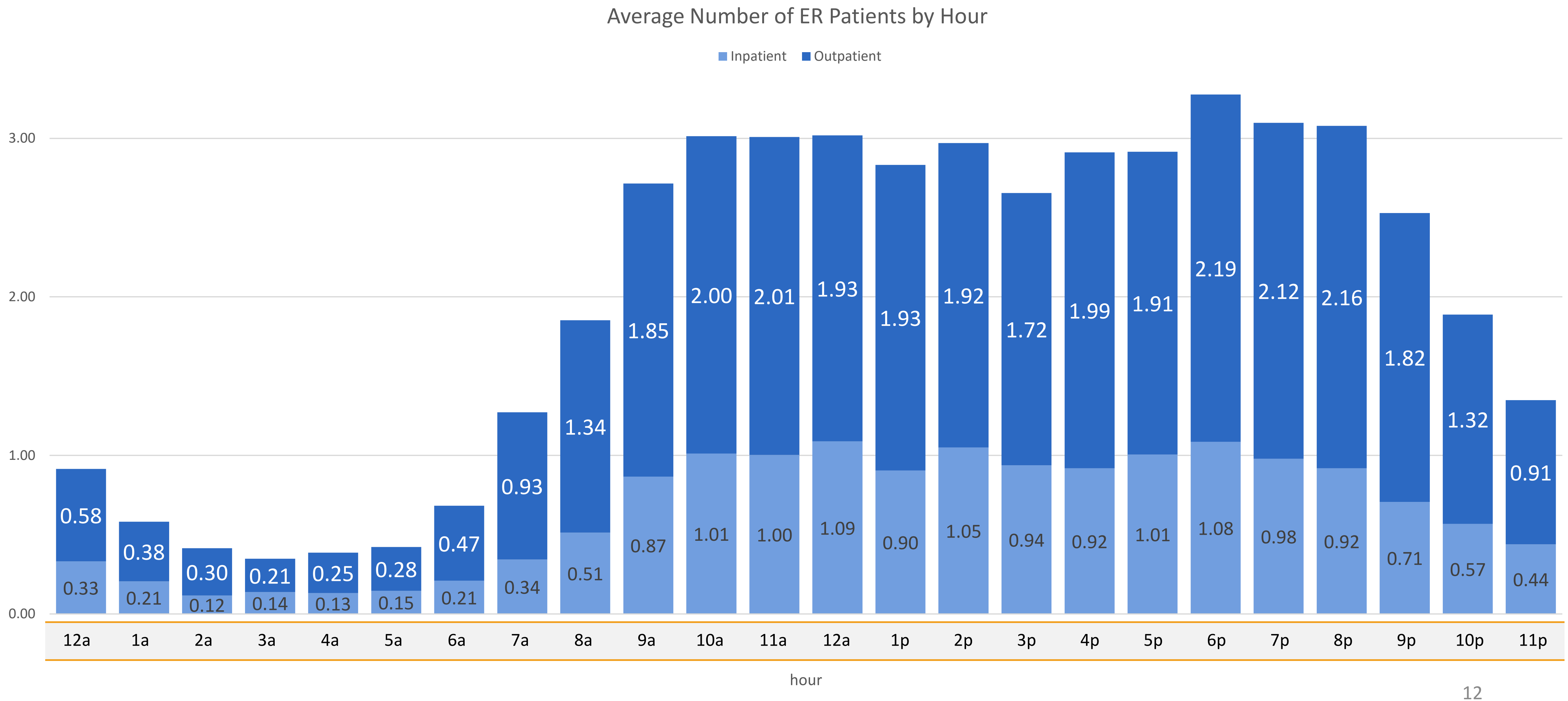


FIGURE 6: AVERAGE NUMBER OF ER PATIENTS BY TIME OF DAY
2019

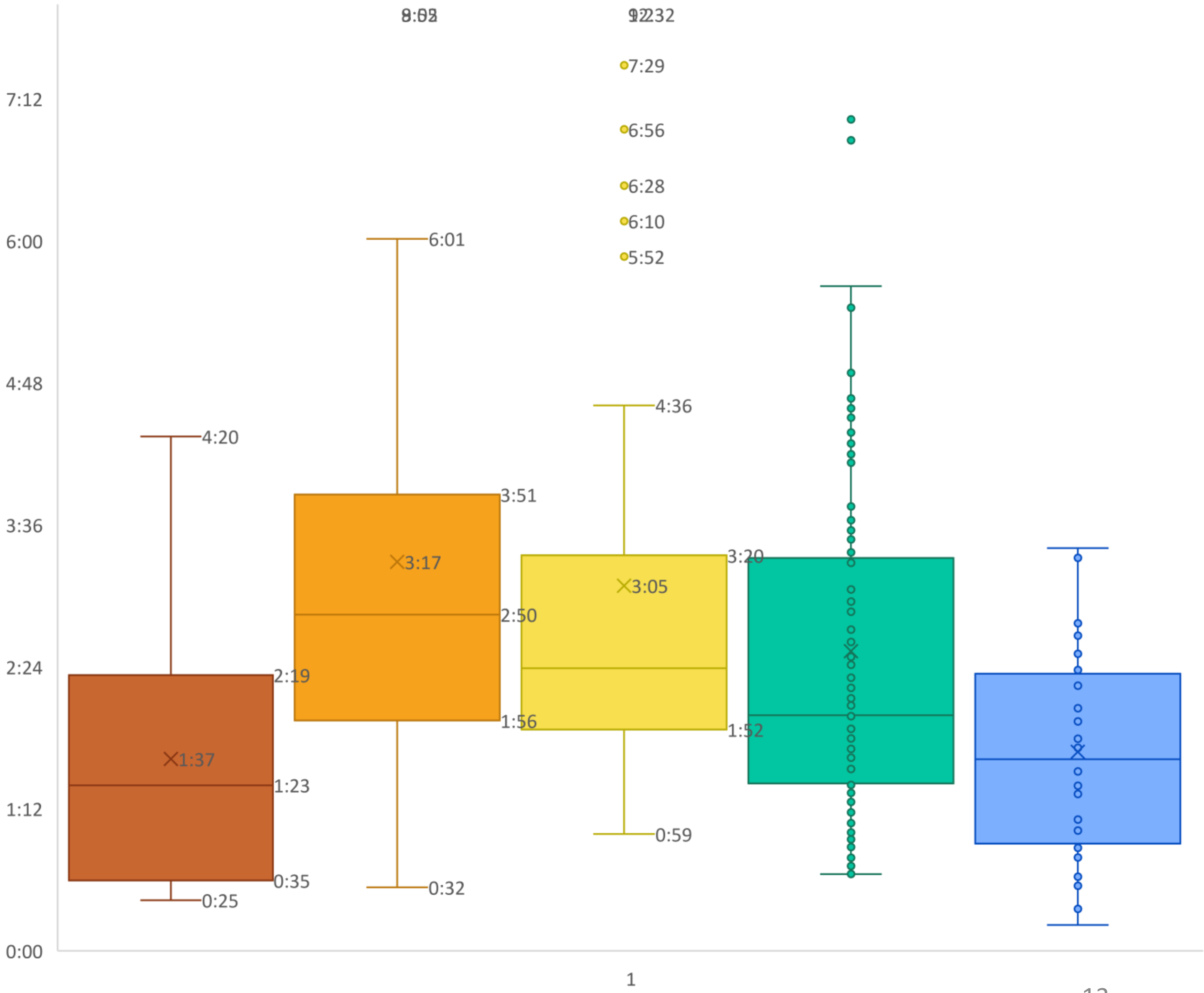


Outpatient Lengths of Stay

On the whole, lengths of stay decrease as acuity decreases. The distribution of LOS for patients with a mESI score of 1 is substantially lower than that of other scores because 17 out of a total of 20 were euthanized. The remaining 3 were outpatients whose owner's left against medical advice (AMA) but elected to euthanized at a later time.

The outliers are all patients that underwent procedures (such as wound repair or abscess drainage) and are usually considered "day patients," although this is not an official designation in the Stringsoft software. These owners are instructed to leave a deposit for the cost of the procedure and may leave the hospital to pick up their pet later in the day.

FIGURE 7: OP LOS by mESI Score
(Saturday Samples, 2019)



Inpatient Wait Times

- 8 of the 13 inpatients with wait times longer than 4 hours arrived during the afternoon
  - This could be a result of reduced staff in the evenings (across the entire hospital)
- Of the 7 inpatients with a mESI score of 1, two were eventually euthanized and one died in the hospital
- The one inpatient with a mESI score of 4 presented for limping. The SOAP gave no indication why her wait time was 4 hours.
- Given this data, the average wait time for inpatients with mESI scores of 1, 2, or 3 is approximately ***2 hours and 12 minutes.***

FIGURE 8: Inpatient Wait Time Distribution by mESI Score

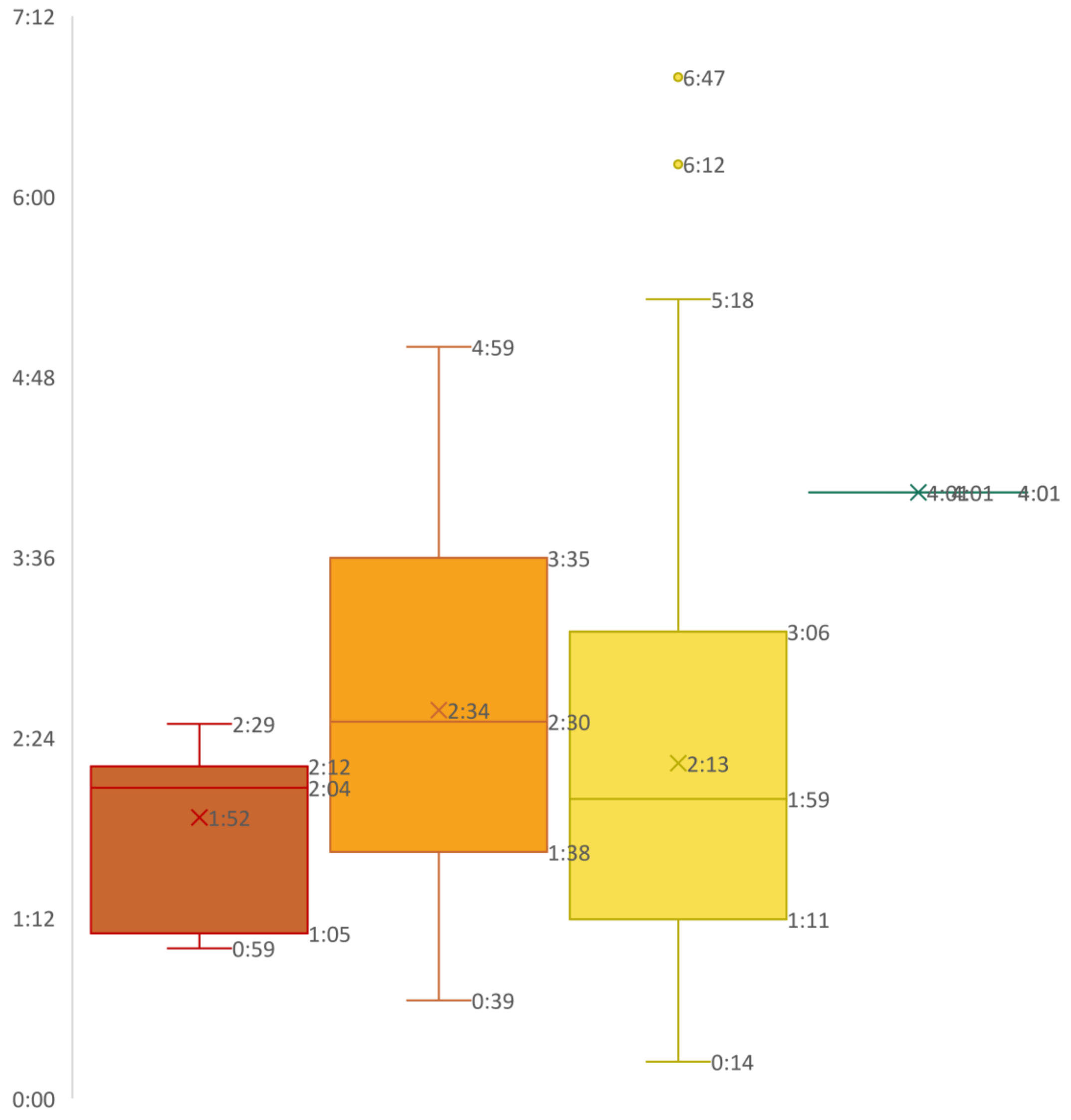
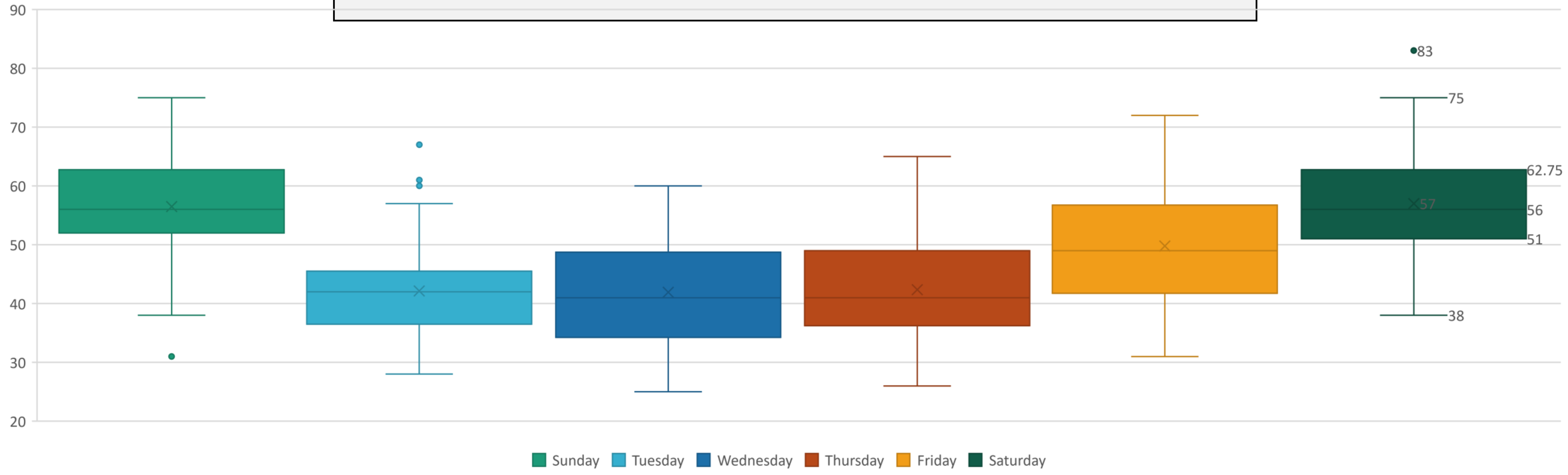


FIGURE 9: DISTRIBUTION OF TOTAL ER PATIENTS PER DAY

BY DAY OF THE WEEK

2019



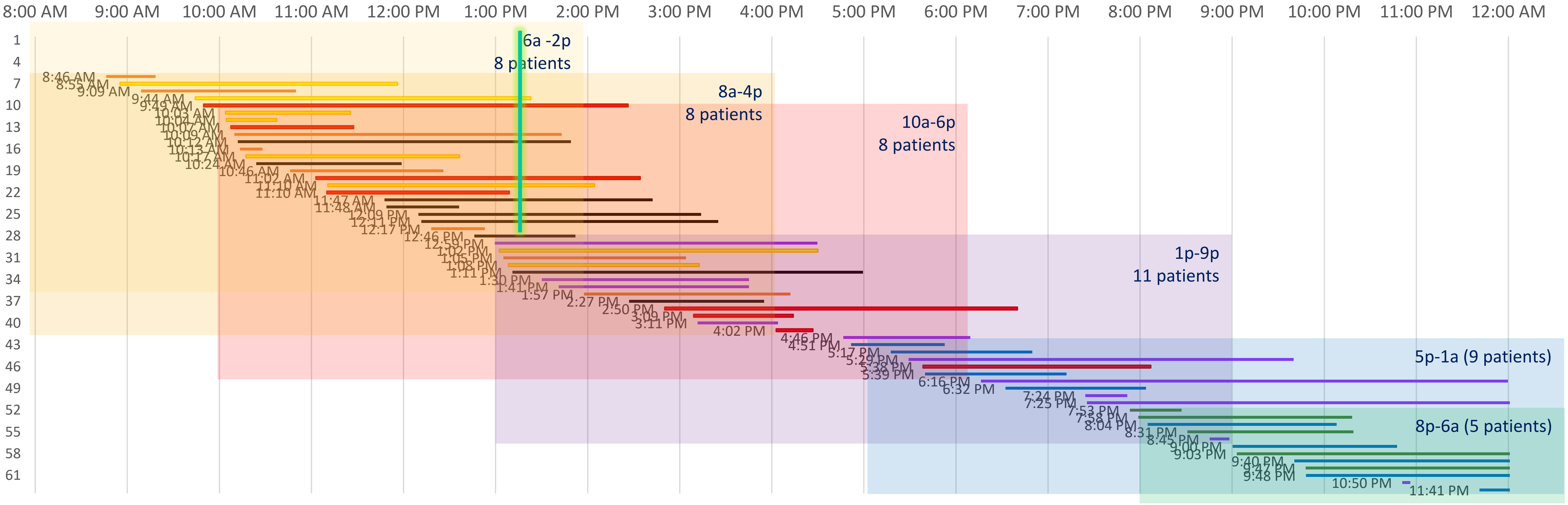
The difference between average case load between weekdays and weekends is obvious in the curve of this data. This would suggest that the most efficient use of staffing resources would be to create a schedule in which more staff would be available to cover the extra cases. However, this is not the case. The current scheduling strategy in the emergency and critical care (ECC) department has most employees scheduled from Sunday to Wednesday or Wednesday to Sunday, effectively having the most number of technicians on the day when the ER caseload is the lowest.

The Effects of Patient Accumulation

This Gantt chart outlines both outpatient lengths of stay and inpatient wait times on February 16, 2019. The colored boxes indicate the scheduled shifts for each doctor working that day between 8:00am and 12:00a. Each OPLOS or IPWT has the corresponding color to the doctor that took the case. The nine black bars represent patients that were seen by doctors outside of the ER, including four patients transferred directly to ophthalmology, one surgery patient that needed a prescription refill, and four patients taken by doctors from ICU to help lighten the load for the ER doctors.

One purpose of this graph is to show how patients accumulate over the course of the day. For example, at one point during the 1:00pm hour (see green line), there were 15 patients whose assessment, treatments, or procedures were in progress. During the 10am hour, 8 patients arrived within a twenty minute span. Five of those cases were given a mESI score of 4 and one was given a score of 5, suggesting that these patients could have waited to be triaged. Had a triage nurse been there to assessed these patients and assign them mESI scores, the staff and students in the ER would have been able to see them in an timely, organized manner. This is a perfect example of how the lack of a triage system can cause significant stress because of overwhelming numbers of patients in a short amount of time.

FIGURE 10: GANTT CHART OF OUTPATIENT LENGTHS OF STAY AND INPATIENT WAIT TIMES – FEBRUARY 16, 2019



Conclusions and Recommendations

I have worked in the intensive care unit and emergency room at the Foster Hospital for Small Animals at Tufts University, Cummings School of Veterinary Medicine since June 2017. In that time I have had the pleasure of working and learning with some of the most talented technicians, interns, residents, and faculty in this field. Unfortunately, I have also seen a hard downward spiral in many of my colleagues, suffering from burnout and exhaustion. This job is tremendously taxing mentally, physically, and emotionally but we are devoted to helping those animals of critical care.

I chose to complete this IQP at Tufts because I wanted put a spotlight on a situation that is hurting both humans and the patients we love. People who work in veterinary medicine are incredible strong individuals who can withstand some of the hardest experiences of any profession. But our ranks are beginning to dwindle because of poor working conditions, overwhelming work load, low pay, lack of support, and severe compassion fatigue.

The objective of this IQP was not to solve these enormous and pervasive problems, but to acknowledge that change must start from within to create safer and more efficient working environments. The aim of this project was to investigate just what we are dealing with and how to address the issues at hand.

I invite future IQP teams to take this work and help us bring real change to fruition.

<u>Here are a few ideas:</u>

- Create a computer program or app to apply the mESI algorithm in real time
- Create a database open to all veterinary hospitals to track types of cases and their given or estimated mESI scores
- Develop a method to track actual wait times and write code to project estimated wait times for future patients

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Additional Resources

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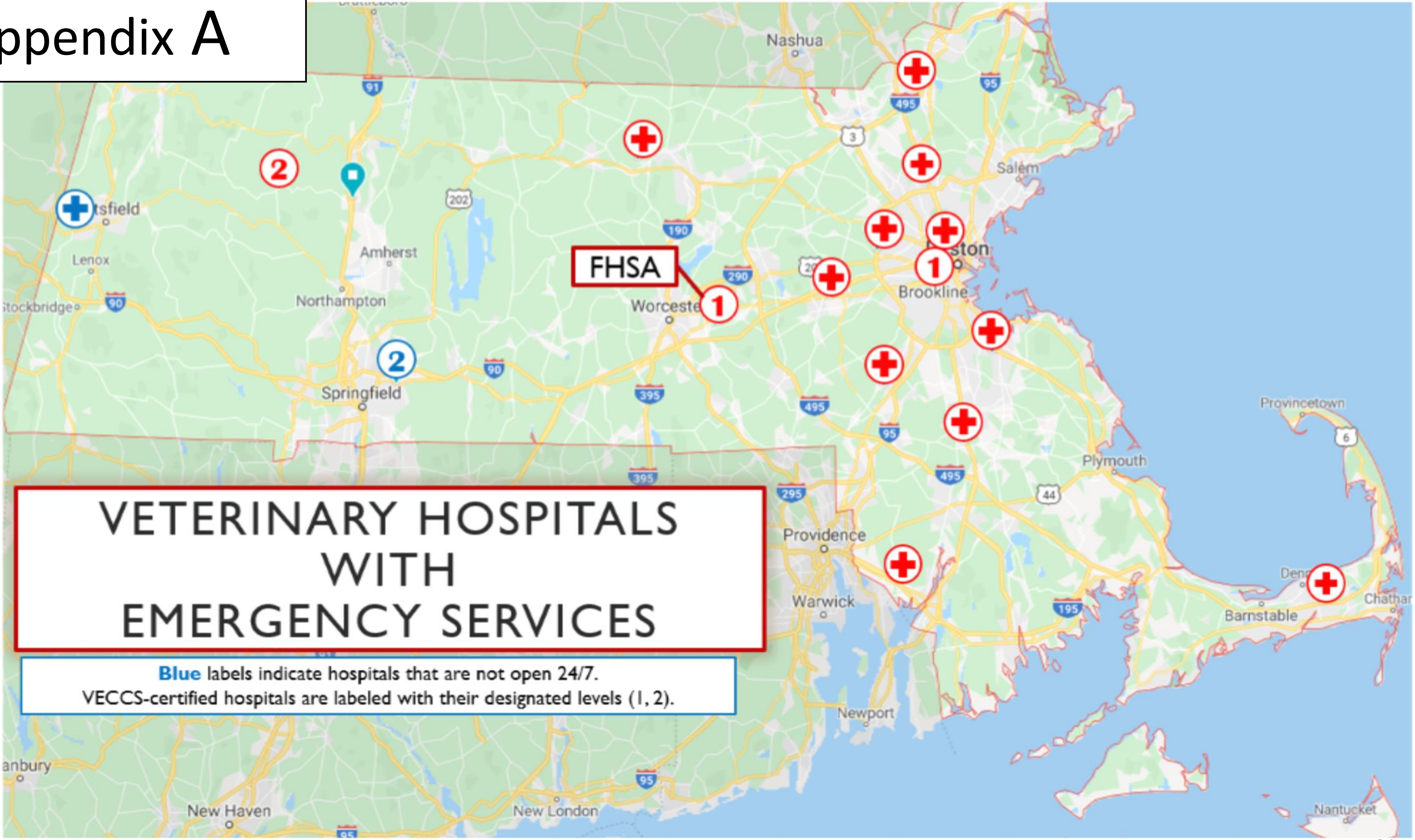
Appendices

A. Map of Veterinary ERs in Massachusetts with 24-hour services
B. VECCS Certification Criteria for Level 1 Facilities
C. Non-emergent triage form (NETF)
D. Google Sheet of NETF Data
E. Map of FHSA and the distance between the ER and the lab
F. Sample of electronic triage board at FHSA ER
G. Definitions of Triage Discriminators from the Veterinary Triage List (Ruys, et al. 2012)
H. ESI Certificate

Appendix A


VETERINARY HOSPITALS
WITH
EMERGENCY SERVICES
Blue labels indicate hospitals that are not open 24/7.
VECCS-certified hospitals are labeled with their designated levels (1, 2).
FHSA
Nashua
Salem
Amherst
Northampton
Lenox
Springfield
Worceste
Brookline
Providence
Warwick
Newport
Plymouth
Provincetown
Barnstable
New Haven
New London
Nantucket
1
1
2
2

Appendix B: Certification Criteria for VECCS Level-1 Hospital

VECCS
VETERINARY EMERGENCY & CRITICAL CARE SOCIETY
CERTIFIED FACILITY

Veterinary Emergency and Critical Care Society (VECCS) certification of veterinary emergency and critical care facilities:

The VECCS is offering a certification program to veterinary facilities that provide emergency and critical patient care. The purpose of this certification is to recognize those hospitals that meet and exceed the minimum standards and guidelines published by the VECCS. The VECCS does this in the hopes of raising the standard of care while also increasing public and professional awareness in the area of veterinary emergency and critical patient care.

This certification program identifies 3 levels (I through III) based on facility operating hours, equipment and personnel. The following is a description of the different levels of certification with associated requirements for each level.

veccs.org/facility-certification/certification-levels/

Level I

A Level I emergency and critical care facility is a 24 hour acute care facility with the resources and specialty training necessary to provide sophisticated emergent and critical patient care. This facility is open to receive small animal emergency patients 24 hours a day, 7 days a week, 365 days a year. The level I facility must have a Diplomate of the American College of Veterinary Emergency and Critical Care employed full time and available for consultation either on-site or by phone 24/7.

The level I emergency and critical care facility must be in compliance with the requirements listed in the appendix "Minimum Requirements for Certification of Veterinary Emergency and Critical Care Facilities".

The level I emergency and critical care facility also must meet these additional requirements in the areas of:

Staffing

- It is recommended that there be at least one veterinarian on duty at all times with at least 2 years practice experience or 1 year small animal internship experience.
- Must have at least two certified technicians employed full time, and it is recommended that at least one of the technicians is a certified Veterinary Technician Specialist (Emergency and Critical Care).

Continuing Education

- A comprehensive, written training and continuing education program to include as a minimum the following components: journal club, morbidity and mortality rounds, and wet labs.

Emergency Capabilities

- Have the resources (equipment and staff training) to evaluate and stabilize any small mammal, avian and reptile (exotic) "pets". These patients can be referred to a local exotic specialist that sees emergencies, if a documented relationship is present.
- Providing volume or pressure cycled mechanical ventilation.
- Performing invasive blood pressure monitoring.
- The proficiency and resources to perform endoscopy and bronchoscopy.
- Have proficiency in abdominal ultrasound and echocardiography or a documented relationship with a Diplomate of the American College of Veterinary Radiology and Diplomate of the American College of Veterinary Internal Medicine.

Facilities

- A system in place to ensure continuous ongoing power that will support the operation of critical equipment for an indefinite period of time in the event of a power outage. An example of such a system would be a combination of either a centralized or distributed uninterruptable power supply (UPS) unit(s), supplying short term uninterrupted power to the computers, phone system and emergency lighting, and a generator for stand by and long term power needs. The system needs to be maintained and have documented performance checks at least twice a year.

In-Patient Support Capability

- To provide total parental nutrition.
- To perform peritoneal or hemodialysis.

Appendix C: Electronic Non-Emergent Triage Form for Pilot Study
(created using Google Forms)

Non-emergent Triage Form - updated 1/24/20

The name and photo associated with your Google account will be recorded when you upload files and submit this form. Not **tuftsertriage@gmail.com**? Switch account

* Required

Photo of patient

Add file

Owner's name (Last, First) *

Your answer

Pet's name *

Your answer

What species is your pet? *

- ◯ dog
- ◯ cat
- ◯ rabbit
- ◯ ferret
- ◯ guinea pig
- ◯ bird
- ◯ reptile (e.g. bearded dragon, gecko, tortoise, etc)
- ◯ Other: ________

Did a veterinarian from another hospital or clinic advise you to bring your pet to the Tufts ER today? *

- ◯ Yes
- ◯ No

Has your pet been a patient at the Tufts University Foster Hospital for Small Animals before? *

- ◯ Yes
- ◯ No
- ◯ Tufts @ Tech

Please select your pet's symptoms from the following list: *

- ☐ vomiting
- ☐ diarrhea
- ☐ not eating, decreased appetite
- ☐ not acting like him/herself
- ☐ lethargic, no energy
- ☐ possible or witnessed toxin ingestion (e.g. chocolate, medication, rat poison, marijuana, etc)
- ☐ painful
- ☐ bloody or odd-colored urine
- ☐ vaginal discharge
- ☐ difficulty or inability to defecate
- ☐ blood in stool
- ☐ coughing or sneezing
- ☐ limping or not bearing weight on a limb
- ☐ difficulty or inability to stand
- ☐ wound (bite, laceration, broken toenail, etc)
- ☐ swelling of the face
- ☐ swelling elsewhere
- ☐ problem with one or both eyes (swelling, redness, discharge, injury, etc)
- ☐ problem with one or both ears
- ☐ skin problem (rash, hives, etc) or abscess
- ☐ Other: ________

Has your pet been previously diagnosed with any of the following medical conditions? *

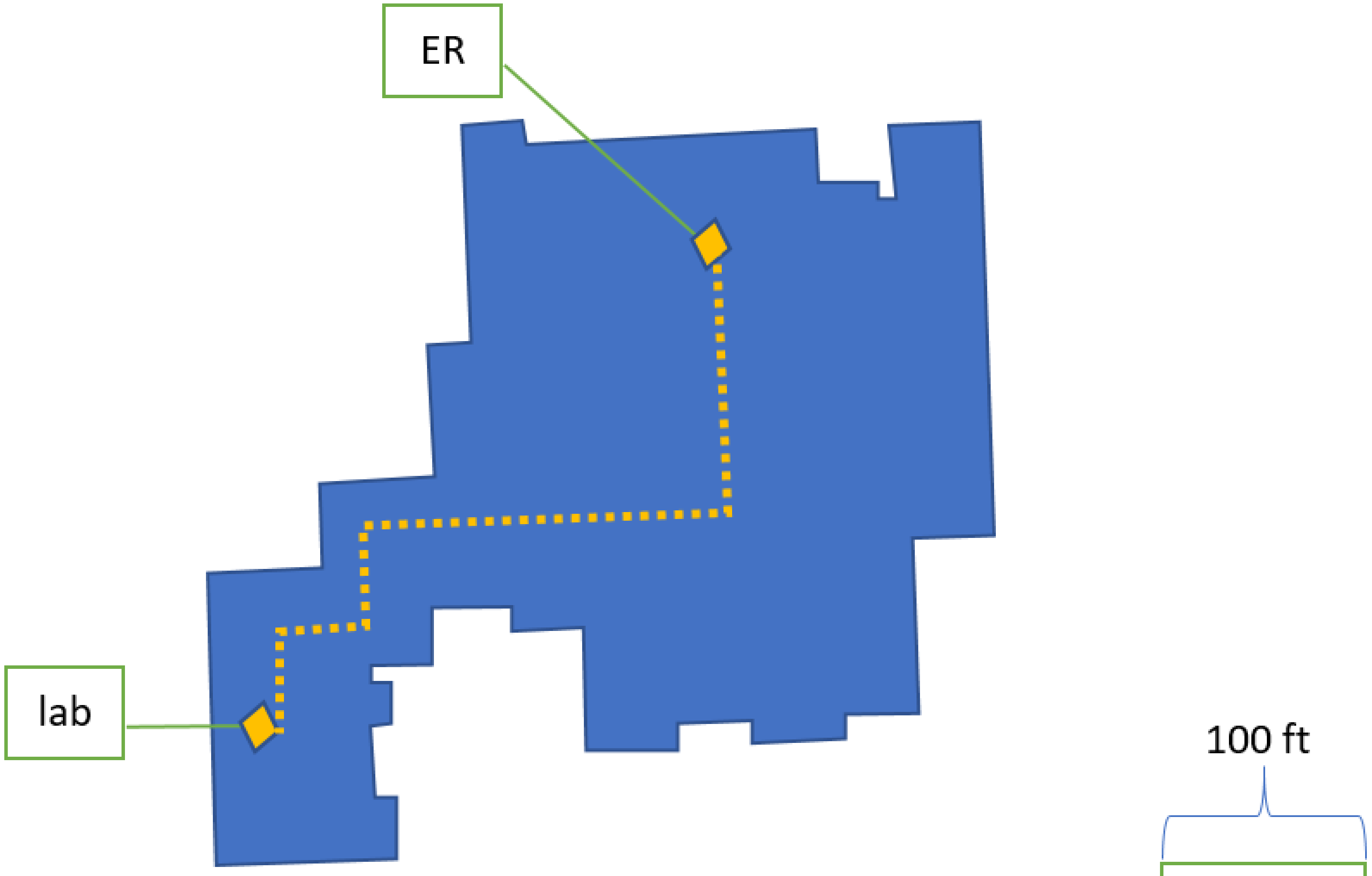
- ☐ None
- ☐ Heart disease (heart murmur, congestive heart failure, DCM, etc.)
- ☐ kidney disease
- ☐ Diabetes
- ☐ epilepsy
- ☐ Cushing's
- ☐ Addison's
- ☐ Hypothyroidism
- ☐ Hyperthyroidism
- ☐ cancer
- ☐ Lyme or other tick-borne disease
- ☐ Heartworm disease
- ☐ Other: ________

Appendix D: Google Sheet Synced with Non-Emergent Triage Form

	A	B	C	D	E	F	G	H	
1	Photo of patient	Timestamp	Owner's name (Last, First)	Pet's name	Previous FHSA Patient?	CHRONIC? Y/N	REFERRAL? Y/N	RECURRENT? Y/N	Sy
2									
3	https://drive.google.com/o	1/26/2020 10:06:02	[redacted]	Tigger	No	n	No	n	sw
4		1/26/2020 12:47:15	[redacted]	Josie	No		No		cc
5		1/26/2020 13:21:10	[redacted]	Merlin	No	n	Yes	n	pc
6	https://drive.google.com/o	1/26/2020 13:35:32	[redacted]	Oden	No	n	No	n	nc
7	https://drive.google.com/o	1/26/2020 16:21:35	[redacted]	Mocha	Yes		Yes		vc
8									

I	J	K	L	M
Symptom(s)	Previous diagnosis/es.	Brief description of problem	Additional information	Species
swelling elsewhere	None	Swelling/lump on right neck		cat
coughing or sneezing	None	coughing and hacking up foam since 12/31	Been to another vet. Has appt for rads on Tues. Been on do	dog
possible or witnessed toxin inge	None	Friday evening ingested houseplant leaf-quieter than usual. Sat- limping , back legs seemed stiff but stil		dog
not acting like him/herself	None	He hasn't eaten a full meal in 2 days, he's	Oden is supper shy, but very lovey with his family.	cat
vomiting, not eating, decreased	Lyme or other tick-borne disease	Vomiting. All his dog food early morning be	Behaviour has been strange, seeking out my daughter and I	dog

Appendix E: Map of distance between ER and the laboratory at FHSA



Appendix F: Example of ER Triage Board at FHSA (names of owners blocked out for privacy)

ER Triage Board Hospital: Foster Hospital for Small Animals

Insert New Lines on Top Row : Last update @ 3/10/2020 11:13:41

	Active	Level	Trauma	Non-Emer	Referred	Client	Patient	CaseNo	Species	Arrival Time
*	☑		☐	☐	☐					Filled Automatically
▶	☑	Stable in ER	☐	☐	☐	[redacted]	Luna / [redacted]	328639	Canine	3/10/2020 10:49:28 AM
	☑	Stable in ER	☐	☐	☑	[redacted]	Kayden / [redacted]	321106	Canine	3/10/2020 10:14:57 AM
	☑	Stable in ER	☐	☐	☐	[redacted]	Yogi [redacted]	466111	Canine	3/10/2020 10:04:14 AM
	☑	Stable in ER	☐	☐	☑	[redacted]	Divot [redacted]	S218360	Canine	3/10/2020 9:39:22 AM
	☑	Stable in ER	☐	☐	☐	[redacted]	Elle / [redacted]	S187089	Canine	3/10/2020 7:33:36 AM
	☑	Stable in ER	☐	☐	☐	[redacted]	Foxy [redacted]	440058	Canine	3/10/2020 6:55:13 AM

Show Inactive Also | Smaller | Larger

p Row : Last update @ 3/10/2020 11:14:13 AM

Complaint	TriagedBy	Seen	Clinician	Student	Outcome	Notes
eye discharge OS	jh		Sands, Jessica	Hammer, Jessica		history of cataract sx
V/D	mk	Yes	Sands, Jessica	Hammer, Jessica		
shaking/pant after age		Yes	Sands, Jessica	---	ta	
IMHA		Yes	Doran, Alma	Cosaro, Emma	op	probably no IMHA
anorex, leth, hematoche		Yes	Doran, Alma	-------		diabetic, waiting on rads
neck pain	md	Yes	Doran, Alma	Cosaro, Emma	op	

Appendix G: Definitions for the Discriminators of Veterinary Triage List

Table A2: Definitions of discriminators used in alphabetical order

Anorexia in puppy or kitten	A dog or cat younger than 12 weeks[16] that has not eaten for ≥12 hours.
Cluster seizures	More than 2 generalized seizures in 24 hours.[17]
Dehydration	Severe (>8%) – tented skin stands in place, prolonged capillary refill time but < 2 seconds, sunken eyes and dry mucous membranes.[18] Moderate (5–8%) – subtle decrease in skin turgor, slight prolongation in capillary refill time, eyes possibly sunken in orbit, possible dry mucous membranes.[18]
General weakness[11]	A general reduction in muscle tone combined with mental depression. Animals are usually able to stand or walk but are reluctant to rise and will lay down as soon as they are allowed.
Gross deformity[11]	Gross and abnormal angulation or rotation is implied.
Hemorrhage[11]	Exsanguinating – occurring at such a rate that death will ensue unless the bleeding is stopped. Uncontrollable major – not rapidly controlled by the application of sustained direct pressure and in which blood continues to flow heavily or soak through large dressings quickly. Uncontrollable minor – not rapidly controlled by the application of sustained direct pressure and in which blood continues to flow slightly or ooze.
Hypoglycemia	Serum glucose ≤3.3 mmol/L (60 mg/dL).[19,20] Animals that are on insulin therapy and lethargic puppies and kittens are at risk of hypoglycemia. Typical signs include decreased responsiveness, general weakness, and a staring look.
Hyperglycemia with ketosis	Serum glucose ≥11 mmol/L (200 mg/dL) combined with signs of ketosis.[11] Animals with a history of diabetes mellitus that did not receive insulin for a certain period of time are at risk of having hyperglycemia with ketosis. Sometimes an acetone breath can be perceived.
Medium to large skin wounds[11]	Subjective assessment. Lacerations of skin and subcutis that are medium to large for the size of the animal are implied. In deeper wounds pain assessment will prevail.
Persistent vomiting[11]	Vomiting that is continuous or that occurs without any respite between episodes.
Pain	Severe: uncontrollable and intense. Stops normal activities. Animals may cry out when touched and may become tachycardiac and tachypneic. Painful extremities will not be used or the animal is unable or unwilling to rise.[11,21] Moderate: Stops some activities. Animals may respond with groaning when touched, may demonstrate trembling and can have anorexia. Painful extremities will most likely not be used.[11,21] Mild: Animals can perform most activities. Painful extremities will still be (intermittently) used.[11,21]
Respiratory distress	Severe: Directly life threatening or rapidly worsening. Patient can have blue or very pale mucous membranes, open mouth breathing, increased work of breathing, may demonstrate exhaustion or depression, may have oral moist breathing sounds, and very likely have abnormal lung sounds. Moderate: Not immediately life threatening, not worsened in the past hour. Animals can have pale or pink mucous membranes, clear increased work of breathing, may have (intermittent) open mouth breathing, especially when stressed and may have abnormal lung sounds. Mild: Mildly increased work of breathing. Patients do not have open mouth breathing, do not require oxygen therapy and may have localized abnormal lung sounds.
Shock (decompensated)	Inadequate perfusion of tissues. Classical symptoms of early decompensated shock include a reduced level of consciousness, pale mucous membranes, a capillary refill time > 2 seconds, poor peripheral pulse quality, low rectal and peripheral temperature, bradycardia in cats (defined as a heart rate <120/min)[22] and tachycardia in dogs[22] (defined as a heart rate >160/ min).[20] Symptoms of late decompensated shock include bradycardia and an absent capillary refill time.[23]

Ruys, L.J., Gunning, M., Teske, E., Robben, J.H. and Sigrist, N.E. (2012), Evaluation of a veterinary triage list modified from a human five-point triage system in 485 dogs and cats. Journal of Veterinary Emergency and Critical Care, 22: 303-312. doi:10.1111/j.1476-4431.2012.00736.x

Appendix H

The ESI Triage Research Team

presents

Certificate of Completion

to

Alli Butler

With a grade of **100%**

For

The Emergency Severity Index Interactive Web Based Training Course

Test A - 100% **January 17, 2020**