VetMed: A Feline Cystocentesis Teaching Model

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Function: Sterile urine is vital in diagnosing a variety of diseases in animals. Cystocentesis is a common procedure that is used to access sterile urine from cats due to the difficulties associated with catching their urine. This procedure involves great risk, as the needle being inserted into the bladder must be accurately placed to avoid puncturing organs around the bladder that can cause fatality, such as the kidney and caudal aorta. At the University of Wisconsin-Madison Veterinary School, there is currently no way for students to practice this procedure except on live animals, which if done incorrectly can cause death, or on cadavers which do not do a great job of simulating an actual procedure because the bladders are often empty. The goal of this project is to develop a teaching model for veterinary students to practice this procedure, and be notified when they have made mistakes, thus aiding in the learning of proper techniques that can be used when performing this procedure on live animals.

Client requirements:

- Budget of $500
    - Most of which is expected to be spent on providing a realistic bladder
- Develop a realistic urinary tract
    - Includes the bladder, kidney, and urethra
    - Liquid can be drawn from the bladder
- Simulate the cystocentesis procedure
    - Compatible to a cat lying on its side or back
    - Able to feel and stabilize the bladder during the procedure
- Resemble at least the lower portion an eight pound cat
    - Prefer plastic skin and bone structures
    - Secondary options include a stuffed animal
    - Capable of opening model to identify structures and replace parts

Design requirements:

1. Physical and Operational Characteristics

a. ***Performance Requirements:*** Cystocentesis is a very delicate procedure that many veterinary students do not feel confident in performing. Research has shown that veterinary students have strongly preferred to be employed at practices that provide them with mentors and have a lot of supervision because they do not feel they have the proper skills or abilities to complete procedures [1]. Veterinary students that have had hands-on practice with these procedures have reported feeling more confident in their line of work. One of the main purposes of this model is to allow students to practice the cystocentesis procedure and learn how to improve their techniques when mistakes are made. The constructed model will have an artificial bladder, made with material that can be poked with a 1.5-inch needle numerous times, that is filled with artificial urine for students to practice palpating and extracting urine from the bladder. During cystocentesis procedures, it is possible for other organs and veins to get lacerated causing uroabdomen and hemorrhage among other things. Because of this, the final model will be constructed to notify students, with a sound similar to the game Operation, when they have hit something they should not have during the procedure.

b. ***Safety:*** In order to use this teaching model, users will need to handle a syringe and needle. The FDA regulations for sharps are as followed, used sharps should immediately be placed in a FDA cleared sharps disposal container [2]. The model should minimize the likelihood of contact of the sharp with the operator's hand. If struck by a sharp, the FDA approved procedure is to wash the area with water and soap/disinfectant. Seek medical attention immediately afterward [2].

c. ***Accuracy and Reliability*:** The testing model should accurately depict the urinary system of a cat. The bladder should be able to hold 145 to 155 mL of liquid as the average cat holds around 150 mL of urine [3]. The device must contain a bladder that can hold liquid after being punctured repeatability; the device should be able to be punctured around 500 times before the bladder needs to be replaced.

d. ***Life in Service:*** The device will be used as a teaching model for many students, and as such it must be able to withstand multiple uses. The model skin and bladder must be able to withstand multiple punctures from a syringe. As a goal, this device should be in service for 500 demonstrations. If the device is made with a replaceable bladder, the bladder should withstand one use while the teaching model as a whole is in service for the previously stated 500 demonstrations.

e. ***Shelf Life:*** The testing model should be stored in a cool, dry environment and should last a minimum of seven years in such an environment. The alkaline batteries that are going to be used to power the electrical portion of the device have a shelf-life of five to ten years [4].

f. ***Operating Environment:*** The cystocentesis teaching model will be used by students and instructors in the Veterinary School at the University of Wisconsin-Madison. The goal of the model is to assist students in gaining experience and practice performing the cystocentesis procedure to prevent them from making fatal mistakes when performing the procedure on a live specimen. When not in use, the teaching model will be stored on a shelf in a room temperature environment. This means that the model may be exposed to dust and/or dirt when left unused for a while. While the device is being stored, it should not undergo any shock loading because nothing would be placed on top of it to prevent damage. The liquid that is inside the bladder should be removed after the model is done being used and placed in storage to prevent breakdown of the artificial bladder's material.

g. ***Ergonomics:*** As the device will be modeling the cystocentesis, the operator should use as much force as they would during the actual procedure. The bladder of the device should be able to withstand five newtons of force, as the full bladder of a cat undergoes around 1700 Pa of pressure [3].

h. ***Size:*** For the purpose of the device, the size and shape should mimic that of an eight pound cat. A healthy cat of this weight would average about 18 inches in head and body length (excluding the tail). [5] Considering that only the lower half of the cat is needed to teach cystocentesis, the design will most likely measure 9 inches plus the length of the tail. With these size restraints, the device will be easily portable for maintenance or general use.

i. ***Weight:*** The device is supposed to mimic the structure of an adult cat, which can range in weight from five to twenty pounds [5]. For the teaching model, the team is trying to replicate the average adult cat at eight pounds [6]. The weight of the model will differ from this due to the electronic portion as well as the possible elimination of the upper torso and head. The device should be anywhere from five to ten pounds so it can be easily transported and semi-replicate the feel of a live-subject.

j. ***Materials:*** The device can encompass any material except those that may release harmful chemicals or shatter when punctured. The materials used should replicate the biomechanical properties of the tissue of a cat. The frame and bone structure will most likely be constructed of plastic.

k. ***Aesthetics, Appearance, and Finish:*** From looking at the few cystocentesis simulation models that have been made around the world and discussing with the client, the final cat model should be the average size of an adult cat which is no more than 8lbs. A stuffed animal can be used for the skin of the model; however, if there is time following testing periods, the client would like to see a silicon based skin made for the model. The client has requested that the model is made in such a way that the exterior wall can be opened so that students can study the anatomy of the cat prior to practicing the procedure. The major organs and veins that need to be present within the model include the vena cava, the kidneys, and the urinary bladder. In addition to these, skeletal structures such as the pelvis and spine will need to be 3-D printed and placed inside the model.

2. Production Characteristics

a. ***Quantity:*** The veterinary school needs one teaching model-- the model would consist of reusable bladder, a structural component, an electrical component to notify when a mistake was made, and other important body tissues.

b. ***Target Product Cost:*** The budget for the creation of the cystocentesis teaching model is 500 dollars. Previous models used by the veterinary school are made up of a stuffed animal and a water balloon [7]. As the design aims to more accurately reflect the possible dangers of the cystocentesis procedure, the 500 dollar budget is appropriate. The majority of this budget will most likely go toward purchasing and developing a model bladder that can withstand multiple fluid drawings and punctures.

3. Miscellaneous

a. ***Standards and Specifications:*** There are no specific international or national standard approvals needed for a veterinary teaching model.

b. ***Customer:*** The main customer of this device is veterinary hospitals and schools; therefore, the model should reliably replicate the anatomy and physiology of a cat bladder. The external portion of the device should be realistic but this is of less importance than the bladder itself. The model should notify the operator when a mistake is made such as nicking the aorta or kidneys.

c. ***Patient-Related Concerns:*** As is the nature of the project, there is no “patient”. There is a concern related to the operator. It is possible for an accidental needle stick, but that chance will be minimized as much as possible. There are no concerns about patient data or sterilization.

d. ***Competition:*** There are no official competitors on the market. However, other universities, such as Michigan State University and Universidad Buenos Aires, have developed models to help students in the veterinary school gain practice on the cystocentesis procedure. Although difficult to find further information, it is known that Michigan State has created a urinary bladder simulation model to allow students to practice withdrawing sterile urine through a needle [8]. Universidad Buenos Aires developed a low cost cystocentesis model using a stuffed animal, latex balls, a baby diaper, a latex probe, a rubber clamp, and artificial urine. This model was tested by 19 faculty members and 90 students with 90% and 89% of individuals reporting that the model was very good, respectively [9].

Works Cited

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