Research Report

A survey of the use of theriogenology related models across veterinary curricula

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Abstract

The use of models within theriogenology curricula has become increasingly more common over the last few years. Currently, there are no compiled data regarding the types of theriogenology related models used at veterinary institutions across the world. A 55-question survey regarding the use of models in the theriogenology curricula was distributed via multiple listservs. A total of 31 responses were garnered representing 24 veterinary institutions from 5 continents. Data collected in the survey indicated that large animal transrectal palpation models, dystocia models, and small animal ovariohysterectomy and castration models are the most used models. Commercial models are widely used; however, multiple models are built at institutions. Only 1 model listed by respondents has been validated in the literature. Institutionally created models are most often built by faculty and most of the models described are used only for developing technical skills. A large percentage of respondents that listed models believed that the models improved students' technical skills, but for the most part are not a substitute for live animal experiential learning.

Keywords: Model, theriogenology, veterinary medicine, clinical skills

Introduction

In the past 2 decades, model use in veterinary curricula has become widespread.[1] Veterinary institutions have moved toward a competency-based curriculum.[2] This trend has necessitated the need for clinical and professional skills courses in the curriculum to be developed or to become more robust. Traditionally, cadaver tissue was used before students were introduced to live animals, particularly for surgical skills, whereas other hands-on skills were performed first on live animals.[3] However, challenges in sourcing cadaver tissue, increasing class sizes, costs of animals and cadavers, and institutional animal care and use committees (IACUC) and the United States Department of Agriculture (USDA) regulations led to efforts to reduce, refine, or replace (3 Rs) direct animal use.[4] This, combined with identified gaps between traditional approaches to training veterinary professionals and current demands of the modern veterinary practice to hire veterinarians who are practice-ready, has increased the need for the use of models and clinical skills simulators within veterinary medical education.[5–8] The use of models in the curriculum can also increase the time dedicated to practicing and enhancing skill development by the student. Model use has been demonstrated to be effective in teaching clinical skills in veterinary medicine.[5]

Models can come in a variety of forms, from low fidelity to high fidelity, commercially produced or made at institutions. High-fidelity models are characterized as being life-like and mimic a high level of realism, often using technology. Comparatively, low-fidelity models use minimal to no technology, do not interact with the student, are not life-like, and are not intended to hone specific technical skills.[9,10] Veterinary simulation models commonly would be considered medium- to low-fidelity with a small number of high-fidelity models available for use in the veterinary curriculum. Nonetheless, even low-fidelity models were sufficient for teaching veterinary clinical skills.[11–13] Cadaver tissue may be used in models to mimic realism or better simulate experience with live-animals.[3] High-fidelity models often are associated with higher cost, potentially limiting the number of models available for instruction. The level of fidelity chosen by an institution should provide the end user with the simulation needed to achieve the skill desired, thus fidelity level of the model should be validated. Models of varying fidelity can be used to provide users with the means to learn a new skill, to refine a current skill, or to expand current skill repertoire.

The use of models has meant that clinical skills can be introduced earlier in the curriculum than previously, due to the decreased chance in causing harm to an animal secondary to lack of knowledge or experience. Models allow for multiple reiterations/practice sessions that ultimately allows for greater development of technical skills.[1] Introduction to technical skill is key in developing mastery.[1] Models can also be available 24 hours per day and 7 days a week, enabling students to practice technical skills without direct veterinary supervision but with clinical use direction. Simulations and models can also be used throughout the curriculum when there is the desire to add more skills than animal or case availability

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allows (e.g. learning fracture repair or surgical procedures). Clinical skills can be combined with professional skills, allowing students to integrate hard and soft skills.[6,14]

Models offer many advantages in the curriculum. One of the top advantages is that it creates a 'safe space to fail' for the student, without the pressure of harming a live animal.[15–18] In addition, the challenge of time or repeated use is not an issue compared to live animal.[18] Models can also be useful to simulate situations when it is not possible to have large numbers of live animals, there are a large number of students that need experience in a certain procedure that far surpasses the number of animals a university has, or a certain procedure (e.g. cesarian surgery) that is hard to recreate on demand.

Multiple studies across species have investigated what skills and other competencies are required of new veterinary graduates. Common reproductive skills and competencies that appear in these studies include, but are not limited to, bovine castrations, bovine pregnancy transrectal palpation and ultrasonography, bovine dystocias including the use of fetotomy, bovine cesarian surgery, bovine and equine artificial inseminations, bull breeding soundness examinations, equine pregnancy transrectal palpation and ultrasonography, small animal abdominal ultrasonography, small animal castrations and ovariohysterectomies, and swine reproductive examinations.[19–31] These studies have focused on what species-specific veterinarians do for the most part, leaving individual institutions to adapt their skills lists for core and elective courses as they reflect on their specific curricula and regional veterinary needs.

As mentioned, models can be bought or developed intra-institutionally. Purchased models are often expensive, limiting the number potentially purchased, whereas models created in-house require a space to develop and build the model, labor and expertise in construction, and purchase of construction equipment and building materials. Many types of equipment can be potentially used to create models, varying from simple metal and woodworking machinery to more complex equipment such as 3-D printers, vacuum formers, and computer numerical control machines.

A search of veterinary models that pertain to the field of theriogenology, and that were published as validated models in the peer reviewed literature, include bovine castration,[32] canine ovariohysterectomy,[10,33,34] bovine transrectal palpation,[6,35–39] canine castration,[40,41] and an ovine cesarian surgery model.[42] Commercially available theriogenology related models include bovine and equine palpation (Veterinary Simulation Industries (VSI) Calgary, AB, Canada, Breed'n Betsy Byaduk, Victoria, Australia), dystocia (VSI), artificial insemination (Breed'n Betsy), uterine prolapse (Breed'n Betsy), and canine spay (VSI, SynDaver Tampa, FL, Rescue Critters Simi Valley, CA).

The objective of this paper is to describe models that are used in veterinary theriogenology curricula worldwide, and how they are integrated into the curriculum.

Materials and methods

An online survey was created using Survey Monkey® and distributed on the following listservs: Society for Theriogenology Large Animal, Society for Theriogenology Small Animal, American College of Theriogenologists, and Veterinary Clinical Skills + Simulation, allowing for a world-wide audience. A 55-question survey asked respondents geographic information, general information about their veterinary curriculum, which skills they used theriogenology models for, and in what context they most frequently used the models. Additionally, respondents could choose to give details on 2 of the main models used, and check a list of all models that they used in their program. An 'other' category was available for models not included on list. Respondents could choose to remain anonymous and choose not to answer questions (Appendix). Descriptive analyses of the survey results were performed.

Results

A total of 31 responses were collected from a minimum of 24 veterinary institutions representing 5 continents (all but Antarctica and South America). The response rate cannot be calculated as the number of people that accessed the survey is unknown. Some respondents chose to not identify their home institutions. Six respondents chose to remain anonymous. Full completion rate for this survey was 55% including description of at least 1 model; respondents finished in an average of 5 minutes.

Six of the 31 respondents reported using a validated model. Twenty-six various types of models were further described by the survey takers that included: 6 large animal dystocia, 5 canine ovariohysterectomy, 4 bovine transrectal palpation, 4 equine transrectal palpation, and 1 each of equine female perineum, small ruminant vaginal suture, feline ovariohysterectomy, canine transcervical insemination, feline castration, canine castration, and small ruminant dystocia.

Models were most commonly used in Year 3, followed by Years 4, 2, 5, and 1. Models were most frequently used only for technical skills with 1 model used for professional skills/communication training and 4 models used in clinical scenarios. Those models used in clinical scenarios include canine ovariohysterectomy, canine transcervical insemination, bovine dystocia, and bovine transrectal palpation.

Of the models further described and built at institutions, most were built by faculty members. These models included: transrectal palpation boxes, and models for large animal dystocia, canine ovariohysterectomy, equine female perineum, bovine dystocia, small ruminant vaginal suture, feline castration, canine transcervical artificial insemination, canine abdomen, canine castration, and feline ovariohysterectomy. Eight of the described models were built by faculty, with 2 involving students. Five were built by staff/veterinary nurses and 1 respondent reported using a model builder associated with the university. Nine models were obtained from commercial vendors. The most frequently named vendors and models were VSI, SynDaver, and Breed'n Betsy and Breed'n Bonnie.

Cadaver tissue was reported to be used with 3 models including 2 transrectal palpation models and a large animal dystocia model. Tissue was most commonly sourced from an abattoir, followed by sourcing from the institutional necropsy service.

Types of theriogenology models (Figure)

Dystocia and fetotomy models

Large animal dystocia models were the most common type of model reported by respondents with 74% stating that they use 1 or more types of models within the curriculum. A variety of models were described from commercially available sources including bovine models from VSI to bovine models made in-house from plywood and uterine bags. One lambing model and 1 farrowing model were also reported; these were made within their respective institutions. Cadaver tissue may or may not have been used in these models. Cadaver and live animal experiences usually followed the use of dystocia models, depending on the institution. Respondents reported that dystocia models on average improved students' skills and were a moderate to good replacement for live animals.

The 6 respondents who gave further information regarding dystocia models stated that they owned between 1 and 5 dystocia models, with an average of 3. They also reported a ratio of students to faculty ranging from 4:1 to 24:1 with an average of 13:2.

One small ruminant dystocia model was described. Two models were used in that particular curriculum. The model was used at a student to faculty ratio of 5:1 and was thought by the respondent to greatly improve students' technical skills and was a very acceptable substitute for live animals.

Fetotomy models are also frequently used with 45% of participants marking that they used that model in their curriculum. No respondents gave further details.

Transrectal palpation models

Equine and bovine transrectal palpation models are the second most commonly reported models. Commercially available models were most frequently used with VSI, Breed'n Betsy, and Breed'n Bonnie being named. Homemade bovine transrectal palpation boxes were also mentioned by some respondents.

Four respondents gave more information regarding bovine transrectal palpation models. They reported an average of 4 models per institution with a range of 1 to 8. Student to faculty ratios ranged from 6:1 to 35:3 with an average of 8:1. Most respondents felt that models greatly improved student skills but were not adequate replacements for transrectal palpation of live animals. Models were primarily used as an introduction to transrectal palpation and were followed by palpation of abattoir-derived reproductive tracts and live animals.

No respondents further elaborated on the use of equine transrectal palpation models in the curriculum.

Small animal ovariohysterectomy and castration models

Thirty-five percent of respondents reported that canine ovariohysterectomy models were used in their curriculum, whereas 19% reported using feline ovariohysterectomy models and 26% reported the use of both canine and feline castration models. Both commercial (SynDaver) and intra-institutionally derived models were described, with 1 validated canine castration model.[40]

Use of canine ovariohysterectomy models was further described by 5 respondents. It was reported that institutions owned between 2 and 50 ovariohysterectomy models with an average of 26. Student to faculty ratios for the use of the models ranged from 4:1 to 21:2, with an average ratio of 19:2. Model use was commonly followed by live animal surgeries, or cadaver use was followed by live surgeries. Respondents believed that use of models improved the students' skills but were not an adequate substitute for live animals.

One feline ovariohysterectomy model was further described. The respondent indicated that the institution owns 50 of these models and that the model was used with a student to faculty ratio of 15:2. Exposure to the model was followed by cadaver and live animal experiences. The respondent reported that the model improved students' skills but was not a replacement for live animals.

A feline castration model was also described by 1 respondent. Only 1 model was owned by the institution, and it was used with a student to faculty ratio of 12:1. This model was the only experience for this activity within the institution and was thought to greatly improve technical skills, but not a replacement for live animals.

Cesarian surgery models

Nineteen percent of respondents reported the use of large animal cesarian surgery models; only 1 respondent noted the use of small animal cesarian surgery models. No further description of these models was given by respondents.

Artificial insemination and advanced reproductive techniques models

Multiple models representing artificial insemination in various species were utilized by respondents. Eleven respondents reported the use of models for large animal artificial insemination. Additionally, there was 1 report of the use of a porcine artificial insemination model, 1 report on the use of a small ruminant laparoscopic artificial insemination model, and 1 report on the use of a canine transcervical insemination model. Regarding the transcervical insemination model, the respondent reported that the model was made intra-institutionally and its use was followed by procedures on live animals. The model was used with a student to faculty ratio of 1:1. The respondent reported that the canine transcervical insemination model slightly improved students' skills and was not a replacement for live animals. A bovine embryo transfer model was reported by 1 respondent, but no further information was reported.

Large animal castration models

Twelve percent reported the use of bovine castration models, and 9% of respondents reported the use of equine castration models. No further descriptions were given.

Caslick's surgery models

Nine percent used equine Caslick's surgery models. No further descriptions were given.

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Large animal vaginal prolapse models

Nine per cent of respondents reported the use of large animal vaginal prolapse models. One respondent described the use of a small ruminant vaginal suture model for teaching technical skills associated with large animal vaginal prolapse. Two of these models were available for use with a student to faculty ratio of 8:1. The respondent believed that the model improved students' skills and was not an acceptable replacement for live animals.

Other models

Multiple other models were noted by respondents including 1 canine neonatal care model, 1 male dog urethral catheterization model, 1 pregnancy ultrasonography model, and 1 equine perineal preparation model. The equine perineal preparation model was used in a veterinary nurse program with a student to faculty ratio of 15:1. Use of this model was the only experience with the technical skill and the survey respondent believed that it greatly improved students' skills and was an adequate replacement for live animals.

Discussion

A total of 31 respondents representing 5 continents and both 4- and 5- year veterinary education programs were studied. Large animal transrectal palpation, large animal dystocia, and small animal ovariohysterectomy and castration models were the most prevalent models used by the respondents that provided feedback. It is not surprising that these models were the most prevalent considering the reduced number of teaching animals available at some veterinary institutions, decreased use-limits per animal, increasing class sizes, and increased controversy surrounding the use of cadavers in veterinary medical education.[6] All of the respondents felt that models improved students' skills to some degree. Respondents reported that dystocia models could replace live animal, whereas other model types (specifically transrectal palpation and surgical) could not entirely replace live animals. This is important as it is not possible to replace training with live animals for all skills performed on a model. As an example, use of models as preparation for progression to live surgery is highly valuable for sequential development of skill level and confidence.

Commercially available full species models, while widely used, are expensive to buy, with some costing over $10,000 USD for a single model. They may also be costly to replace if damaged during use or if one must replace parts due to single-use or wear-and-tear. To reduce expenses and allow for a smaller student to model ratio it is often necessary to build lower-fidelity models at an institution. Based on the findings of this survey, that job primarily falls to faculty who may have other academic responsibilities and may not have expertise in model building. Additionally, it could not be elucidated from our survey if model building was the primary duty of the staff/veterinary nurses that are creating models or if this was an additional duty. The price of intra-institutionally derived models was also highly variable and was reportedly inconsistent and therefore was not included in the results. Other factors to consider are the expertise needed for model building, the cost per square foot of space allocated for construction equipment, the cost of construction equipment, maintenance of equipment, licenses and fees associated with software, and numerous other expenses depending on the complexity of the model-building space and needs of the institution. The above-mentioned factors can weigh into the decision about where and how models are created by each institution.

As the use of models and the increased demand to teach clinical skills grows, faculty and staff alike may find it very useful to turn to validated models and methods to aid in the development and refinement of courses. The authors believe that continuing to foster a culture of collaboration and sharing of model design is important to improve student competency. For those unfamiliar with model validation, validation of a model is an endeavor by the creator to associate data such as scores produced by a grading rubric with the skill that the model is claimed to teach. Validation methodology is highly varied amongst published reports, but current dogma would suggest that a validation argument should be constituted as 5 sources of validity evidence.[10,43–45] A validated, effective model would assemble evidence from several but not all 5 sources. These 5 sources include: content evidence, response process evidence, internal structure (reliability) evidence, evidence of relationship with other variables, and consequences evidence.[10,43] Validation of veterinary models has taken the form of experts on the subject using the models and then providing their opinion on the realism, fidelity, and effectiveness of the model for skill development. Alternatively, validity studies have taken the form of students using a model versus another accepted training model (e.g. cadaver or training video) with final assessment on a traditional teaching method (e.g. live animal). The associated rubric along with the model may then be used by other institutions. The process of validation of a model and creation of an associated grading rubric can be very time consuming.[10] Nonetheless, use of shared resources may help many educators as they develop and build their institutions' clinical skills program.

Another point of discussion is the student to faculty ratio. The ideal ratio likely varies depending on the educational level of the student, type of task, and the type of prelaboratory learning that is expected, but most tasks are guessed to be in the range of 4:1 to 12:1 for effective teaching.[46] A ratio of 10:1 student to faculty ratio was efficient and effective for teaching suturing in one study.[46] Teaching ratios reported for many of the models far exceeded this ratio and it would be of interest to determine many of the models noted far exceeded this ratio and it would be of interest to determine if this is an appropriate ratio for those models as noted by faculty and students.

Authors recognize several survey limitations. The survey was taken by participants on multiple continents in which the veterinary curriculum differs greatly in the number of years spent in a program and the definition of preclinical versus clinical training. Another limitation was that the survey was lengthy and further questions were not added in efforts to prevent survey fatigue and decreased response rate. A final limitation was the relatively low response rate to the survey, likely associated with inability of this study to capture all reproductive models that are in use at veterinary colleges across the world.

Conclusion

Models in the theriogenology curriculum do not replace live animals but do allow veterinary students to gain key technical skills prior to performing skills on live animals. This allows students to gain mastery of a skill, to practice in a safe situation, and have repetitive practice without detriment to an animal while embracing the 3 Rs of animal use. Models do not

have to be high-fidelity to be effective teaching models and many models may be built intra-institutionally. A cost-analysis should be considered when trying to decide if models should be bought or built in-house. Dedicated faculty and staff are often needed by a program to effectively provide clinical skills opportunities and develop models. Many iterations of a model may need to be developed and tested before an effective model is produced. Continued validation of theriogenology models followed by publication may be an aid to help faculty and staff across institutions provide effective learning opportunities for their students. There is a need amongst veterinary institutions to create a repository of model building plans, how the specific model is used, and how the model can be altered for other purposes. In conclusion, the use of models and simulators are advantageous for augmentation of theriogenology curriculum, and can be used to improve the reproductive skill levels of veterinary graduates.

Conflict of interest

None

Authors' contribution

The corresponding author declares that everyone who made significant contributions to the study or manuscript appear as coauthors. Furthermore, all authors contributed to design and analysis of the survey and construction of the manuscript.

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Appendix

Survey instrument

1. Please enter the name of your institution

2. Please enter the name of your institution

3. If you would like to share information about how you built your model(s) please enter your name and email

4. Please enter your continent of origin
   a. North America
   b. South America
   c. Europe
   d. Australia/Oceania
   e. Asia
   f. Africa

5. Please check all models that you use in your program. Add additional in the other option
   a. Canine ovariohysterectomy
   b. Canine castration
   c. Feline ovariohysterectomy
   d. Feline castration
   e. Bovine castration
   f. Equine castration
   g. Equine caslicks
   h. Large animal dystocia
   i. Large animal fetotomy
   j. Bovine palpation per rectum
   k. Equine palpation per rectum
   l. Large animal vaginal prolapse
   m. Large animal uterine torsion
   n. Large animal AI
   o. Small animal cesarian section
   p. Large animal cesarian section
   q. Other (please specify)

6. You will have the opportunity to add up to 2 of the major models you use. A comment box at the end of the survey will allow you to list all models you use. Please enter the name of the reproductive model you most commonly use

7. What technical skill is this model for
   a. Canine ovariohysterectomy
   b. Canine castration
   c. Feline ovariohysterectomy
   d. Feline castration
   e. Bovine castration
   f. Equine castration
   g. Equine caslicks
   h. Large animal dystocia
   i. Large animal fetotomy
   j. Bovine palpation per rectum
   k. Equine palpation per rectum
   l. Large animal vaginal prolapse
   m. Large animal uterine torsion
   n. Large animal AI
   o. Small animal cesarian section
   p. Large animal cesarian section
   q. Other (please specify)

8. Which year of the curriculum is this model primarily used
   a. Year one
   b. Year two
   c. Year three
   d. Year four
   e. Year five

9. Choose all years that the model is used in the curriculum
   a. Year one
   b. Year two
   c. Year three
   d. Year four
   e. Year five

10. What is the course title for the course where this model is primarily used

11. Is this course core (required) or elective

12. Is the model used for technical skills only or in combination with a clinical scenario or professional skills (communication training)
   a. Only technical skills
   b. Used with clinical scenarios
   c. Used with professional skills (communication training)
   d. Other (please specify)

13. Where is the model obtained
   a. Commercial model vendor
   b. Another university's workshop
   c. Created within your institution
   d. Other (please specify)

14. Please enter the name of the commercial vendor

15. Is the model you are using validated in the literature
   a. Yes/no

16. Please enter the citation for the model validation

17. Does the model use cadaver tissues
   a. Yes/no

18. What is the source of the cadaver tissue
   a. In house pathology service/euthanasia of in-house case
   b. Local abattoir/slaughterhouse
   c. Local shelter
   d. Other (please specify)

19. How many of this exact model do you use in the primary course at one time

20. How many students are in the class where this model is used

21. How many students are in the instructional laboratory where this model is primarily used (i.e., 50 students per lab group)

22. How many instructors are in the laboratory where this model is primarily used

23. What is the cost to create/purchase this model (in USD)

24. What is the cost to maintain this model (in USD)

25. Do you use this model as the only experience prior to students going to clinics (clinical rotations) with live animals
   a. Yes, the model is the only experience for this activity
   b. No, a live animal experience follows the use of the model
   c. No, a cadaver experience follows the use of the model

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d. No, a cadaver then a live animal experience follows the use of this model
e. No, another model follows the use of this model
f. Other (please specify)

26. Do you feel this model has improved students' skills
    a. A great deal
    b. A lot
    c. A moderate amount
    d. A little
    e. None at all

27. Do you feel the use of this model can replace use of live animals
    a. A great deal
    b. A lot
    c. A moderate amount
    d. A little
    e. None at all

28. Do you feel you have the expertise to create this model in house, whether by you or others at your institution
    a. A great deal
    b. A lot
    c. A moderate amount
    d. A little
    e. None at all

29. Do you have another model to enter (if yes, questionnaire repeats)

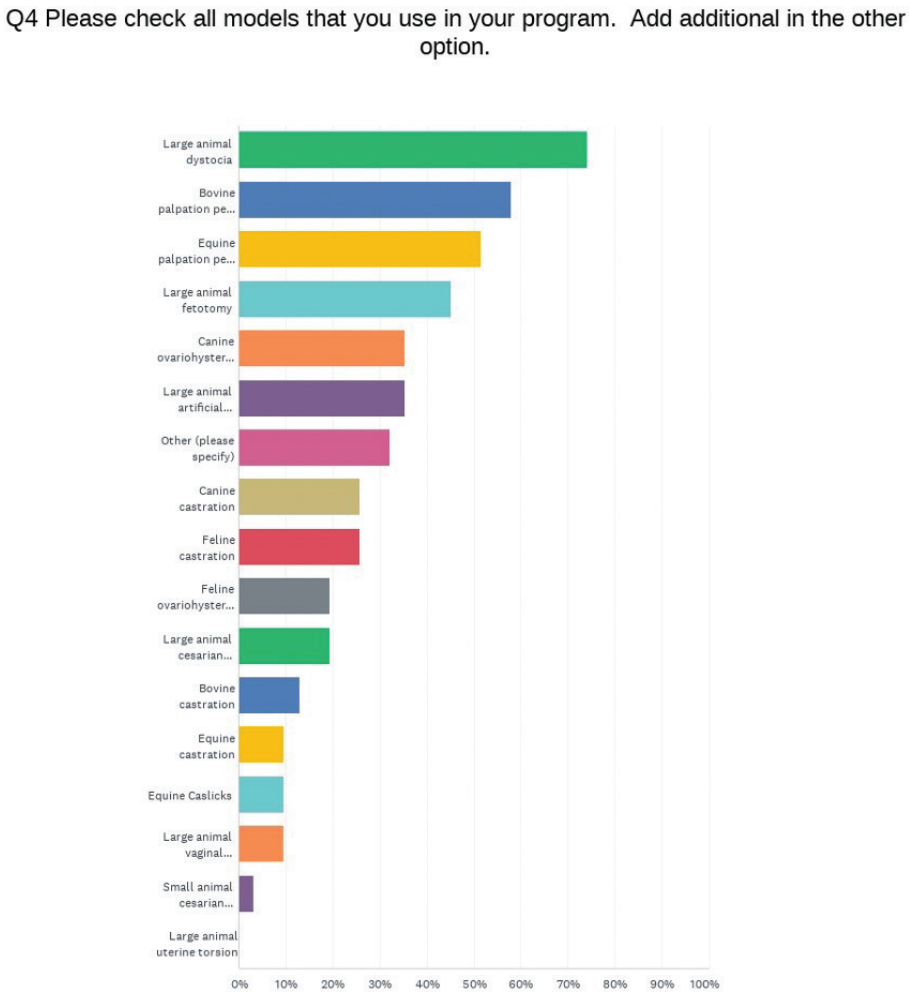

Figure. Percentage of different types of theriogenology models used by respondents.