Development and Evaluation of Two Canine Low-Fidelity Simulation Models

Maria Aulmann ■ Maren März ■ Iwan A. Burgener ■ Michaele Alef ■ Sven Otto ■ Christoph K.W. Mülling

ABSTRACT

Two self-made low-fidelity models for simulation of canine intubation and canine female urinary catheterization were developed and evaluated. We used a study design that compares acquired skills of two intervention groups and one control group in a practical examination. Fifty-eight second-year veterinary medicine students received a theoretical introduction to intubation and were randomly divided into three groups. Group I (high-fidelity) was then trained on a commercially available Intubation Training Manikin (item #2006, VetEffects), group II (low-fidelity) was trained on our low-fidelity model, and group III (text) read a text describing intubation of the dog. Forty-seven fifth-year veterinary medicine students followed the same procedure for training urinary catheterization using the commercially available Female Urinary Catheter Training Manikin (Paws 2 Claws), our self-made model, and text. Outcomes were assessed in a practical examination on a cadaver using an Objective Structured Clinical Examination (OSCE) checklist. Considering a value of \( p \leq 0.05 \) significant, intervention groups performed significantly better than the text groups. Group I (high-fidelity) and group II (low-fidelity) showed no significant differences (\( p = 0.684 \), intubation; \( p = 0.901 \), urinary catheterization). We thereby conclude that low-fidelity models can be as effective as high-fidelity models for clinical skills training.

Key words: evaluation of simulation models, simulation manikin, low-fidelity simulation, low-fidelity model, developing low-fidelity models, clinical skills, OSCE

INTRODUCTION

Veterinary medical education in Germany focuses on acquiring large quantities of theoretical knowledge.\(^1\) Although the Federal Regulation of Veterinary Education and Licensing recognizes the acquisition of practical skills as an essential part of education,\(^1\) opportunities for developing and training these skills are often limited. Overall more than 1,000 students begin their studies in the five German veterinary faculties every year.\(^2\) According to the current regulations, students do not pay fees.\(^3\) Many faculties of veterinary medicine have a relatively restricted budget\(^4\) and are facing ongoing budget cuts. The faculty in Leipzig, for example, was cut by an average of 6% to its operational budget over the last three years. At the same time, according to the objectives of the European Association of Establishments for Veterinary Education (EAEVE), European veterinary curricula are expected to meet the changing demands of the profession and to improve in quality.\(^5\) The use of animals in veterinary medical education has significantly decreased in the past decades.\(^6\) For reasons of financial limitations,\(^4\) animal welfare concerns, and availability,\(^7,8\) live animals cannot always be used for clinical skills training and alternatives must be considered.\(^6\)

In human medical and nursing education, simulation training has played a continuously increasing role in the past three decades.\(^4,9,10\) In 2007, a survey revealed that in Germany, Austria, and German-speaking Switzerland, 33 out of 43 Faculties of Medicine were using a skills lab in their curricula.\(^11\) The use of simulation models is also becoming increasingly popular in veterinary medical education.\(^4,12,13\) Simulation manikins range from low- to high-fidelity models depending on their cost, maintenance level, and degree of fidelity.\(^16\) A low-fidelity model is a simple and often low-cost representation of an animal or a body part\(^16\) such as an infusion tube filled with water used to represent a vessel. In contrast, a high-fidelity model represents the appearance, haptic elements, and functionality as close to reality as possible,\(^16\) in a more complex and often far more expensive way.\(^15\) Many veterinary faculties have started to share pictures of self-made models and tips for building up a clinical skills lab using the platform NOVICE (Network of Veterinarians in Continuing Education).\(^12\) Typing keywords such as “veterinary simulation model, veterinary training manikin” into Google Images reveals that a wide selection of veterinary simulation models are commercially available. Some of these models have a high price, though. Costs of low-fidelity and high-fidelity models differ greatly, for example, from around US$100 (the material costs of our self-made catheterization model) to US$1852.65 (Paws2claws’ Female Urinary Catheter Training Manikin\(^17\)). For this reason, low-fidelity (low-cost) models are being developed and used in veterinary education.\(^18\)
We wanted to know if low-fidelity simulation could be as successful as high-fidelity simulation. In this study our self-made models represent the low-fidelity models and the commercially available models represent the high-fidelity models. Our hypothesis is that training on our self-made low-fidelity models in combination with instructor assistance leads to the same learning outcomes as training on high-fidelity models in combination with instructor assistance. We sought to determine if our simple low-fidelity models were appropriate for clinical skills training; therefore, we measured the learning effects using an OSCE (Objective Structured Clinical Examination) checklist, a widely recognized tool for assessing clinical skills.19

Numerous studies have already illustrated that training on simulation models enhances students' practical skills.8,20–22 Anxiety and stress have adverse effects on learning processes.23 Training in a surgical skills lab before training on live animals has been shown to have an anxiety-reducing effect.24 Simulation training provides a safe learning environment25 and offers the opportunity for repeated training without the risk of harming an animal.13

Intubation and female catheterization were chosen because they are important clinical skills. Anesthesia is always required for intubation training and sometimes also for urinary catheterization. Placing a urinary catheter can be a harmful procedure for the animal. Other training possibilities available for the students would thus be a reasonable alternative. Dealing with resuscitation procedures or breathing difficulties and collecting samples are listed in the recommended “Day-One Skills” of the EAEVE.

MATERIALS AND METHODS
Development of Two Canine Low-Fidelity Models
Our activities focused specifically on the development and evaluation of low-fidelity models as we have a very limited budget at our university. Prior to the development of the models, the process was discussed with the sections of Anesthesiology and Internal Medicine of the Department of Small Animal Medicine, University of Leipzig. The objective was to determine and consider the important elements that the models should feature.

**Canine Endotracheal Intubation Model**
The base of the model is a toy dog.a The representation of the trachea and epiglottis were key features in this model. To form these anatomic structures, several basic materials such as tubes, strings, foam, cotton, and wire (bought at do-it-yourself stores) were used. The inner structures were assembled and fixed inside the toy dog. A zipper was sewed into the stuffed dog’s chest region to allow access to the inner structures for replacement and for providing feedback to the students as required (Figure 1A, 1B).

**Canine Female Urinary Catheterization Model**
The base of this model is again a toy dog.b In this model, the goal was to have a good representation of the urogenital tract, especially the ostium urethrae externum and the urethra. The modeling process was based on the urogenital tract of a cadaver (a German shepherd euthanized for veterinary medical reasons and donated to the Institute of Anatomy, Histology and Embryology for teaching). First a 3D template was created by filling the
urogenital tract with a casting material. After the overnight setting process, the tract was cut open and the template was removed and then fixed into a mold (clay or plastic mold of appropriate size, do-it-yourself store). The mold was then filled with fluid silicone. Finally, the real-life representation of the urogenital tract was removed from the template. A zipper was sewed into the stuffed dog’s pelvic region and the inner structures fixed in the anatomically correct positions (Figure 2A–C).

**Study Design**

In this study, we wanted to evaluate if our self-made low-fidelity models could achieve learning outcomes comparable to those achieved after training on commercially available models. We used a study design that compared the acquired skills of two intervention groups and one control group. The control group (text group) was supplied only with theoretical material (text describing the particular skills) whereas the intervention groups had training sessions (repeated practice of the skills using manikins) on simulation models of different fidelity. All participants then performed a clinical examination on a cadaver to test the transfer of learned skills to a real animal. Participants were assessed using an OSCE checklist. The study design is given in Figure 3.

On the first day, all participants completed a questionnaire that assessed their interest in small animals and their pre-existing practical experiences with these specific skills. The questionnaire focused on whether they had performed an intubation or catheterization before. In this article we selected four central questions and focused on their analysis:

1. Have you had some hands-on training in small animal clinic so far?
2. Have you ever intubated a dog or a cat (Study Intubation)? Have you ever placed a urinary catheter in a female dog (Study Catheterization)?
3. How do you assess your dog handling skills?
4. Would you like to work in small animal clinic after your studies?

The students who had previous experiences with the specific skills (n = 4, n = 2) were separately randomly distributed into the three groups. In accordance to requirements of privacy protection, all subscribed students signed a form confirming that they were participating voluntarily and that they were informed of their right to withdraw from the trial at any time. Furthermore, they agreed to the publication of anonymous results. The ethical review committee of the University of Leipzig approved this study.

**Experimental Study Endotracheal Intubation**

Fifty-eight out of 63 second-year veterinary medicine students (6 male, 52 female) participated in this study (experimental group I [high-fidelity] n = 20, experimental group II [low-fidelity] n = 17, text group n = 21). One participant failed to return the questionnaire. The two training and text reading sessions and the practical examination were conducted at an interval of two weeks respectively. On day one, before participants started the first training session, the entire group received a short theoretical introduction from the head of the anesthesiology section. Then the three groups were divided into three different areas to avoid interaction between them. The students of the text group were encouraged to carefully read the book chapters they were given describing the intubation of the dog through text and images. They had the opportunity to ask questions after reading the chapters and discussed intubation with the first author (Aulmann). Both intervention groups were encouraged to practice with instructor assistance on their respective simulation models. During the second session, the text group read a handout written by the head of the anesthesiology section that summarizes the important steps in canine intubation. During their second training session, each intervention group received further supervision from an anesthetist of the anesthesiology section of the Department of Small Animal Medicine. Participants in the intervention groups discussed intubation with their instructor, who offered them help and support during the training. To ensure consistent training conditions, the instructors of the anesthesiology section discussed the specific teaching and learning objectives. They received a written summary on the day before the first training session and were asked to point out the teaching and learning objectives to the students. We used Vet Effects’ Intubation Training Manikin® as the high-fidelity model for experimental group I and our self-made model as the low-fidelity model for experimental group II.

**Experimental Study Female Urinary Catheterization**

A total of 47 fifth-year veterinary medicine students (7 male, 40 female) participated in this study (experimental group I [high-fidelity] n = 17, experimental group II [low-fidelity] n = 16, text group n = 14). One participant failed to return the questionnaire. The two training and text reading sessions and the practical examination were conducted at an interval of one or two weeks. Due to logistics, the study was conducted within a small animal class. The study was carried out in two blocks, one in spring (n = 26) and the second in summer (n = 21). The results of both blocks were combined.

Participants were divided into three groups as described. During the first session, the students of the text group were encouraged to carefully read the book chapters they were given regarding canine female urinary catheterization through text and images. They had the opportunity to ask questions after reading the chapters and discussed intubation with the first author (Aulmann). Both intervention groups were encouraged to practice with instructor assistance on their respective simulation models. During the second session, the text group read our own handout summarizing the assigned book chapters. Each intervention group was supervised during both training sessions by an experienced veterinarian and a senior.
clinician of the internal medicine section of the Department of Small Animal Medicine. Participants in the intervention groups discussed catheterization with their instructor, who offered them help and support during the training. The instructors briefly discussed the specific teaching and learning objectives before the first training session. We used Paws2claws' Female Urinary Catheter Training Manikin as the high-fidelity model for experimental group I and our self-made model as the low-fidelity model for experimental group II.

Development and Use of the OSCE Checklist
The OSCE checklists were developed by consensus with content experts from the Department of Small Animal Medicine. Pre-existing OSCE checklists that have been used for assessment in recent years (at the Faculty of Veterinary Medicine, University of Leipzig and the Faculty of Veterinary Medicine, University of Calgary) served as a guideline. The checklists include a short information section for the candidate that provides background information on the “patient” and specific instructions on the task that they are expected to perform. Furthermore, they include a short information section for the rater, explaining the assessment with the help of the checklist. Fatal flaws and global rating scores (1 = excellent to 6 = inadequate) were included in the checklists’ grading system. Fatal flaws were defined as flaws that potentially endanger the lives of the animal or veterinarian or present staff. Raters assigned global rating scores as a subjective assessment of the procedure. After committing a fatal flaw, candidates were asked to stop and only the scores they had accumulated to that point were counted. Assessment of reliability was performed to analyze the checklists.30

Figure 2A, B, C: Assembly of the model for female urinary catheterization

Training Manikin as the high-fidelity model for experimental group I and our self-made model as the low-fidelity model for experimental group II.

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**Experimental Study Female Urinary Catheterization**

Assessment took place two weeks after the second training session. Candidates had to demonstrate their acquired skills on a female canine cadaver. The rater was an experienced veterinary anesthesiologist. The rater was blinded to the distribution of participants to the three groups. Participants had 2 minutes to read the “patient” information and instructions, and 5 minutes to perform the task. When committing a fatal flaw, they were asked to stop the procedure. Four fatal flaws were recorded: “failed to control tube position,” “failed to test the cuff’s integrity,” “intubation of esophagus,” and “failed to insert mouth gag.”

**Statistical Analysis**

IBM SPSS® was used for statistical analysis. Significances between the three groups were tested with the Kruskal–Wallis test. The Mann–Whitney U Test was used to test two groups for significant differences. A value of \( p \leq .05 \) was considered significant for both tests. The results from the questionnaire were reported in percentages. OSCE checklist scores were calculated and visualized in boxplots. The reliability of both OSCE checklists was assessed using Chronbach’s alpha. Committed fatal flaws were visualized in bar graphs. The global rating scores of each group were listed and the Spearman correlation coefficient was used to test for correlation between the global rating scores and OSCE checklist scores. A value of \( p \leq .01 \) was considered significant here.

**RESULTS**

**Experimental Study Endotracheal Intubation**

The results of the questionnaire revealed that 82.8% of participants had some previous hands-on training in small animal clinics, 91.4% had never intubated a dog or a cat before, and 87.9% described themselves as familiar with dogs. When asked if they planned to work with small animals after their studies, 15.5% answered “no,” 31.0% answered “yes,” and 51.7% were undecided. The answers given revealed no major differences between the three groups. One participant failed to return the questionnaire.

A maximum score of 22 was achievable on the intubation OSCE checklist. All groups together achieved a mean score of 12.52 and a median score of 13.0. Experimental group I (high-fidelity) reached a mean of 13.76 (minimum 6.5, maximum 22, median 13.75) and experimental group II (low-fidelity) reached a mean of 14.27 (minimum 6, maximum 21, median 14.5). The text group ranged from a minimum of 4 to a maximum of 20.5 and reached a mean of 9.91 (median 9.0). The distribution of the total scores is shown in the boxplot in Figure 4. Experimental group I, experimental group II, and the text group differed significantly (\( p \leq .009 \)). Experimental group I and the text group also differed significantly (\( p \leq .012 \)), as well as experimental group II and the text group (\( p \leq .006 \)). The difference between the results of experimental group I (high-fidelity) and experimental group II (low-fidelity) was not significant (\( p \leq .684 \)). Reliability was \( \alpha = .887 \) for the intubation OSCE checklist.

Participants committed a total of 44 fatal flaws: 17 did not control the position of the tube after intubation, 23 did not check the cuff’s integrity, three intubated the esophagus instead of the trachea, and one failed to insert the mouth gag. Distribution within the groups is shown in Figure 5. One participant stopped the procedure.

The given global rating scores per group are displayed in Table 1.

The Spearman correlation coefficient for the global rating scores and OSCE checklist scores was \( r_s = -0.734 \). The correlation coefficient is negative because the highest attainable global rating score was 1 (excellent) and the best achievable OSCE result was a score of 22. The correlation was strong, which indicates that the OSCE checklist result reflects the global impression of the candidates’ performance.

**Experimental Study Female Urinary Catheterization**

The study was carried out in two blocks, one in spring \( (n = 26) \) and the second in summer \( (n = 21) \). For the statistical analysis, the results of both blocks were combined.

The results of the questionnaire revealed that 95.7% of participants had some previous hands-on training in small animal clinics, 93.6% had never placed a urinary
catheter in a female dog before, 87.2% described themselves as familiar with dogs. When asked if they planned to work with small animals after their studies, 8.5% answered “no,” 55.3% answered “yes,” and 34.0% were undecided. The answers given revealed no major differences between the three groups. One participant failed to return the questionnaire.

A maximum score of 18.5 was achievable in the catheterization OSCE station. All groups together achieved a mean score of 13.55 and a median score of 14.50. Experimental group I (high-fidelity) reached a mean of 14.85 (minimum 9.5, maximum 18, median 14.5) and experimental group II (low-fidelity) reached a mean of 14.56 (minimum 5.5, maximum 18.5, median 15.0). The text group ranged from a minimum of 3.5 to a maximum of 14.5 and reached a mean of 10.82 (median 13.0). The distribution of the total scores is shown in the boxplot in Figure 6. Experimental group I, experimental group II, and the text group differed significantly \((p < .001)\). Experimental group I and the text group also differed significantly \((p < .001)\), as well as experimental group II and the text group \((p < .006)\). The difference between the results of experimental group I (high-fidelity) and experimental group II (low-fidelity) was not significant \((p = .901)\).

Reliability was \(\alpha = .889\) for the catheterization OSCE checklist.

Participants committed a total of 15 fatal flaws: 11 failed to maintain the catheter’s sterility and four positioned the catheter in the anus instead of the vagina. Distribution within the groups is shown in Figure 7. Four participants stopped the procedure themselves.

The given global rating scores per group are displayed in Table 2.

The Spearman correlation coefficient for the global rating scores and OSCE checklist scores was \(r_s = -0.908\). Again, the correlation coefficient is negative because the highest attainable global rating score was 1 (excellent) and the best achievable OSCE result was a score of 18.5. The correlation was very strong, which indicates that the OSCE checklist result reflects the global impression of the candidates’ performance.

## DISCUSSION

We found in both studies that students who had been trained on our low-fidelity models performed slightly, although not significantly, better than students who had been trained on the high-fidelity models we used. The calculated correlations demonstrated that global rating

### Table 1: Results of experimental study intubation: global rating scores according to the group

<table>
<thead>
<tr>
<th>Frequency of global rating scores in experimental study intubation</th>
<th>Text Group</th>
<th>Experimental group II</th>
<th>Experimental group I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>–</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Good</td>
<td>–</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>–</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Poor</td>
<td>9</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Inadequate</td>
<td>9</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Text group: \(n = 21\); Experimental group II (low-fidelity): \(n = 17\); Experimental group I (high-fidelity): \(n = 20\)
scores and OSCE checklist scores were related. Coefficient α was high, which indicates that our checklists had very good reliabilities.30 Our findings suggest that self-made models can be valuable teaching tools and a good low-cost alternative.

Depending on the educational objective and the level of the learners, models of different fidelity can be used. There is a wide range of available simulation models addressing different educational needs, starting with initial training of single technical skills and advancing to clinical scenarios with a complex combination of skills, such as resuscitation.31 When focusing on the training of a specific psychomotor skill, a simple model representing no more than the essential required structures can be chosen to minimize distractions.31 Our low-fidelity models give the opportunity to train a basic psychomotor skill and can therefore facilitate the novices’ learning process. Our study focused on clinical skills training with novice learners. Whether training with models of higher fidelity might be easier for higher semesters needs to be further explored.

Challenges and Limitations of the Study
Like most other veterinary colleges, we have a relatively small number of students (140 per year in Leipzig). Consequently, we had a rather small number of participants per group. Our student population and the group size used are representative for many other colleges. Outcomes of this study should be applicable to the situation in other veterinary schools. We evaluated the skills in only one semester. To explore the range of use in different semesters, further research is required.

One of the difficulties in catheterization is finding the ostium urethrae externum. Our low-fidelity model for catheterization presents a separate access to the “urethra” inside the vagina vestibule whereas the Female Urinary Catheter Training Manikin presents just one way to go. This fact influences the degree of fidelity between what we determined to be a low- or high-fidelity model in experimental study catheterization. Furthermore, due to logistics we could not blind the rater of experimental study catheterization. This might have influenced his perception of candidates’ performances during the OSCE. However, as the OSCE took place two weeks after the second training session, it did not seem to have a major

Table 2: Results of experimental study catheterization: global rating scores according to the group

<table>
<thead>
<tr>
<th>Frequency of global rating scores in experimental study catheterization</th>
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</thead>
<tbody>
<tr>
<td>Text Group</td>
</tr>
<tr>
<td>Excellent</td>
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<tr>
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<tr>
<td>Poor</td>
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<td>Inadequate</td>
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Text group: n = 14; Experimental group II (low-fidelity): n = 16; Experimental group I (high-fidelity): n = 17
We tried to create perceptible air pressure with a two-way valve and two balloons, but the result was not satisfactory. Despite all these limitations, students performed the procedure quite well. In our training sessions, they received immediate feedback by looking into the dog, where it is clearly visible if intubation of the “trachea” or the “esophagus” has taken place.

**Catheterization Manikin**

The fact that our low-fidelity model had just one opening at the back instead one for the anus and one for the vagina seemed to have confused quite a few students by the time they had their practical examination on a cadaver. Building the model, the “bladder” at the end of the “urethra” was a challenge. We tried using balloons but failed to find a reliable way to fix them without leakage. Students again found their way and were able to look inside for immediate feedback. Furthermore the insertion of the speculum is different from reality. Instead of moving dorsally at the beginning and then cranially, the model presents only the possibility of moving cranially. The silicone we used is remarkably tearproof, but nevertheless tore after 200 to 250 usages.

The OSCE results revealed no significant differences between experimental group I (high-fidelity) and experimental group II (low-fidelity). Therefore, the model limitations did not seem to have had an impact on the learning processes. Students seem to have fully used the training opportunity and compensated for missing cues. Furthermore, all kind of models need maintenance. Despite their technical and substantial limitations, our low-fidelity models were remarkably stable and withstood quite intensive training before parts had to be exchanged or repaired.

**CONCLUSION**

We were not able to find significant differences between the two intervention groups (experimental groups I and II). This means that the low-fidelity models we used in our study combined with instructor assistance seem to be as effective as the high-fidelity models when teaching these clinical skills. To distinguish more accurately between the performance levels of the high- and low-fidelity groups would require far more participants across different semesters.

Our results indicate that expensive high-fidelity models are not necessarily needed to obtain good learning outcomes when teaching canine intubation and canine female urinary catheterization. Our findings support other studies showing that low-fidelity simulation and high-fidelity simulation may be comparable tools when teaching practical skills. The quality of simulation must therefore not necessarily be related to high costs.

Low-fidelity simulation is a useful tool to complement traditional education in veterinary medicine. Whenever finances limit a veterinary medical curriculum, affordable low-fidelity models can be a very helpful way to start simulation training. However, low-fidelity simulation requires, in addition to material costs, someone who develops the models, maintains them, and keeps using them for teaching.

**Limitations of the Low-Fidelity Models**

Our low-fidelity models are made of low-cost materials. Despite their simplicity, they seem to be very useful tools for clinical skills training, which confirms what other studies on low-fidelity simulation have found. Still, they do have limitations. Safe positioning of the inner structures has been challenging.

**Intubation Manikin**

The “epiglottis” was built out of a foam tube. This material withstands about 200 usages but then has to be replaced. Other inexpensive materials, such as bicycle tubes, could serve as an alternative. Our low-fidelity model’s “epiglottis” does not have a correlated tongue, which makes intubation with a curved spatula unease. The head of our model is difficult to stretch, which makes intubation with a curved spatula unfeasible. The head of our model is difficult to stretch, which makes intubation with a curved spatula unfeasible. Furthermore it lacks an immediate feedback system for the trainees, such as the floating meter in the Vet Effects Intubation Training Manikin.

Despite these limitations, the results show the same tendency in the low-fidelity group as in the experimental study intubation.

Participants of the intervention groups discussed the topics with their instructors and received support during the training sessions. Participants of the text groups had the opportunity to ask questions and discuss the subject with the first author, although this was probably a less intensive form of support. This might have affected their performance.

Participants committed a conspicuously high number of fatal flaws. This might be explained by the fact that we declared quite a few possible mistakes as fatal flaws. Second, a tight timetable restricted the amount of training every student could obtain. The participants had most problems with checking the cuff’s integrity and controlling the position of the tube after intubation. Mostly, the text group appears to have missed the information about the cuff having to be tested before intubation, although it was clearly described in the given material. Surprisingly, nine candidates out of the high-fidelity group failed to control the tube position. The direct feedback cue of the high-fidelity model could have had an influence on their perception of the importance of this step. In terms of catheterization, mostly the text group struggled with maintaining the catheter’s sterility. This might be a step that has to be trained in particular rather than read in a text. Overall, students seem to have failed to focus on some steps during training, but they also could not practice certain steps due to time and model limitations.

Participants from the first examination group may have revealed information to the participants who were examined on the second day, thereby giving them a possible advantage. However, this is not proved by our data. Experimental study intubation took place within a class where other clinical skills were also trained. For this class we tried to choose skills that require different psychomotor efforts than intubation, but a transfer of skills could have occurred when students trained on other simulation manikins during this class.

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We were not able to find significant differences between the two intervention groups (experimental groups I and II). This means that the low-fidelity models we used in our study combined with instructor assistance seem to be as effective as the high-fidelity models when teaching these clinical skills. To distinguish more accurately between the performance levels of the high- and low-fidelity groups would require far more participants across different semesters.

Our results indicate that expensive high-fidelity models are not necessarily needed to obtain good learning outcomes when teaching canine intubation and canine female urinary catheterization. Our findings support other studies showing that low-fidelity simulation and high-fidelity simulation may be comparable tools when teaching practical skills. The quality of simulation must therefore not necessarily be related to high costs.

Low-fidelity simulation is a useful tool to complement traditional education in veterinary medicine. Whenever finances limit a veterinary medical curriculum, affordable low-fidelity models can be a very helpful way to start simulation training. However, low-fidelity simulation requires, in addition to material costs, someone who develops the models, maintains them, and keeps using them for teaching.
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A poster outlining the upcoming trial was presented at the Young Generation of Veterinary Anatomists 2013 Meeting.

NOTES

a IKEA, Gosig Golden.
b IKEA, Gosig Golden.
c Alabaster modeling plaster, Boesner, Germany.
d Silcolan NV, free-flowing, CT60401, Boesner, Germany.
e Intubation Training Manikin (Item #2006) by Vet Effects and Female Urinary Catheter Training Manikin by Paws2claws.
f IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY.

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