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BENEFITS OF A PAPER-MADE CANINE MANIKIN USED FOR VETERINARY TRAINING AT THE ENTRY-LEVEL

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Abstract

The purpose of this study is to understand how the paper-made canine manikin to teach clinical skills in affecting the learning of the beginning veterinary students. We have made a paper-made canine manikin to teach clinical skills in a step-by-step fashion to beginning veterinary learners. To determine the educational efficacy of this manikin, we then performed a crossover study. Participating subjects were 15 freshmen who were asked to present fundamental clinical skills, (i.e., the sitting or standing restraint; n=eight); as well as advanced clinical skills (i.e., the intramuscular or subcutaneous injection; n=seven). After demonstrating to the evaluating audience a clinical skill, each presenter had ten minutes either to repeat the demonstration or to show a new skill, with the provided manikin and PowerPoint slides. The evaluating audience consisted of a teacher, five final-year veterinary students, and one non- veterinarian. The audience had to rate the performance of each presenter on a 5-point Likert-type scale according to 4 aspects: three on the speaker, i.e., regarding fluency, clarity and stability of the speech, and one on the audience themselves, i.e., regarding their understanding of the speech. Two-tailed Student's t and paired-t tests were used to compare differences of scores obtained before and after using the manikin. Results showed that the manikin usage produced significant improvements ($p<0.001$) in all 4 evaluated aspects (i.e., speakers' fluency, clarity and stability, as well as the audience's understanding). Without the manikin, it was harder to demonstrate how to restrain pets ($p<0.05$). Results showed advantages of using this manikin in teaching clinical skills to beginning veterinary students.

Keywords: animal welfare, mannequin, manikin, simulator, teaching tools, models, veterinary education

Introduction

To assure the health and wellbeing of animals, the World Organization for Animal Health (OIE) proposed that the veterinary training core curriculum should include relevant clinical and diagnostic skills (OIE, 2013). Veterinary teachers need to give students enough opportunities in hands-on practice to improve clinical skills of their students. However, scheduling inexperienced first year veterinary clinical students, (who in Taiwan would be in their 3rd year curriculum) to skill-practice with live animals might actually harm animals. Media supports in the form of oral instructions, photos and videos are becoming the mainstream educational materials. The pitfall of this media-based approach is the consequence of providing little practical experience to students. Students with insufficient practical experiences will likely be least confident in performing the taught clinical skills when encountering their first animal patient (Lofstedt, 2003).

Miller in 1954 was the first to use simulators as a teaching aid (Miller, 1954). The primary advantage of simulation-based learning is on the one hand to develop professional knowledge and skills of students, and on the other hand without imposing risk to animals used for practice (Lateef, 2010). There are currently 6 types of simulation devices: (a) part task trainer, (b) computer-based system, (c) virtual reality and haptic system, (d) simulated patient, (e) simulated environment, and (f) integrated simulator (Maran and Glavin, 2003). According to this classification, our paper-made canine manikin can be considered a part task trainer. The manikin itself is relatively inexpensive so a school can easily acquire multiple sets of the manikin (Maran and Glavin, 2003). Dependent on the manikin's approximation to reality, it is divided into 4 levels - from low to high - based on the fidelity of simulation (Maran and Glavin, 2003). High-fidelity simulators have better results (Munshi et al., 2015). But some reported that even low-fidelity simulators could achieve good educational purpose comparable to those of high-fidelity simulators (Matsumoto et al., 2002; Lee et al., 2008; De Giovanni et al., 2009). A study based on a prospective randomized design also reported that for naive learners, low-fidelity simulators can achieve the same or even better educational purposes (Maran et al., 2003, Grober et al, 2004). As long as repetitive practice and curriculum integration are fulfilled, simulators are able to achieve the prescribed educational purpose regardless the levels of fidelity (Barry et al., 2005). Thus, teachers should choose simulators of proper fidelity levels to suit their desired educational purpose (Grady et al, 2008).

A manikin used in teaching is a life-size model with some simulated organs. Manikins are used widely in medical or veterinary medical education (Holmberg et al., 1993; Lateef 2010; Tefera 2011; Cardoso et al., 2012; Baillie et al., 2005; Biggs, 2011; Ziv et al., 2006). In veterinary medical education, a canine abdominal surrogate was developed to teach surgery (Holmberg et al., 1993). A simulator for teaching rectal examination was developed in 2005 (Baillie et al., 2005). Haptic cow, a simulator developed for teaching palpation of bovine uterus, has been successfully used in veterinary undergraduate training (Baillie et al., 2005). Virtual reality-equipped simulators have also been used to improve teaching skills in artificial insemination (Cardoso et al., 2012). Above- mentioned simulators are manufactured for teaching advanced clinical skills. As most of them are expensive commercialized products, they are less popular here in Taiwan, due to high costs and shipping restrictions. Those low-cost simulators that can be purchased are not always well-built and need additional personnel and budgets to maintain (Lateef, 2010). For educators in Taiwan, having to purchase new simulators regularly for small groups of students or to use live dogs for practice are not practical given the tight budgetary conditions of veterinary schools the legal needs to respect animal welfare.

A good simulator needs to satisfy certain criteria (Biggs, 2011; Ziv et al., 2003; Eichel et al, 2013; Kinight, 2007) as described below. Firstly, it should be of a good quality and can be accessed easily (Biggs, 2011). Secondly, it should accommodate both the 3'R's (replacement, reduction, and refinement) and dog welfare principles (Ziv et al., 2003; Eichel et al., 2013; Knight, 2007). Thirdly, a good simulator allows students develop their clinical skills, and to equip them with the proper professional knowledge, skills and attitude (Lofstedt, 2003) in facing their first real patient at a later stage of their career.

In the present study, we sought to determine whether the paper-made canine manikin can help students learn fundamental and advanced clinical skills. Our alternative hypothesis is that the paper-made canine manikin does not help in teaching these clinical skills.

Materials and methods

Figure 1. shows the different versions of finished canine manikins.

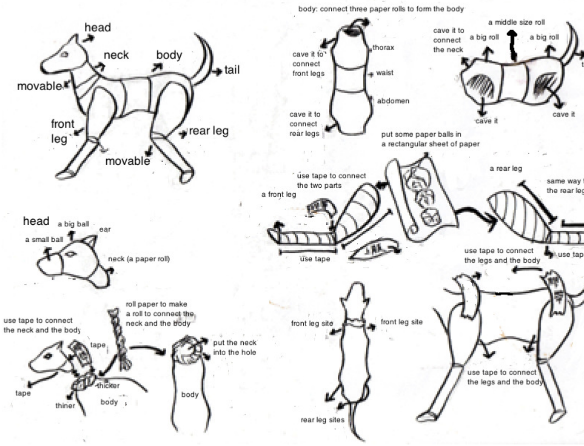

Figure 2. illustrates how the manikin is made.

Figure 2 indicates the design diagrams of the paper-made canine manikin illustrated with the step-by-step procedure on making it. 1) Two paper boli forming the head and nose; and a paper roll forming the neck. 2) Three paper rolls forming the body. 3) Joining the head and body with adhesive tapes, allowing flexible movements. 4) A few paper balls rolled inside a rectangular piece of paper forming each leg. 5) Compositing the front and hind legs. 6) Joining together with adhesive tapes, the head and neck, the body with the front and hind legs.

Setting and participants

As volunteer subjects for this study, we recruited 15 first-year veterinary students with no previous experience in clinical courses. Of these students, one group (n=7 students) was each asked to explain how to perform fundamental clinical skills (such as sitting restraint or standing restraint), while the other group (8 students) was each asked to explain the steps of performing advanced clinical skills (such as intramuscular injection or subcutaneous injection). In this study, non-invasive clinical skills were defined as fundamental skills, while invasive skills were defined as advanced skills. The fundamental clinical skills demonstrated by the two groups of students were very similar, so were their advanced clinical skills (as judged by the expert teachers).

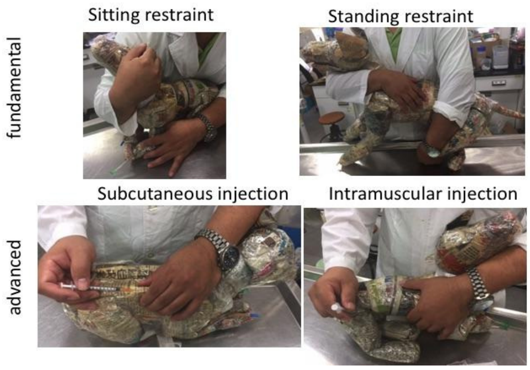

Figure 3. shows these four types of skills.

Experimental design

A prospective randomized crossover design was used (Tan et al., 2012; Penn State Eberly College of Science, 2018). In essence, this is a design of repeated measurements (Penn State Eberly College of Science, 2018). Each volunteer performed clinical skills in different ways during the presentation period. This differs from a parallel design in which throughout the trial period, volunteers are randomized in performing a clinical skill either with or without the mannikin. In our study, each student was given 10 minutes to prepare for their first presentation, and to demonstrate skills step by step without the manikin. They were then given another 10 minutes to prepare demonstrating the same level of skills with the manikin.

Measurement and statistical methods

The evaluating audience consisted of one veterinary professor, one non-veterinary postgraduate, and 5 final-year veterinary students. A successful and effective presentation contains 4 aspects or elements (Doumont, 2010): 1) what the speaker says, in which the verbal issue is measured by the term "fluency", 2) how the speaker says, in which the vocal issue is measured by the term "clarity", 3) how confident the speaker tries to persuade the audience, which is measured by the term "stability", and 4) what the audience can see, in which the degree of understanding by the audience is measured by the term "understanding". The audience scored the 4 aspects of a speech using a 5 Likert scale, where 1 stands for very bad, 2 for bad, 3 for fair, 4 for good and 5 for very good. Scores between the two presentations by the same presenter were compared using a two tailed paired t- test. Scores between the two clinical skills were also compared with a two tailed Student t-test. With p <0.05, the null hypothesis was accepted. The alternative hypotheses were 1) the manikin improves the speaker's fluency, clarity and stability, 2) the manikin helps audience better understand the presentation.

Results

Comparisons between fundamental and advanced clinical skills before using the manikin

Before using the manikin, for 7 speakers presenting fundamental skills, their scores were as follows: fluency 2.50±0.56, clarity 2.50±0.55, stability 2.38±0.50 and understanding 1.50±0.53 (Table 1). Similarly, for 8 speakers presenting the advanced skills, their scores were: fluency 3.51±0.17, clarity 3.43±0.25, stability 3.23±0.18, and understanding 2.75±0.22. Two tailed Student t test showed only score differences in fluency are statistically significant (p=0.03). Regarding other aspects: i.e., clarity (p=0.31), stability (p=0.06), and understanding (p=0.06) were all similar between the fundamental and advanced clinical skills.

Table 1. Points evaluated by the audience on presentations of subjects according to the fundamental and advanced clinical skills before and after using the manikin. The 4 aspects rated are speaker's fluency, clarity, stability and listeners' understanding. Means and standard errors (SE) are listed. In addition, the differences in points obtained before (First) and after (Second) using the manikin are also listed, along with *p* values of their comparisons.

	Fluency	Clarity	Stability	Understanding
Before using the manikin				
Fundamental skills (*n*=8 subjects)	2.50±0.56	2.50±0.55	2.38±0.50	1.50±0.53
Advanced skills (*n*=7 subjects)	3.51±0.17	3.43±0.25	3.23±0.18	2.75±0.22
After using the manikin				
Fundamental skills (*n*=8 subjects)	2.75±0.52	2.63±0.53	2.88±0.48	3.75±0.39[*,a]
Advanced skills (*n*=7 subjects)	3.77±0.17	3.71±0.23	3.67±0.20	3.73±0.19[*,a]

a: difference of the same skill set compared between scores before and after using the manikin. *: *p* <0.05.

Comparisons between fundamental and advanced clinical skills after using the manikin

After using the manikin for teaching, the scores on fundamental skills from the same groups of speakers were: fluency 2.75±0.52, clarity 2.63±0.53, stability 2.88±0.48 and understanding 3.75±0.39 (Table 1). And for the advanced skills, the scores were: fluency 3.77±0.17, clarity 3.71±0.23, stability 3.67±0.20, and understanding 3.73±0.19. Using two tailed Student t test, speakers performed better in advanced skills, based only on fluency scores (p=0.03), with no changes in other three aspects: clarity (p=0.06), stability (p=0.11) and understanding (p=0.94).

Comparisons before and after the manikin use on presentation scores for the fundamental and the advanced clinical skills

Table 2 shows the scores of the first presentation (without manikin) and second presentation (with manikin), together with their statistical comparisons. Overall, the scores after using the manikin were significantly higher than those without (p<0.001). Both fundamental skills and advanced skills showed significant improvements over all the 4 aspects - i.e., fluency, clarity, stability, and understandability (Table 2).

Table 2 Points evaluated by the audience on presentations of subjects according to the fundamental and advanced clinical skills before and after using the manikin. The 4 aspects rated are speaker's fluency, clarity, stability and listeners' understanding. Means and standard errors (SE) are listed. In addition, the differences in points obtained before (First) and after (Second) using the manikin are also listed, and *p* values of their comparisons shown.

	First±SE	Second±SE	Difference±SE	*p* value
Total (*n*=15 subjects)	12.32±0.68	16.14±0.57	3.82±0.50	<0.0001
Level 1 (*n*=8)	9.38±2.10	16.38±1.70	7±1.26	=0.001
Level 2 (*n*=7)	13.11±0.64	16.26±0.58	3.15±0.48	<0.0001
Fluency (*n*=15)	3.30±0.18	3.55±0.18	0.25±0.09	=0.006
Clarity (*n*=15)	3.23±0.49	3.48±0.52	0.64±0.04	=0.014
Stability (*n*=15)	3.05±0.46	3.48±0.52	0.43±0.07	=0.001
Understanding (*n*=15)	2.75±0.42	3.72±56	0.98±0.15	<0.0001

Scores given by different professional members in the evaluating audience

Scores given by various groups of the evaluating audience (i.e., professor, senior veterinary students and non-veterinary students) are compared in Table 3. The teacher scored an improvement on the speaker’s stability with the use of manikin (p<0.05). The final year students scored an improvement on the speaker’s fluency (p<0.05).

In summary, after using the manikin, all presenters received higher scores, while the audience also had a better understanding. the results of Table 5, CR of the two latent variables in ERB scale is above .90 and values of Cronbach's alpha is above .80. This shows the scale has a high reliability. In terms of validity, factor loading of each observed variable are all more than .80. AVE of each latent variable are also more than .70. This means that there is a good convergent validity.

Table 3 Differences of points evaluated on the 4 aspects (or components) of presentations (fluency, clarity, stability, and understanding) before and after using the manikin are listed separately for the three groups of audience: teacher, final year students, and non-veterinarian (*n*=15 subjects).

	ΔFluency±SE	ΔClarity±SE	ΔStability±SE	ΔUnderstanding±SE
Teacher	0.25±0.17	0.18±0.16	0.63*±0.24	1.75^{*}±0.23
Final year students	0.29^{**}±0.12	0.19±0.14	0.29±0.17	0.43^{*}±0.21
Non veteri-narian	0.14±0.14	0.57±0.20	0.43±0.20	0.86^{*}±0.34
All evaluators	0.25^{**}±0.09	0.64*±0.04	0.43^{**}±0.07	0.98^{*}±0.15

Δ: score difference between before and after using the manikin, SE: standard error, *: $p<0.05$, **: $p<0.01$

Discussion

Using the paper-made manikin, significant improvements of presenting learners were found in scores of all 4 aspects we had evaluated. The paper-made canine manikin therefore helped in teaching. Results are important since a clear presentation is highly related to student learning (Donald et al., 1986). A good presentation allows the audience to grasp a good idea of contents. Effective educational materials must also be easy to understand (Doumont, 2014).

In this study, an interesting finding is the speakers could present the advanced skills more fluently and clearly. When the skill contents were reviewed, the procedure to perform intramuscular injection is more easily understood. The basic principle of an intramuscular injection is to insert a syringe needle into a muscle. The steps of performing sitting restraint requires proper postures and gestures.

Without the use of manikin, it is harder to imagine how to restrain an animal.

After the manikin had been used for teaching, listeners were able to better understand the skills. Results showed that naive students did not really need a high-fidelity simulator to show educational benefits. Our results are also consistent with the report that when a manikin is used in line with its educational goal, its outcome can be satisfactory (Munshi F et al., 2015).

People in general, consider that it is better to practice fundamental clinical skills using live or real animals. However, it is impractical to prepare many pets in a small classroom as animals may fight with one another and might make excessive noises to disturb the class. A simulator, if can function like a real animal, can overcome these problems. Previous studies suggested that simulator uses can strike a balance between educational needs and animal welfare (Capile et al., 2015; Ziv et al., 2003). For example, students are happy to practice prostate examination with a simulator because no animals suffer from the procedure (Capilé, et al. 2015). Simulators also ensure safety of trainees, trainers, and animals (Ziv et al., 2003). Nowadays, a lot of monetary resources are being spent in developing hi-fidelity simulators. For naive students, a low-fidelity simulator is sufficiently good in practice (Munshi, 2015)

The crossover design used in our study has the advantage of requiring a smaller number of subjects to yield a more efficient comparison of treatments, than a parallel design, while maintaining the same level of statistical power. Its disadvantage is that carryover effects may be confounded with direct treatment effects. In order to prevent the bias caused by different skills or different presenters, the paired-t test was applied. It is efficient to reduce the bias caused by a single subject. Therefore, a significant difference could be obtained without a bigger sample size (PennState Eberly College of Science, 2018).

The benefit of simulators is the effectiveness of learning (Knight, 2007; Patronek and Rauch, 2007). A low-fidelity simulator, like our paper-made canine manikin, is helpful to provide a balance between training cost and animal welfare. The flexibility of modification of this paper-made simulator allows students to practice the more difficult clinical skills. For example, students can perform tracheal intubation after a little modification, as the "first do no harm" principle is widely emphasized (Ziv et al., 2003). Our simulator is easy to handle, manage, modify and repair and our results showed that it is a good simulator.

We therefore concluded that this paper-made canine manikin can help teachers teach learners and audience, and facilitate better understanding of these clinical skills.

Reference

Baillie, S., Mellor, D.J., Brewster, S.A, & Reid, S.W. (2005). Integrating a bovine rectal palpation simulator into an undergraduate veterinary curriculum. *J Vet Med Educ. 32*(1), 79-85.

Barry, Issenberg, S., McGAGHIE, W.C., Petrusa, E.R., Lee, Gordon, D. & Scalese, R.J. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. *Med Teach. 27*(1), 10-28. doi: 10.1080/01421590500046924

Biggs,. J.B. (2011). Teaching for quality learning at university: What the student does. McGraw-Hill Education (UK). p. 29.

Capilé, K.V., Campos, G.M., Stedile, R. & Oliveira, S.T. (2015). Canine prostate palpation simulator as a teaching tool in veterinary education. *J Vet Med Educ. 42*(2), 146-50. doi: 10.3138/jvme.1214-120R1. Epub

Cardoso, A., Júnior, E.A.L., & de Mattos, Faro, A. (2012). The use of virtual reality for simulation and training of bovine artificial insemination with haptic devices. In Virtual and Augmented Reality (SVR). 14th IEEE Symposium on,

p. 66-73.

Doumont, J., ed. Unit 4: Giving Oral Presentations In:English Communication for Scientists. Cambridge, MA: NPG Education, 2010. Last Updated: January 17, 2014 https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/giving-oral-presentations-14239332

Eichel, J.C, Korb, W., Schlenker, A., Bausch, G., Brehm, W. & Delling, U. (2013). Evaluation of a training model to teach veterinary students a technique for injecting the jugular vein in horses. *J Vet Med Educ. 40*(3), 288-295. doi: 10.3138/jvme.1012-09R1.

De Giovanni, D., Roberts, T. & Norman, G. (2009). Relative effectiveness of high-versus low-fidelity simulation in learning heart sounds. *Med Educ. 43*(7), 661-668. doi: 10.1111/j.1365-2923.2009.03398.x.

Grady, J.L., Kehrer, R.G., Trusty, C.E., Entin, E.B., Entin, E.E. & Brunye, T.T. (2008). Learning nursing procedures: The influence of simulator fidelity and student gender on teaching effectiveness. *J Nurs Educ. 47*(9), 403-408.

Grober, E.D., Hamstra, S.J., Wanzel, K.R., Reznick, R.K., Matsumoto, E.D., Sidhu, R.S. & Jarvi, K.A. (2004). The educational impact of bench model fidelity on the acquisition of technical skill: the use of clinically relevant outcome measures. *Ann Surg. 240*(2), 374.

Holmberg, D.L., Cockshutt, J.R. & Basher, A.W.P. (1993). Use of a dog abdominal surrogate for teaching surgery. *J Vet Med Educ. 20*(3). http://scholar.lib.vt.edu/ejournals/JVME/V20-3/holmberg.html

Knight, A. (2007). The effectiveness of humane teaching methods in veterinary education. *Altex. 24*(2/07), 91. http://www.altex.ch/all-issues/issue/2-07/the-effectiveness-of-humane-teaching-methods-in-veterinary-education

Lateef, F. (2010). Simulation-based learning: Just like the real thing. *J Emer Trauma Shock. 3*(4), 348. doi: 10.4103/0974-2700.70743.

Lee, K.H.K., Grantham, H. & Boyd, R. (2008). Comparison of high-and low-fidelity mannequins for clinical performance assessment. *Emerg Med Australas. 20*(6), 508-514. doi: 10.1111/j.1742-6723.2008.01137.x.

Lofstedt, J. (2003). Confidence and competence of recent veterinary graduates—Is there a problem? Can *Vet J. 44*(5), 359. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC340128/

Matsumoto, E.D., Hamstra, S.J., Radomski, S.B., & Cusimano, M.D. (2002). The effect of bench model fidelity on endourological skills: a randomized controlled study. *The J Urol. 167*(3), 1243-1247.

Maran, N.J., & Glavin, R.J. (2003). Low-to high-fidelity simulation–a continuum of medical education? *Med Educ. 37*(s1), 22-28.

Miller, R., (1954). Psychological considerations in the design of training equipment. Report no. WADC-TR-54-563, AD 71202. Wright Patterson Air Force Base, OH; Wright Air Development Center. Wright-Patterson Air Force Base.

Munshi, F., Lababidi, H., & Alyousef, S. (2015). Low-versus high-fidelity simulations in teaching and assessing clinical skills. *J Taibah Univ Med Sci. 10*(1), 12-15.

OIE (2013). Veterinary education core curriculum OIE guidelines. http://www.oie.int/Veterinary_Education_Core_Curriculum.pdf , accessed date: 2017/10/15

Patronek, G.J., & Rauch, A. (2007). Systematic review of comparative studies examining alternatives to the harmful use of animals in biomedical education. *J Am Vet Med Assoc. 230*(1), 37-43. doi: 10.2460/javma.230.1.37

PennState Eberly College of Science (2018). Lesson 15 Crossover design In: Design and analysis of clinical trials. https://onlinecourses.science.psu.edu/stat509/node/123. Accessed date: 2017/10/15.

Tan, S.C., Marlow, N., Field, J., Altree, M., Babidge, W., Hewett, P., & Maddern, G.J. (2012). A randomized crossover trial examining low-versus high-fidelity simulation in basic laparoscopic skills training. *Surg Endosc. 26*(11), 3207-3214. doi: 10.1007/s00464-012-2326-0

Tefera, M. (2011). Surgical dummy: a surrogate to live animal in teaching veterinary surgery. *Ethiop Vet J. 15*(2), 1-10. doi: 10.4314/evj.v15i2.67690

Ziv, A., Wolpe, P.R., Small, S.D., & Glick, S. (2006). Simulation-based medical education: an ethical imperative. *Simul Healthc. 1*(4), 252-256. doi: 10.1097/01.SIH.0000242724.08501.63.