Large Animal Training for U.S. Army Veterinary Services Soldiers in Europe

An Experiential and Collaborative Approach

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Abstract

U.S. Army veterinary services delivers public health services for companion animals and livestock yet continuously needs to train soldiers to optimize skills and veterinary readiness. We designed an experiential and collaborative large animal (sheep, cattle, horse) training program in the United Kingdom for Public Health Activity–Italy soldiers (from England, Germany, Italy, Spain, and Türkiye). This training targeted specific tasks and incorporated environmental influences, animal handling, and livestock disorders and assessments. Eight veterinarians (64F/A) and 24 animal care specialists (technicians) (68T) participated and completed pre-/postevaluations. An independent sample t test with a nonparametric Mann-Whitney U test was used to determine if changes in knowledge, skills, and abilities occurred. For livestock behavior and handling questions, technicians always reported significant positive changes and veterinarians for 50% of questions. For examination and treatment questions, technicians always reported significant positive changes and veterinarians for 80% of questions. For environment, nutrition, and body condition questions, technicians always reported significant positive changes and veterinarians for 75% of questions. For internal and external parasite questions,

technicians and veterinarians always reported significant positive changes. The magnitude of change was always two times greater for technicians. Fourteen participants stated that hands-on portions were most useful (61%). Future training needs to include blood collection and analysis, injections, trimming hooves, zoonotic diseases, necropsy, and feed and slaughter inspection.

The U.S. Army Veterinary Corps was officially established as a part of the Army Medical Department with the passage of the National Defense Act of 1916. However, the need for the treatment of animals in military service was recognized by Gen. George Washington in the Continental Army (1775–1783). At the beginning of World War I, there were only 72 veterinary officers in the Army and no enlisted soldiers. The Overman Act of 1917 allowed for the expansion of veterinary personnel, including enlisted soldiers, and it peaked at 2,234 veterinarians and 18,007 soldiers (Coates & Caldwell, 1961). These veterinarians and soldiers cared for over 481,000 horses and mules, inspected 1.26 billion pounds of meat and dairy products, and condemned 11 million pounds. During World War II, veterinarian strength peaked at over 2,100 and between 6,000 to 8,000 soldiers, who cared for 56,000 horses and mules and inspected over 142 billion pounds of meat and dairy products. This is a significant change in scope due to the shift to mechanized warfare but also to the volume of soldiers. In the China-Burma-India theater, veterinarians inspected whole herds of animals as U.S. forces had to live off the land. Due to rinderpest, foot-and-mouth disease, and anthrax, numerous animals were rejected (Derstin, 1991). Today, Army Veterinary Services is composed of approximately 2,580 soldiers (700 veterinary corps officers, 80 food safety warrant officers, 1,800 68T animal care specialists, and 68R veterinary food inspection specialists), fewer than 400 horses, and the auditing responsibilities at more than 1,600 facilities around the world.

Throughout its history, the mission of Army Veterinary Services has largely remained the same. Special Regulations No. 70, 15 December 1917, *Special Regulations Governing the Army Veterinary Service*, defined two focus areas. The first was "to protect the health and preserve the efficiency of the animals of the Army"; and the second was to "also provide for the inspection of meat-producing animals before and after slaughter and of dressed carcasses; and for the inspection of dairy herds supplying milk to the Army." (AMEDD Center of History & Heritage, 2024). Beginning with the 1922 version of Army Regulation 40-2005 and remaining through the end of World War II, the mission further clarified duties in both peace and war and the provision of food for soldiers, as stated, "is charged in peace and war with duties falling under two definite heads: First, those in connection with the animals of the Army; second, those connected with the food supplies of troops that are of animal origin" (Coates & Caldwell, 1961, p. 17). Today, the Army is the Department of Defense's executive agent for providing veterinary public and animal health services.

As such, veterinary services are charged "to plan and deliver food protection, animal health and welfare, veterinary public health, training, research, development, testing, and evaluation across a range of military operations" (Department of Defense, 2013, pp. 1–2).

Clearly the modern mission of the U.S. Army Veterinary Services has evolved as military technology has moved from animal-based combat (i.e., the reliance on horses for transport and attack) to machines and computers (Bielakowski, 2000; Hendrix, 1993). Further, the rules of engagement have changed, international conflicts have varied, and global supply chain and connectedness have grown. The growth of international commerce and transmission also requires that an enhanced inspection and surveillance program is in place to reduce or avoid the transmission of problematic insects and disease pathogens (Burke et al., 2012; Calkins & Scasta, 2020; Dudley, 2004). Tasks have therefore required that U.S. Army veterinarians and animal care specialists, henceforth "technicians," have an enhanced understanding of the social and environmental context of animals. This enhanced understanding ensures that they can continue to provide critical animal care and also surveille, inspect, and communicate about diverse and ever-changing food animal needs in addition to providing support to military working dogs. This complex modern mission requires innovative and interdisciplinary training that is learning-centric (Williams, 2020). Ideally, such training would employ diverse teaching methods including delivery of technical details via lecture, teaching from multiple subject-matter experts (Diezmann & Watters, 2015), experiential learning (Barron et al., 2017), critical thinking with a framework for future duties (Parenteau, 2021), and problem-solving (Dale et al., 2008).

Given the modern evolution of the U.S. Army Veterinary Services' mission and training needs, we designed targeted hands-on learning opportunities in the European context through a collaboration among the U.S. Army Veterinary Services' Public Health Activity–Italy, University of Wyoming (UW), Scotland's Rural College (SRUC), and the British Army's Household Cavalry. This integrated training curriculum targeted specific tasks and was designed to understand the environment in which these animals exist, the influence of the environment on animal health, how to handle animals, and how to conduct specific tasks and techniques. Implications of this project will inform future training for U.S. Army Veterinary Services to develop a modern and globally ready force with contextually relevant competencies (Brou et al., 2022).

Materials and Methods

Specifically, we designed an experiential training opportunity focused on sheep, cattle, and horses. The idea for the training emerged after Calkins completed a long-term health education and training program at UW that included research on livestock pathogens, parasites, and toxic plants. In these research endeavors (and under

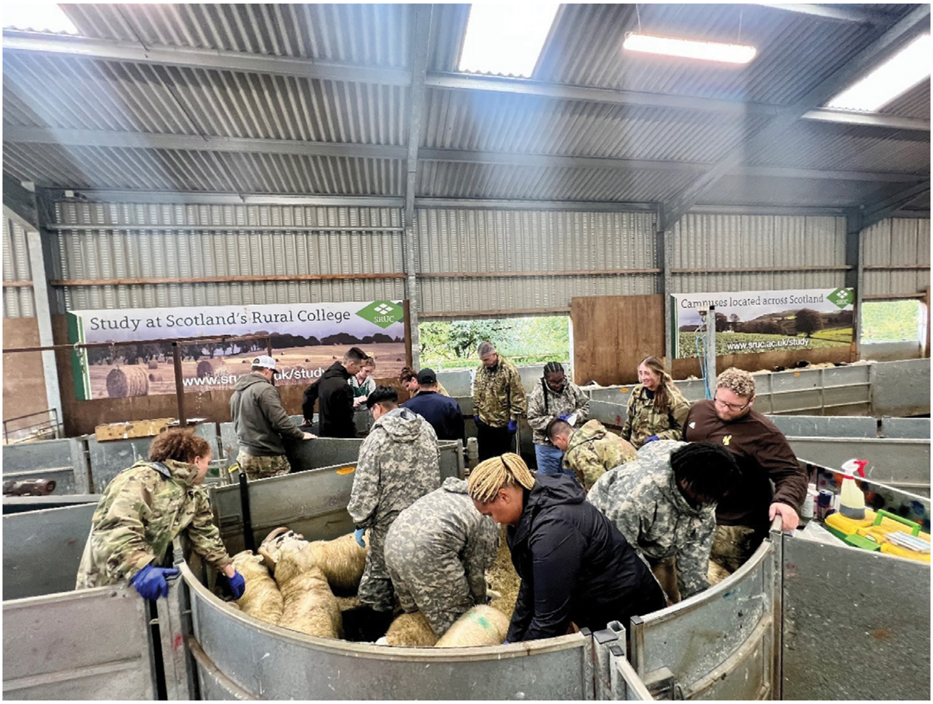
UW Institutional Animal Care and Use Committee approval as appropriate), Calkins analyzed disease data from public databases. Additionally, he analyzed collected cattle weights, blood from the coccygeal vein for hematology profiles, vital rates, ultrasounds, and invited a veterinary detachment from Fort Carson, Colorado, to assist, where they received hands-on training (Calkins, 2020; Calkins & Scasta, 2020; Calkins et al., 2021). In addition, Calkins assisted other UW graduate students with sheep research in which the team measured growth performance and body weight changes, rectal fecal collection, and blood collection from the jugular vein. These Long-Term Health Education and Training (LTHET) opportunities facilitated the development of this training idea for active-duty U.S. Army veterinarians and technicians.

Collaboration among the Public Health Activity–Italy, UW, SRUC, and the Household Cavalry Regiment was initiated to design targeted hands-on learning opportunities in the European context (i.e., the specific regulatory context for disease, medicine, approval, and reporting that is unique to Europe and the European Union). Training curriculum targeted specific tasks and was designed to understand the environment in which these animals exist, the influence of the environment on animal health, how to handle animals, and how to conduct specific tasks and techniques listed in the 68T individual critical task list (ICTL). ICTLs are skills identified by the Army for the maintenance of combat readiness in each military occupational specialty. Skill level 10 68Ts (E–E4) are responsible for mastering 105 ICTLs, of which 13 (12.38%) of the tasks are specific to large animals. Tasks range from performing physical restraint, physical examinations, administering oral and intravenous medications, to providing hoof care, taking radiographs, and providing first aid for equine colic (potentially a life-threatening gastrointestinal problem). Understanding the environment is important for an enhanced understanding of problems with animal productivity, disease and parasite exposure, physical capabilities, immunity, and reproduction potential. This will assist soldiers with not only treating symptoms but also causes of disorders.

A total of eight veterinarians and 24 technicians participated fully in the training and completed pre- and postevaluations. Other attendees included three veterinarians and technicians that assisted in setting up the training as well as two higher ranking Army officials. We used a combination of teaching strategies to meet various student learning preferences (Driver, 2021), including lecturing, live animal demonstrations, experiential opportunities to handle livestock, team tasks that required the use of specific techniques, and two retrospective problem sets (see Figure 1). This combination of teaching strategies correlates with cognitive learning theory proposed by Bloom (1956) and the increasing complexity of learning that scaled from knowledge (addressed by introductory lectures) to application (addressed by hands-on tasks), and ultimately to synthesis (addressed by retrospective problem sets). All animal handling for educational and training purposes was approved by the SRUC-Animal Experiments Committee on 15 August 2023 (Protocol

Figure 1

29 August 2023, Scotland's Rural College Hill and Mountain Research Centre-Crianlarich, Scotland



Note: Soldiers from Public Health Activities–Italy and Rhineland Pfalz, and the 64th Medical Detachment (Veterinary Service Support) along with professors from the University of Wyoming perform comprehensive physical examinations and FAMACHA© scoring to assess internal parasitism levels. Sheep are sorted into smaller groups to allow for ease of handling and to reduce animal stress. (Photo by Maj. Craig Calkins, U.S. Army)

Identification: BOR 2023-018 MIX A00). To measure the efficacy of the training, we administered a participant evaluation at the beginning of the training ("pre") and at the conclusion of the training ("post") (approved by the UW-Institutional Review Board as exempt for human subjects research on 18 August 2023). The evaluation included 22 questions assessing either knowledge or ability/application with a five-point Likert scale (1 = "Strongly Agree," 2 = "Agree," 3 = "Neutral," 4 = "Disagree," 5 = "Strongly Disagree"). In addition, three open-ended questions were asked about what was the most useful, how could the training be improved, and what additional topics should be covered.

Day 1. The training started at the SRUC Hill and Mountain Research Centre near Crianlarich, Scotland. After introductions, a safety briefing was provided as well as an overview to provide clarity of purpose. At this point, we administered the baseline or preevaluation. A sheep gathering demonstration was then provided by SRUC staff that used two trained working dogs and three personnel to bring the flock into the barn with an ad hoc discussion about animal movement and how to optimally position oneself. We then moved to the pasture sites (improved pasture, cultivated pasture, and rangeland) representative of forage resources used in grazing systems where presentations regarding types of plants, forage production, poisonous plants, and grazing animal nutrition were delivered by SRUC and UW staff. Participants were able to examine pastures, identify plants, and interact with subject-matter experts from SRUC and UW individually or in small groups. We then moved into the sheep barn and handling facilities and discussed principles of animal handling facility design and animal movement (by hand, with traditional panels and gates, and with a belt conveyor system) and concepts of flight zones and points of balance, which was followed by a presentation about sheep body condition scoring by UW staff. Additional emphasis was placed on designing temporary handling facilities to simulate in-field conditions where resources may be limited. We then split participants into three smaller groups to allow for hands-on learning including (1) group-pen handling and restraint basics, (2) processing sheep through a typical alley/raceway for body condition scoring (Thompson & Meyer, 1994), and (3) to work sheep through the conveyor system and examine sheep generally including feet. We concluded the day with a hypothetical scenario problem set about animal handling facility design and environmental considerations on nutrition and animal well-being. Soldiers had to consider the task of procuring 400 lambs from a north African country in an extensive pasture with limited forage. Specifically, soldiers had to describe (1) how they would gather the sheep, process the sheep, and separate lambs from ewes; (2) how they would assess the body condition of sheep; (3) and anticipate any additional logistical considerations of procurement.

Day 2. We returned to the SRUC–HMRC and started the morning with presentations by Dr. Paul Wood, an SRUC veterinarian, about how to conduct routine physical exams, vital rates, oral and injection administration of medicines, sedation and anesthesia, and hoof care. Wood then provided more hands-on demonstrations of handling sheep and sheep restraint techniques to conduct physical exams and locate the jugular vein. We then split participants into three groups where they were each assigned around 10 ewes each and challenged to conduct routine exams of each animal including identification, general assessments, body condition score, hoof, udders, vital rates (pulse and respiration), and fecal soiling, which can be an indication of internal parasite infestation. We then received presentations about ectoparasites and endoparasites by Army, SRUC, and UW staff followed by presentations about methods for assessing fecal samples and applying the FAMACHA assessment of ocular mucous membrane color as an indicator of anemia and internal parasite infestation (Van Wyk et al., 2002). We then split participants into two groups to allow for the opportunity to (1) conduct microscope assessments of fecal slides for endoparasites and (2) assess lamb identification, FAMACHA score, and fecal soiling (mean of 28 lambs per group) (see Figure 1). We concluded the day with a hypothetical scenario problem set about parasites. Soldiers had to consider the task of procuring 2,000 lambs from a European country characterized by a wet climate with high potential for internal parasite infestations, and they had to oversee the subsequent feeding program prior to slaughter. Specifically, soldiers had to consider internal parasite infestations and treatment for (1) how they would assess individual animals and what internal parasites would be of potential concern, (2) how slaughter would be delayed relative to administration of an anthelmintic, and (3) feed and housing program.

Day 3. We traveled to the SRUC Barony and SRUC Crichton farms near Dumfries where we focused on cattle. After receiving presentations from the SRUC staff, we then split participants into five groups where they had the opportunity to (1) gather a group of 15 heifers in a pasture and move them through a gate and down a lane; (2) sort, weigh, administer bolus and an oral drench to heifers; (3) observe cattle hoof trimming; (4) observe calf rearing and discuss calf health including pneumonia and an ultrasound of lungs; and (5) halter a cow and conduct routine assessments of pulse, respiration, rumen motility, with a discussion of blood collection from the coccygeal vein. After lunch, soldiers moved to the dairy for videos about cattle handling, milking system overview, nutrition and rations, and ultimately to milking cows.

Day 4. This was a travel day from Glasgow, Scotland, to London, England.

Day 5. We traveled to the Household Cavalry stables in London where we focused on horses. We received an orientation from a major (Royal Army Veterinary Corps) in the unit and then spent time as the rotating guard prepared in the yard for inspection. This allowed for the opportunity to talk to the mounted unit commander. We then proceeded to break into three groups to go through (1) the stables with a veterinary technician, (2) the farrier shop with farriers, and (3) the saddlery and equipment stockroom. Presentations included general comments about nutrition, feet handling, and tack. We then proceeded to the Household Cavalry Museum for presentations about the military history of the unit. At the end of these presentations, participants completed the postevaluation.

To determine if changes in knowledge, skills, and abilities were significant, we used an independent sample *t* test with a nonparametric Mann-Whitney U test for the Likert-scale data from the pre- and postevaluation with a p value of < 0.05 considered statistically significant (de Winter & Dodou, 2010). In these analyses, for each of the 22 Likert-scale questions we used the alternative hypothesis that preevaluation responses ≠ postevaluation responses stratified separately for each job type (veterinarian or technician). For the veterinarian group, three questions had variance equal to zero in the postevaluation responses, which did not allow for models to run; in these instances, we plotted bar graphs with standard errors and if the mean of the postevaluation response did not fall within the range of the standard error of the preevaluation response, then we considered those changes significant. All analyses were conducted in JASP open-source software (JASP Team, 2023). For the three open-ended questions, we summarized responses into major themes and particularly unique or useful responses.

Results

The preevaluation was administered on Monday, 28 August 2023 (day 1) with 16 technicians and eight veterinarians completing the instrument. The postevaluation was administered on Friday, 1 September 2023 (day 5) with 15 technicians and eight veterinarians completing the instrument. Attendees came from cross the European theater, including Germany, Italy, Spain, England, and Türkiye. Veterinary corps officers included one lieutenant colonel 64F (veterinary clinical medicine officer), and seven captain 64As (field veterinary service officer). Animal care specialists (68T) varied in rank, including two staff sergeants, 11 sergeants, and three specialists. At the time of training, the average age of captains was 30 years and eight months, with two years and one month average time as a veterinarian and an average of three years' time in service. Technician average age at the time of training was 28 years and four months, with six years and 11 months average time as a 68T and an average of seven years and four months' time in service.

For the four questions about livestock behavior, handling, and restraint, technicians always reported significant and positive changes and veterinarians reported significant and positive changes for two of the four questions (see Table 1). For understanding of how to perform restraint of sheep, technicians changed from "Disagree" to "Strongly Agree" ($p < 0.001$) and veterinarians changed from "Agree" to "Strongly Agree" ($p = 0.027$). For understanding of how to perform restraint of cattle, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians did not significantly change ($p = 0.112$; reporting "Agree" in the preevaluation). For understanding of how to perform restraint of horses, technicians changed from "Disagree" to "Agree" ($p = 0.010$) and veterinarians did not significantly change ($p = 0.444$; reporting "Agree" in the preevaluation). For understanding animal flight zones, blind spots, and optimal handler position to initiate movement, technicians changed from "Neutral" to "Strongly Agree" ($p < 0.001$) and veterinarians did not significantly change ($p = 0.096$; reporting "Agree" in the preevaluation) (Table 1).

For the five questions about examination and treatment of livestock, technicians always reported significant and positive changes and veterinarians reported significant and positive changes for four of the five questions (see Table 2). For ability to perform physical examination of livestock, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Agree" to "Strongly Agree" ($p = 0.043$). For understanding how to administer oral medication to livestock,

Table 1
Livestock Behavior, Handling, and Restraint

	Technicians (68T)			Veterinarians (64F/64A)		
Question	**Pre**	**Post**	**Pre → Post Change**	**Pre**	**Post**	**Pre→ Post Change**
I understand how to perform restraint of ***sheep***?	4.4	1.4	Disagree → S. Agree	2.4	1.3	Agree → S. Agree
I understand how to perform restraint of ***cattle***?	4.4	1.9	Disagree → Agree	2.0	1.3	Agree; NS
I understand how to perform restraint of ***horses***?	3.6	2.4	Disagree → Agree	1.6	1.6	Agree; NS
I understand animal flight zones, blind spots, and where to position myself to initiate animal movement?	3.2	1.5	Neutral → S. Agree	2.1	1.1	Agree; NS
Mean	3.9	1.8	Magnitude = 2.1	2.0	1.3	Magnitude = 0.7

Note. Pre → Post changes noted are significant at $p < 0.05$ and nonsignificant = NS.

technicians changed from "Disagree" to "Strongly Agree" ($p < 0.001$) and veterinarians changed from "Agree" to "Strongly Agree" (note models for veterinarians would not converge due to zero variance in the postevaluation group; changes are considered significant based on no overlap of standard errors). For capability of routine hoof care of livestock, technicians changed from "Disagree" to "Neutral" ($p < 0.001$) and veterinarians did not significantly change ($p = 0.501$). For ability to assess fecal material from livestock and identify potential animal health problems, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Agree" ($p = 0.007$). For understanding injection site selection, types of injections, and withdrawal time concepts, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Agree" to "Strongly Agree" ($p = 0.016$).

For the eight questions about the environment, nutrition, and body condition of livestock, technicians always reported significant and positive changes and veterinarians reported significant and positive changes for six of the eight questions (see Table 3). For ability to systematically assess sheep body condition, technicians changed from "Strongly Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Strongly Agree" (note models for veterinarians would not converge due to zero variance in the postevaluation group; changes are considered significant based on no overlap of standard errors). For ability to systematically assess beef cattle body condition, technicians changed from "Strongly Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Strongly Agree" ($p = 0.009$). For ability to systematically assess dairy cattle body condition, technicians changed from "Strongly Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral"

Table 2
Examination and Treatment of Livestock

	Technicians (68T)			Veterinarians (64F/64A)		
Question	**Pre**	**Post**	**Pre → Post Change**	**Pre**	**Post**	**Pre→ Post Change**
I can perform physical examination of livestock?	4.1	2.0	Disagree → Agree	2.3	1.3	Agree → S. Agree
I understand how to administer oral medication to livestock?	3.5	1.3	Disagree → S. Agree	1.8	1.0	Agree → S. Agree[1]
I am capable of routine hoof care of livestock?	4.1	2.5	Disagree → Neutral	2.6	2.0	Neutral/Agree; NS
I am able to assess fecal material from livestock and identify potential animal health problems?	4.4	1.6	Disagree → Agree	3.3	1.6	Neutral → Agree
I understand injection site selection, the type of injections, and withdrawal time concepts?	4.3	2.0	Disagree → Agree	2.0	1.1	Agree → S. Agree
Mean	4.1	1.9	Magnitude = 2.2	2.4	1.4	Magnitude = 1.0

Note. Pre → Post changes noted are significant at $p < 0.05$ and nonsignificant = NS.
[1] Indicates models that cannot converge due to 0 variance in the postevaluation group where all participants indicate "strongly agree" and changes are considered significant based on no overlap of standard errors.

to "Strongly Agree" ($p = 0.017$). For ability to systematically assess horse body condition, technicians changed from "Disagree" to "Neutral" ($p = 0.010$) and veterinarians did not significantly change ($p = 0.273$; generally reporting "Agreed"). For understanding the reproductive and animal health implications of poor body condition in livestock, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Agree" to "Strongly Agree" ($p = 0.016$). For understanding the forage characteristics that can influence body condition of livestock, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Agree" ($p = 0.026$). For ability to rapidly assess the nutritional quality of rangeland and pasture, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians did not significantly change ($p = 0.220$; generally reporting "Neutral"). For understanding minimum nutrient requirements of livestock, technicians changed from "Strongly Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Agree" ($p = 0.049$).

For the five questions about internal and external parasites of livestock, technicians and veterinarians always reported significant and positive changes (see Table 4). For understanding the biology, ecology, and animal health implications of internal parasites of livestock, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Strongly Agree" ($p = 0.011$). For ability to

Table 3

Environment, Nutrition, and Body Condition of Livestock

	Technicians (68T)			Veterinarians (64F/64A)		
Question	**Pre**	**Post**	**Pre → Post Change**	**Pre**	**Post**	**Pre→ Post Change**
I can systematically assess the body condition of ***sheep***?	4.6	1.5	S. Disagree → Agree	3.0	1.0	Neutral → S. Agree[1]
I can systematically assess the body condition of ***beef cattle***?	4.6	2.1	S. Disagree → Agree	2.6	1.3	Neutral → S. Agree
I can systematically assess the body condition of ***dairy cattle***?	4.6	1.8	S. Disagree → Agree	2.6	1.4	Neutral → S. Agree
I can systematically assess the body condition of ***horses***?	3.9	2.8	Disagree → Neutral	2.5	1.9	Agree; NS
I understand the reproductive and animal health implications of poor body condition in livestock?	4.3	1.7	Disagree → Agree	2.3	1.3	Agree → S. Agree
I understand the forage characteristics that can influence body condition of livestock?	.2	1.7	Disagree → Agree	3.1	1.8	Neutral → Agree
I can rapidly assess the nutritional quality of rangeland and pasture?	4.4	2.3	Disagree → Agree	3.5	2.8	Neutral; NS
I understand minimum nutrient requirements for livestock?	4.5	2.3	S. Disagree → Agree	3.0	1.9	Neutral → Agree
Mean	4.4	2.0	Magnitude = 2.4	2.8	1.6	Magnitude = 1.2

Note: Pre → Post changes noted are significant at $p < 0.05$ and nonsignificant = NS.
[1] Indicates models that cannot converge due to 0 variance in the postevaluation group where all participants indicate "strongly agree" and changes are considered significant based on no overlap of standard errors.

apply the FAMACHA assessment technique to quantify internal parasite loads of small ruminants and develop treatment recommendations, technicians changed from "Strongly Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Strongly Agree" (note models for veterinarians would not converge due to zero variance in the postevaluation group; changes are considered significant based on no overlap of standard errors). For understanding the biology, ecology, and animal health implications of external parasites of livestock, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Agree" ($p = 0.048$). For the ability to apply visual assessments of external parasite loads of livestock and develop recommendations for treatment, technicians changed from "Strongly Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Agree" ($p = 0.013$).

Table 4
Internal (endo-) and External (ecto-) Parasites of Livestock

	Technicians (68T)			Veterinarians (64F/64A)		
Question	**Pre**	**Post**	**Pre → Post Change**	**Pre**	**Post**	**Pre→ Post Change**
I understand the biology, ecology, and animal health implications of internal (endo-) parasites in livestock?	4.4	1.9	Disagree → Agree	2.5	1.3	Neutral → S. Agree
I can apply the FAMACHA assessment technique to quantify internal parasite loads of small ruminants and develop a recommendation for treatment accordingly?	4.6	1.5	S. Disagree → Agree	2.6	1.0	Neutral → S. Agree[1]
I understand the biology, ecology, and animal health implications of external (ecto-) parasites in livestock?	4.4	1.9	Disagree → Agree	2.8	1.6	Neutral → Agree
I can apply visual assessments of external parasite loads of livestock and develop recommendations for treatment accordingly?	4.6	2.0	S. Disagree → Agree	3.4	1.8	Neutral → Agree
I understand the role external parasites serve in vectoring disease pathogens and the associated integrated approaches necessary to managing external parasite infestations and subsequent animal health problems?	4.4	1.8	Disagree → Agree	2.9	1.6	Neutral → Agree
Mean	4.5	1.8	Magnitude = 2.7	2.8	1.5	Magnitude = 1.3

Note. Pre → Post changes noted are significant at $p < 0.05$ and nonsignificant = NS.
[1] Indicates models that cannot converge due to 0 variance in the postevaluation group where all participants indicate "strongly agree" and changes are considered significant based on no overlap of standard errors.

For understanding the role external parasites serve in vectoring disease pathogens and the associated integrated approaches necessary to managing such infestations and subsequent animal health problems, technicians changed from "Disagree" to "Agree" ($p < 0.001$) and veterinarians changed from "Neutral" to "Agree" ($p = 0.033$).

The magnitude of change was two times greater for technicians (i.e., averaging two points on the Likert scale) compared to veterinarians (i.e., averaging one point on the Likert scale; Tables 1–4) regardless of the type of question.

For the open-ended question of "What was the most useful task or topic covered in this training?," 14 participants explicitly stated that the hands-on portions were the most useful (61%). When stratified by job, seven of eight veterinarians (87.5%) and seven of 15 (46.7%) technicians highlighted this value. Other noteworthy responses from a single participant only included parasite testing, body condition scoring and physical exam, insects and internal parasites, understand herd mentality, and the adaptation and living environments of the animals.

For the open-ended question of "How could this training be improved to enhance your knowledge, skills, and abilities?," four participants expressed drawing blood and administering vaccines, three participants expressed separating veterinarians and technicians for some tasks, three participants expressed a desire for more hands-on with horses, and one participant suggested giving handouts prior to allow for review and reduce didactic portions, which could increase hands-on training time.

For the open-ended question of "What additional topics would you be interested in for future trainings?," four participants suggested more hands-on with horses (and these four participants were not the same participants who suggested the same in the question above). Other noteworthy responses from a single participant only included exotic animals, goats, small animal emergency care, blood and laboratory analysis, reproduction, economics and food security, and hands-on hoof trimming. Finally, one veterinarian suggested "more time to go through a case, develop a treatment plan, and discuss pros and cons."

One noteworthy comment from a veterinarian was "I thought it had a pattern of 'brief lecture' followed by 'hands on activity' to promote learning." One noteworthy comment from a technician was "For me, this is spot on, I am a hands-on learner; explain it and let's go do it. That way it actually sticks instead of just talking about it but never actually performing the task."

Discussion

This experiential and integrated training of U.S. Army veterinary services soldiers positively changed knowledge, skills, and abilities in four broad areas: (1) livestock behavior, handling, and restraint; (2) examination and treatment of livestock; (3) environment, nutrition, and body condition of livestock; and (4) internal and external parasites of livestock. Importantly, the magnitude of change was greater for technicians than for veterinarians. This difference suggests that for technicians, this was the introduction of new knowledge, skills, and abilities whereas for veterinarians, this was reviewing familiar concepts and honing existing knowledge, skills, and abilities. Establishing baseline knowledge and skills of participants to align learning objectives specific to groups may better support optimal learning (Vgotsky, 1978) by providing an appropriate level of challenge. The scaffolded delivery approach and support from both subject experts and peers was effective in promoting progression through the stages of conscious competence to improve proficiency and confidence of participants (Keeley, 2021).

The efficacy of the hands-on (experiential) and active-learning approach (Hamilton, 2019) that was facilitated through university and military animal facilities was noteworthy for participants. This emphasis is reflected not only in the questions addressing techniques requiring handling (i.e., restraint, general handling, physical examination, body condition assessment, application of FAMACHA, and assessment of fecal samples) but also in the open-ended responses where a majority of participants (61%) indicated the experiential opportunities enhanced learning. This is particularly salient given that the lack of hands-on training for new soldiers in the U.S. Army Veterinary Services may lead to a lack of confidence that may hinder comprehensive veterinary care (Torring & May, 2014), suggesting that scaffolding learning could lend to the development of conscious competence.

The organization of soldiers in groups during the training also deserves additional consideration. Small groups always included both technicians and veterinarians in order to develop operationally adept teams (Schatz et al., 2017) that would simulate work in a clinic but also enable peer-to-peer learning (Guldberg, 2008) where veterinarians could emphasize topics and techniques based on their substantial training and experience. Interprofessional education, including veterinarians and veterinary nurses or technicians (Kinnison et al., 2011), is recognized in encouraging a greater understanding of the roles and attributes of each and fostering improved collaboration and teamwork to promote effective interprofessional practice (Kinnison et al., 2014). However, both types of participants suggested separating small groups by job types at least for some portions of training. The logic behind this suggestion seems to be rooted in the level of detail desired and/or needed by respective groups where veterinarians may want to delve deeper into the physiology, mechanisms, or theory, while technicians may need less in-depth details and more repetition of task. For example, veterinarians verbally articulated during the training the desire for more discussion about sedation and anesthesia, treatment plan development, and slaughter, whereas technicians in writing expressed more time for hands-on tasks with less lecturing. Thus, this could allow for tailoring learning objectives for each group, addressed independently and collaboratively as appropriate. Adopting a flipped learning approach by providing theoretical content prior to the training days may promote confident skills development (Decloedt et al., 2020) by facilitating increased time for practical application.

It is also important to consider the impetus and vision for this training, which was an unexpected outcome of the LTHET program. In the case of the authors of this manuscript, the LTHET opportunity revealed resources for training and teaching at universities and opportunities for handling animals (Calkins & Scasta, 2021). Through this professional development opportunity, and rooted in rangeland livestock research, the development of critical animal handling and measurement tasks facilitates the opportunity for soldiers to handle a critical mass of patients and hone skills through repetition (Calkins, 2020). Such numbers of livestock at university farms could be compared to caseloads at a veterinary clinic when considering the value of such trainings in terms of animal cases available. The volume of livestock available maximizes the number of opportunities for each participant, whilst reducing impact on any individual animal's welfare, a required consideration for ethical approval of the training. Finally, this learning approach could also be considered case-based learning, which stimulates deep learning, improved clinical reasoning, and increased confidence (Patterson, 2006), with a reflective opportunity for assessment of learning and for participants to employ critical reflection at the end of each day.

Participants made suggestions for future training, many of which included hands-on opportunities, particularly drawing blood, blood laboratory analysis, administering medication, trimming hooves, emergency care, and other species (goats and exotic animals). Future training may also need to include more instruction about zoonotic diseases, of which U.S. Army Veterinary Services may experience an elevated risk (Vest & Clark, 2012). Future training should ensure Army Veterinary Services are prepared to assess for the presence of transboundary animal diseases and investigate unexplained livestock and wildlife deaths that may impact agricultural systems in the United States with the movement of military vehicles and personnel. Additionally, Veterinary Services personnel must evaluate host-nation capabilities to integrate policy with multinational forces. Moreover, they must be prepared to advise commanders on zoonotic disease transmission, provide medical care to local livestock, build relationships with food production facilities, and agricultural and veterinary medical agencies (Department of the Army, 2020). Although Army Veterinary Services does not routinely work with large animals, virtually all tasks performed using large animals as a training model builds readiness in the small animal clinic, for example, performing comprehensive physical exams, venipuncture, hematological preparations and evaluation, and ultrasonography. By utilizing large animals, soldiers are able to repeatedly perform tasks over the course of a few days in quantities greater than or equal to what is achievable over the course of a year in small animal practice, leading to improved proficiency and skill retention. With that said, future efforts should include an evaluation plan and longitudinal data collection to quantify proficiency and sustained skill retention. In addition, we recognize that this study has a relatively small sample size that is constrained by multiple factors including the risk of moving a large group of soldiers away from posts to a single location for training. Finally, we recognize the potential biases of self-reported data and suggest that future training efforts have objective measures of skill acquisition in addition to the self-assessments.

Conclusion

This learning-centric (Williams, 2020) training of U.S. Army Veterinary Services veterinarians and technicians effectively enhanced soldiers' knowledge, skills, and abilities for sheep, cattle, and horse care. The integrated approach of this training that focused on active (Hamilton, 2019) and experiential learning to understand the environment in which these animals exist, the influence of the environment on animal health, how to handle animals, and how to conduct specific tasks and techniques in the context of the 68T ICTL can serve as a learning model for future trainings. Projecting forward, such collaborative training needs continued priority given the U.S. Army's role in stabilization and reconstruction of failed or failing nations, with a focus on agricultural operations via function of the U.S. Army Veterinary Services because such endeavors stimulate agricultural productivity and improve animal and human health, ultimately accelerating stabilization (Smith, 2007). Finally, the role of the U.S. Army Veterinary Services continues to evolve while it serves historic and enduring core functions while endeavoring to be nimble and embrace new roles (Vroegindewey, 2007). Ultimately, this may have potential long-term benefits for military veterinary readiness for addressing emergent roles. Such emergent roles as disease surveillance, food defense, and reconstruction and stabilization with a focus on agriculture require that future training be innovative, multidisciplinary, and capitalize on possible partnerships as demonstrated in this training with agricultural universities, both domestically and abroad. Finally, our teaching model may have applications to other training contexts where repetition of tasks is needed.

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