PEER REVIEWED

A survey of veterinary student exposure to and performance of clinical skills necessary for success in beef cattle veterinary practice and the relationship to the supply, demand, and value of proper training as beef cattle veterinarians

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Abstract

Veterinary graduates (n=489) from 39 universities across 4 continents participated in a survey to evaluate veterinary training of clinical skills and the monetary value of education for recent graduates. The objectives of this study were to conduct a survey of veterinarians and current veterinary students regarding the exposure to or ability to perform certain clinical skills during veterinary school that are important to beef cattle veterinary practice. Another objective was to survey veterinary practitioners regarding their willingness to pay a new graduate more if the new veterinarian could perform these skills on their first day of practice. Participants answered 111 questions in a web-based survey system on their exposure to clinical skills and production concepts while veterinary students, and the value of these skills to new graduates. Eighty-four percent of surveyed veterinarians had adequate or excellent exposure to the calving process and knowledge of when to intervene while in veterinary school, but only 65% had adequate or excellent exposure to caesarian section utilizing a flank approach. Most surveyed veterinarians indicated that they would be willing to pay new graduates more if they entered the practice with competency in the surveyed clinical skills.

Key words: cattle, clinical skills, survey, training, veterinarian

Résumé

Des vétérinaires diplômés (n=489) provenant de 39 universités sur quatre continents ont participé à un sondage pour évaluer l'apprentissage vétérinaire des compétences cliniques et la valeur monétaire de l'éducation chez les diplômés récents. L'objectif de l'étude était de mener un sondage auprès de vétérinaires et d'étudiants présentement en médecine vétérinaire concernant leur connaissance de certaines compétences cliniques pertinentes dans le contexte d'une pratique vétérinaire en bovins de boucherie et aussi leur aptitude à maitriser ces compétences durant l'apprentissage vétérinaire. Un autre objectif était de déterminer si les vétérinaires en pratique étaient enclins à payer un nouvel étudiant diplômé plus cher si ce nouveau vétérinaire maitrisait ces compétences dès le premier jour en pratique. Les répondants ont répondu à 111 questions dans un sondage en ligne sur leur connaissance des compétences cliniques et des concepts de production acquise durant leurs études et sur la valeur de ces compétences chez de nouveaux étudiants diplômés. Parmi les répondants, 84% avaient acquis pendant leurs études vétérinaires une bonne ou très bonne connaissance du processus de vêlage et de quand intervenir. Toutefois, seulement 65% avaient une bonne ou très bonne connaissance de la césarienne par le flanc. La plupart des vétérinaires répondants ont indiqué qu'ils seraient enclins à payer un nouvel étudiant diplômé plus cher si ces derniers avaient déjà acquis les compétences cliniques sondées avant leur début à la pratique.

Introduction

The supply and training of food animal veterinarians have been a focus of several recent national symposia in the United States.[14] Food animal/mixed animal veterinarians are important sources of producer information regarding issues such as food safety, antibiotic stewardship, and preventive medicine.[7] Food animal practitioners also provide critically needed medical services for animals during disease outbreaks and emergency situations.[12] These veterinary practitioners contribute, both directly and indirectly, to the economic viability of rural communities across the United States.[18]

One of the general foundational missions of veterinary colleges is to train graduates to successfully enter veterinary practice. However, there are many constraints that may inhibit this mission, including veterinary college budget priorities, animal rights activist activity, sufficient caseload, demographics, and interest of veterinary students that may limit the ability of faculty to train students on clinical skills essential for beef cattle veterinary practice. The clinical skills necessary for practice have been previously identified through working groups and task forces.[8,10,11] However, literature describing training programs available to veterinary students to physically perform clinical skills under the supervision of faculty is lacking.

Veterinary student debt is also the focus of national and local debates. Colleges of veterinary medicine appear to be increasingly reliant on tuition and fees.[6] By increasing the value of a veterinary education through mentored experience, veterinary schools could produce more day-one qualified graduates, which could subsequently increase the value of the veterinary degree and starting salaries in the workforce. Based on current discussions on beef cattle veterinary supply, veterinary student debt, and veterinary compensation, the objectives of this study were to conduct a survey of veterinarians and current veterinary students regarding the exposure to or ability to perform certain clinical skills during veterinary school that are important to beef cattle veterinary practice; to survey veterinary practitioners regarding their willingness to pay a new graduate more if the new veterinarian could perform these skills on their first day of practice; and to survey practitioners about their opinions of current veterinary training, and if they believe that veterinary schools place proper emphasis on beef cattle clinical skills.

Materials and Methods

Approval to conduct the survey was granted by the Kansas State University Institutional Review Board (IRB #8536).

Data Collection

Data were collected using Kansas State University's web-based survey system.[a] Participants were provided a URL to the survey via an email communication in the listservs provided by the American Association of Bovine Practitioners and the Academy of Veterinary Consultants. The 2320 veterinary subscribers to the AABP listserv and 837 veterinary subscribers of the AVC list were sent an initial listserv invitation to participate in December of 2016. The survey period was open from December 6, 2016 to January 18, 2017, with a total of 3 invitations to participate during that time.

Survey Questions

The survey consisted of 111 total questions. Of these, 3 questions gathered general information and demographics; 70 questions asked about exposure to clinical skills and if the veterinarian had performed that skill as a student; 30 questions asked about exposure to beef production medicine, diagnostic case work up, and veterinary business concepts during their veterinary training; and 8 questions regarding the supply/demand, needs, neglect, and value of clinical skills training for beef cattle veterinary students to make them day-one practice ready (Table 1).

Data Analysis

Data collected via the web-based survey system were downloaded into Microsoft Excel[b] for summary and analysis. Financial responses from veterinarians provided as ranges, i.e. annual salary $65,000 to 75,000, were utilized as a calculated average of the range. When financial responses were reported as a percent of annual income rather than dollars of salary per year, the reported percentage of annual income was multiplied by the median annual income from the entire data set. The number of responses, mode, and mean for each variable were calculated using Microsoft Excel.[b]

Results

A total of 489 veterinarians participated in the survey. There were 360 veterinarians (73.6%) that indicated they were currently active in practice, 83 veterinarians (16.9%) were currently teaching at universities, 33 veterinarians (6.7%) identified as being involved in industry veterinary medicine, and 13 veterinarians (2.7%) classified themselves as being involved in "other" veterinary employment. The range in graduation date of veterinary participants was 1960 to 2016, with almost half (n=237; 48.5%) of respondents having graduated in the last 10 years (Figure 1). A total of 479 participants (98.0%) identified themselves by the veterinary school they attended (Table 2). Participants in this survey represented 39 veterinary colleges or schools from 4 different continents (North America, South America, Europe, and Australia). Graduates from Kansas State University and Iowa State University represented the largest number of respondents from any single school, and together accounted for nearly 28% of total responses.

The first 2 sets of questions focused on auscultation and anesthesia of cattle. Nearly all veterinarians indicated that they performed auscultation of the lungs (99.5% of respon-

Table 1. Descriptive data about demographics, exposure and performance of clinical skills of responding veterinarians (n=489) to a survey evaluating training programs of recent veterinarian graduates.

Topic area		No. of questions
Survey respondent demographics		3
Exposure to and performance of clinical skills	Auscultation	3
	Anesthesia	3
	Castration/dehorning	5
	Female reproductive service	6
	Prolapses	4
	Obstetrics	5
	Male reproductive service	6
	Cattle handling and restraint	3
	Surgery and biopsy technique	10
	General clinical skills	17
	Euthanasia and necropsy	2
	Production medicine	13
	Diagnostic case investigation	9
Veterinary practice management		8
Supply, demand and training of veterinary students		5
Value of clinical proficiency in practice		4

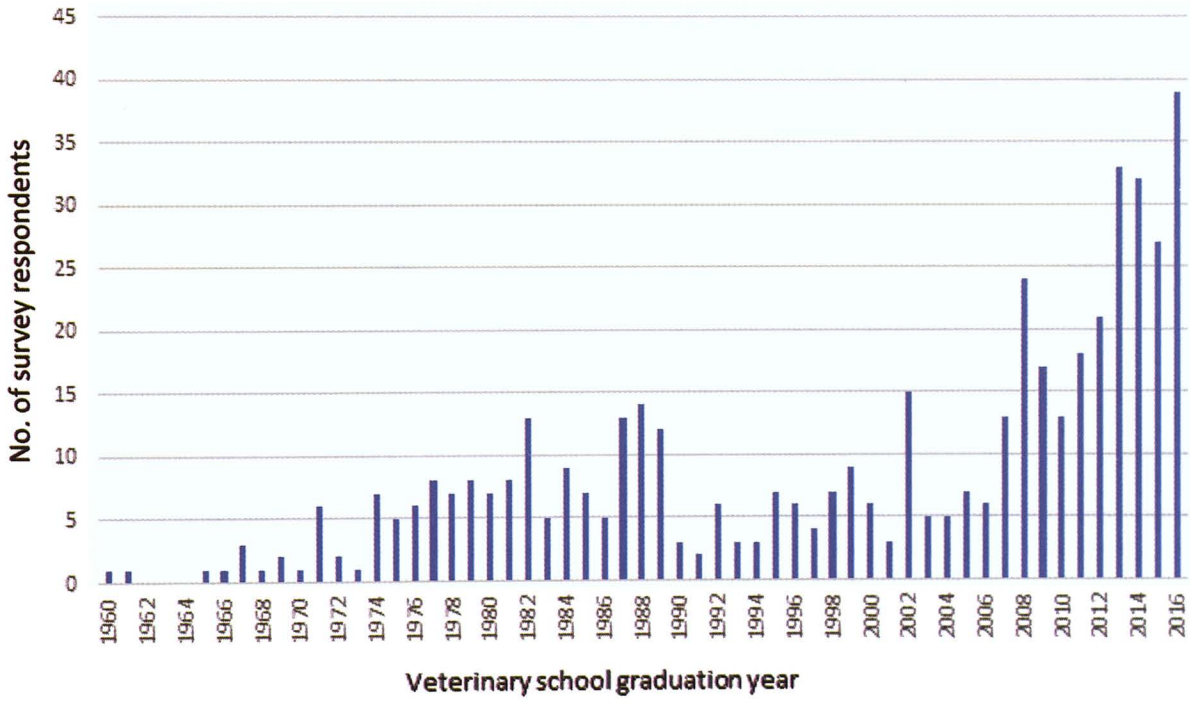

Figure 1. Distribution of the veterinary school year of graduation of survey respondents.

dents), heart (99.7% of respondents), and gastrointestinal tract (98.4% of respondents) while in veterinary school. Over 90% of respondents felt they had excellent or adequate exposure to local and epidural anesthesia, while 65% felt they had excellent or adequate exposure to general anesthesia when attending veterinary school. Survey participants indicated that 91.7% had performed local anesthesia, 88.9% performed epidural anesthesia, and 72.3% had performed general anesthesia while in veterinary school.

Castration and dehorning are basic, but important, animal husbandry clinical services offered by veterinarians. While over 70% of veterinary respondents received excellent or adequate exposure, and 80% of respondents performed surgical castration, approximately 60% of respondents indicated that they received poor or no exposure to banding or elastrator band castration techniques; only 35% (banding castration) and 31% (elastrator band) of students had the opportunity to castrate a calf using 1 of the 2 banding techniques

Table 2. Descriptive data about college or university of responding veterinarians (n=479) to a survey evaluating training programs of recent veterinarian graduates.

Veterinary College or University	No. of respondents	% of responses
Atlantic Veterinary College	5	0.1
Auburn University	14	2.9
Colorado State University	23	4.8
Cornell University	25	5.2
Iowa State University	62	12.9
Kansas State University	72	15.0
Louisiana State University	6	1.3
Michigan State University	15	3.1
Mississippi State University	6	1.3
Murdoch University	2	0.04
North Carolina State University	7	1.5
Ohio State University	31	6.5
Oklahoma State University	24	5.0
Ontario Veterinary College - Guelph	9	1.9
Oregon State University	2	0.04
Ross University	3	0.06
Sao Paulo State University Brazil	2	0.04
St. George's University	1	0.02
Texas A & M University	11	2.3
Tufts University	5	0.1
Tuskegee University	1	0.02
University of Edinburgh	1	0.02
University of California at Davis	11	2.3
University of Florida	3	0.06
University of Georgia	7	1.5
University of Illinois	13	2.7
University of Liverpool	1	0.02
University of Minnesota	26	5.4
University of Missouri	19	4.0
University of Montreal	2	0.4
University of Pennsylvania	10	2.1
University of Purdue	13	2.7
University of Saskatchewan	1	0.02
University of Tennessee	2	0.04
University of Wisconsin	17	3.5
Utrecht University	1	0.02
Virginia Maryland College of Veterinary Medicine	11	2.3
Washington State University	12	2.5
Western University	3	0.06
Total	**479**	**100.0**

while in veterinary school (Table 3). Although 79% of students had performed at least 1 surgical castration, 1 in 5 students graduated from veterinary school without performing this procedure. Non-cosmetic dehorning was covered more adequately in veterinary school than cosmetic dehorning. Three out of 4 veterinarians had the opportunity to dehorn a calf during their veterinary school career, but only 34% of veterinarians performed a cosmetic dehorning in school.

Beef cattle reproductive services are foundational services for many veterinary practices, and include activities such as pregnancy determination, replacement heifer development, obstetrics or male reproduction services. The first set of questions on beef cattle reproduction focused on pregnancy diagnosis, artificial insemination, and embryo transfer (Table 4). Veterinarian responses indicated that cow synchronization programs and manual pregnancy diagnosis exposure was adequate or excellent. In fact, 99.2% of veterinarians surveyed indicated that they performed manual pregnancy palpation during veterinary school. However, less than 50% of survey participants had exposure to artificial

Table 3. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians pertaining to beef calf castration and dehorning by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Banding castration	10.2%	30.3%	16.5%	43.1%	35.4%	64.6%
Elastrator band castration	10.4%	25.9%	17.9%	45.8%	30.9%	69.1%
Surgical castration	31.2%	44.2%	15.9%	8.7%	79.0%	21.0%
Cosmetic dehorning	0.3%	23.7%	22.3%	39.7%	34.2%	65.8%
Non-cosmetic dehorning	28.3%	38.5%	18.6%	14.5%	72.2%	27.8%

*Values are presented as a percentage of total respondents.

Table 4. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians pertaining to beef cow and heifer reproduction services by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Cow reproduction synchronization	23.8%	39.4%	20.2%	16.6%	48.6%	51.4%
Artificial insemination certification	9.2%	16.7%	17.7%	56.4%	29.3%	70.7%
Embryo transfer	7.5%	14.6%	21.2%	56.7%	17.6%	82.4%
Manual pregnancy diagnosis (palpation)	38.4%	40.3%	21.0%	0.2%	99.2%	0.8%
Ultrasound pregnancy diagnosis	8.5%	20.6%	32.2%	38.7%	48.4%	51.6%
Heifer spay	2.4%	5.6%	12.1%	79.8%	7.4%	92.6%

*Values are presented as percentage of total respondents.

insemination, embryo transfer, or ultrasound pregnancy diagnosis, and spaying heifers was only performed by 7.4% of veterinarians during their veterinary school training. Fifty-six percent of veterinarians had no exposure to embryo transfer or artificial insemination during veterinary school. Only 20% of veterinarians had some sort of exposure to spaying heifers in class or lecture in veterinary school.

Beef cattle obstetrics are important clinical skills for the life of the calf and the cow or heifer. Beef producers rely on veterinarians for emergency obstetrical work during calving season. Veterinarian responses indicated that 84% of veterinarians had adequate or excellent exposure to the calving process and knowledge of when to intervene, while 76% of veterinarians had adequate or excellent exposure to methods for manually removing a calf, and 65% had adequate or excellent exposure to caesarian section utilizing a flank approach while in veterinary school (Table 5). This survey indicates that exposure to fetotomy and midline approach to caesarian section were less than adequate for veterinarians during their training. Most students manually extracted a calf during veterinary school; however, 1 in 3 veterinarians did not have the opportunity to perform a caesarian section as a student. Nearly 60% of students had no experience performing a fetotomy during veterinary school.

Prolapses occur in male and female beef cattle. Over 25% of veterinarians received no exposure to vaginal, uterine, or rectal prolapse reductions while in veterinary school (Table 6). Also, less than 50% of the veterinarians ever had the opportunity to perform prolapse reduction of any sort during their training. This would be a difficult clinical skill to model without actual prolapse caseload in the teaching hospital or opportunities during externships in clinics.

Commercial and purebred beef cattle operations rely on veterinarians to provide reproductive services and treatments for their bulls. Based on veterinary responses, veterinary schools adequately expose students to and allow them to perform breeding soundness examinations on bulls (Table 7). Exposure to and actual trichomoniasis testing in bulls is lacking in the curriculum. This could be a function of when surveyed veterinarians attended veterinary school as the recognition and regulatory status of trichomoniasis has changed dramatically in the last decade. Over 60% of surveyed veterinarians had poor or no exposure to treatments for penile injuries, infections or blockages in veterinary school, and 3 of 4 had no hands-on experience with these types of cases.

Cattle handling and field restraint of cattle is important for human and animal safety. Data from this survey indicate that veterinarians have good exposure to cattle handling and restraint in the field (Table 8). Also, it is very encouraging that 67%, 83%, and 88% of veterinarians performed cattle handling, cattle restraint in a squeeze chute, and restrained cattle without a squeeze chute, respectively, while in veterinary school.

Questions in Table 9 were asked to understand the exposure to and performance of clinical skills essential for beef cattle surgical techniques. Exposure to suture patterns and laceration repair were best in the surgical and biopsy clinical skills category. Thirty-five to 82% of veterinarians indicated that they had poor or no exposure to eye nucleation (35%), cancer eye treatment (46%), rumenotomy (36%), rumen

Table 5. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians pertaining to beef cattle obstetrics by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Expectations of calving (knowing when to intervene)	29.4%	53.9%	14.3%	2.4%	78.6%	21.4%
Manual extraction of a calf	29.1%	47.1%	19.2%	4.6%	79.0%	21.0%
Caesarian section flank	23.5%	41.7%	21.3%	13.6%	63.6%	36.4%
Caesarian section midline	6.8%	16.5%	25.7%	51.0%	16.2%	83.8%
Fetotomy	14.6%	36.7%	29.4%	19.4%	41.9%	58.1%

*Values are presented as percentage of total respondents.

Table 6. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians pertaining to vaginal, uterine and rectal prolapses in beef cattle by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Vaginal prolapse reduction	14.7%	36.2%	23.2%	25.9%	44.4%	55.6%
Uterine prolapse reduction	17.4%	32.9%	23.4%	26.3%	45.4%	54.6%
Rectal prolapse reduction	11.4%	33.8%	25.9%	29.0%	41.1%	58.9%
Rectal prolapse amputation	4.9%	16.6%	19.5%	59.0%	11.5%	88.5%

*Values are presented as percentage of total respondents.

Table 7. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians pertaining to beef bull reproduction services by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Breeding soundness exam on bulls	36.7%	43.2%	14.3%	5.8%	82.1%	17.9%
Trichomoniasis test procedures	14.9%	27.3%	16.6%	41.2%	35.5%	64.5%
Treating a penial hematoma	8.0%	27.6%	20.6%	43.8%	24.2%	75.8%
Removing penal warts	6.8%	25.2%	19.4%	48.7%	22.7%	77.3%
Penial hematoma treatment	7.1%	26.3%	21.0%	45.6%	23.5%	76.5%
Penile urethrostomy surgery	7.6%	29.1%	24.2%	39.1%	25.5%	74.5%

*Values are presented as percentage of total respondents.

Table 8. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians pertaining to cattle handling and restraint in the field by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Low stress animal handling techniques	23.3%	35.2%	18.5%	23.1%	66.9%	33.1%
Proper animal restraint w/out a squeeze chute	22.8%	43.8%	25.9%	7.5%	82.9%	17.1%
Squeeze chute operations and cattle restraint	26.5%	43.7%	22.1%	7.8%	88.1%	11.9%

*Values are presented as percentage of total respondents.

fistulation (36%), liver biopsy (72%), gomer bull surgery (66%), hernia reduction (43%), and tail bobbing (82%). General surgical procedures, such as suture patterns and repair of lacerations, were performed by more than 80% of respondents while they were in veterinary school. However, 46% or more of veterinarians did not have the opportunity to perform clinical skills such as eye nucleation, treat a cancer eye, complete a rumenotomy or rumen fistula, a liver biopsy, a gomer bull surgery, repair a hernia in a calf or bob/trim a tail during veterinary school.

Table 9. Descriptive data about clinical skills training in veterinary school for beef cattle veterinarians associated to beef cattle surgery and biopsy techniques by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
General suture patterns	53.3%	42.6%	3.6%	0.5%	96.7%	3.3%
Laceration repair	38.5%	48.8%	7.3%	5.4%	80.1%	19.9%
Eye nucleation	23.3%	40.5%	20.6%	15.5%	53.9%	46.1%
Cancer eye treatment	18.9%	35.2%	25.0%	20.9%	42.2%	57.8%
Rumenotomy	22.7%	41.5%	19.8%	16.1%	52.5%	47.5%
Rumen fistula	16.3%	35.6%	21.7%	26.3%	35.4%	64.6%
Liver biopsy	5.9%	22.0%	23.9%	48.3%	20.0%	80.0%
Gomer bull surgery	11.7%	22.5%	18.8%	46.9%	25.6%	74.4%
Hernia reduction in calf	20.0%	36.7%	19.0%	24.3%	48.6%	51.4%
Tail bobbing/trimming	4.7%	13.5%	15.2%	66.6%	12.6%	87.4%

[1]Values are presented as percentage of total respondents.

Diagnosis of lameness and treatment are important veterinary services to keep cattle healthy and productive. The exposure to and performance of clinical skills associated with diagnosis and correction of lameness in cattle was 1 area where the current veterinary curricula appear to be meeting the needs of veterinary practitioners. Nearly 90% or more of veterinarians had exposure to lameness diagnosis and treatments, except for arthrodesis (Table 10). Arthrodesis is a clinically advanced procedure that can be performed after other treatments have failed. Most veterinarians performed lameness diagnosis, trimmed hooves, and treated toe or sole abscesses during veterinary school. However, the survey indicates more emphasis is needed for training veterinary students to perform claw amputation, arthrodesis, and blocking feet.

There are many general and basic clinical skills necessary for veterinary practice, regardless of the species of animal receiving care. Veterinarians participating in this survey indicated they had adequate or excellent exposure (70 % of respondents or greater; Table 11) to brucellosis vaccination and tattooing, intravenous fluid therapy, venipuncture, injections, administration of oral medication, passing an oral gastric tube, fecal flotation, and proper cleaning of equipment. Areas where training could be improved (defined as 45% or more of respondents indicated poor or no exposure; Table 10) are ultrasound techniques for carcass characteristics, aging cattle, beef cattle radiography, writing health papers, steroid implantation, and sharpening equipment. Eighty-nine percent or more of veterinarians were able to perform clinical skills such as IV fluid therapy, injections, venipuncture, oral administration of medications, passing an oral gastric tube, fecal floatation, and cleaning equipment. Few veterinarians utilized ultrasound to capture carcass characteristics, implanted cattle with steroid implants, wrote certificates of veterinary inspection or sharpened equipment while in veterinary school. Based on responses from veterinarians, veterinary schools do a good job in teaching students and allowing them to perform humane euthanasia and field necropsies (Table 12).

Preventive and production medicine in beef cattle veterinary practices continues to provide significant opportunities for veterinarians to provide valuable input to clients. A series of questions on exposure to beef cattle production and management programs during veterinary school was included in the survey (Table 13). Veterinarians indicated there was better exposure to cow-calf health records and interpretation as veterinary students than to stocker or feedlot cattle health records. Similarly, veterinarians indicated better

Table 10. Descriptive data about clinical skills training during veterinary school on beef cattle lameness diagnosis and treatment by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Lameness diagnosis	29.1%	52.2%	16.8%	1.9%	89.9%	10.1%
Hoof trimming	26.7%	43.0%	23.1%	7.3%	79.2%	20.8%
Toe/sole abscess treatment	30.1%	43.0%	20.2%	6.8%	72.3%	27.7%
Arthrodesis	12.0%	25.7%	24.5%	37.9%	24.7%	75.3%
Blocking feet	23.8%	42.2%	20.9%	13.1%	66.8%	33.2%
Claw amputation	20.2%	39.3%	23.5%	17.0%	51.7%	48.3%

*Values are presented as percentage of total respondents.

Table 11. Descriptive data about clinical skills training during veterinary school on clinical skills required in practice by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Ultrasound for carcass characteristics	0.5%	4.4%	11.5%	83.7%	6.3%	93.7%
Bovine radiography	8.1%	40.1%	32.3%	19.6%	61.8%	38.2%
Applying a cast to a leg of a calf	14.8%	40.8%	26.7%	17.7%	56.3%	43.7%
Applying splint to leg of calf	15.3%	42.1%	25.1%	17.5%	60.1%	39.9%
Aging cattle	15.8%	38.4%	28.5%	17.3%	61.0%	39.0%
Steroid implantation	14.2%	32.5%	14.2%	39.1%	48.6%	51.4%
Brucellosis vaccination and tattoo administration	32.3%	40.3%	10.9%	16.5%	72.1%	27.9%
IV fluid therapy	40.2%	43.6%	12.4%	3.9%	89.6%	10.4%
Injections (i.e. subcutaneous, intramuscular, intravenous, base of the ear)	55.9%	37.5%	5.6%	1.0%	98.2%	1.8%
Venipuncture (i.e. tail, jugular)	58.1%	36.6%	4.4%	1.0%	98.7%	1.3%
Oral administration of medicine	53.5%	39.2%	5.1%	2.2%	97.0%	3.0%
Passing oral gastric tube	52.1%	39.48%	4.4%	4.1%	94.2%	5.8%
Writing a health paper	18.2%	32.9%	22.8%	26.2%	50.0%	50.0%
Tuberculosis testing	28.3%	34.9%	17.2%	19.6%	64.1%	35.9%
Fecal flotation	39.8%	46.8%	10.9%	2.4%	92.4%	7.6%
Proper cleaning of equipment	36.8%	43.3%	14.8%	5.1%	88.6%	11.4%
Sharpening equipment	14.6%	29.2%	24.3%	31.9%	53.6%	46.4%

*Values are presented as percentage of total respondents.

Table 12. Descriptive data about clinical skills for beef cattle veterinarians pertaining to humane euthanasia and field necropsy by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*				Performed skill*	
	Excellent	Adequate	Poor	None	Yes	No
Humane euthanasia	32.68%	47.80%	12.92%	6.58%	71.14%	28.86%
Field necropsy	61.41%	32.77%	5.34%	0.49%	96.72%	3.28%

*Values are presented as percentage of total respondents.

Table 13. Descriptive data about exposure to beef production medicine concepts and practice by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill*			
	Excellent	Adequate	Poor	None
Cow calf herd health records and interpretation	15.00%	38.25%	25.75%	21.00%
Stocker cattle herd health records and interpretation	6.03%	26.63%	30.90%	36.43%
Feedlot cattle herd health records and interpretation	7.79%	26.63%	29.15%	36.43%
Developing herd health plans for the cow herd	17.29%	46.87%	21.55%	14.29%
Developing herd health plans for the stocker operation	6.28%	32.41%	31.66%	29.65%
Developing herd health plans for feedlot cattle	7.02%	31.08%	29.82%	32.08%
Development of a preconditioning program	15.79%	36.34%	21.80%	26.07%
Weaning management options	14.07%	34.92%	26.13%	24.87%
Development of herd reproduction synchronization and AI programs	23.29%	37.72%	20.51%	18.48%
Basic cattle husbandry	32.83%	44.61%	17.54%	5.01%
Nutrition skills	7.77%	34.09%	47.12%	11.03%
Grazing and range management	2.51%	18.30%	42.86%	36.34%
Economic analysis of beef production	5.82%	20.25%	38.99%	34.94%

*Values are presented as percentage of total respondents.

exposure to developing herd health plans for the cow herd during veterinary school than for stocker or feedlot operations. Veterinarian responses indicate that 50% or more of participants had adequate or excellent exposure to preconditioning programs, development of herd synchronization and AI programs, and basic cattle husbandry during their training. Areas of veterinary training that need improvement, based on survey results, include weaning management options, nutrition skills, grazing and range management, and economic analysis of beef cattle operations.

Most veterinarians are contacted by beef clients during a disease outbreak or when there is unexpected mortality. This survey asked a series of questions about the exposure as veterinary students to diagnostic case investigation and preventative medicine program development (Table 14). In general, veterinarians indicated adequate or excellent exposure to abortion cases (86%), diarrhea (89%), pink eye (83%), lameness (77%), respiratory disease (90%), digestive disorders (61%), central nervous disorders (78%), vaccine program development (71%), and anthelmintic program development (69%). This is indicative of the increased emphasis that veterinary schools have placed on beef production medicine, and also reflects the accessibility and ability for students to work within college-associated diagnostic laboratories to provide training in diagnostic case work ups.

Veterinarians are increasingly expected to provide input on the farm and in the media about contemporary issues associated with food animal production. Veterinarians were asked about their exposure to contemporary issues associated with food animal production and field research design (Table 15). Topics in which 50% or more of the veterinarians felt they had adequate or excellent exposure during veterinary school were judicious antibiotic usage and stewardship, pre-harvest food safety, animal welfare guidelines, foreign animal disease preparation, and beef quality assurance. Few veterinarians indicated adequate or excellent exposure to field research design on beef operations, traceability services, beef sustainability, and environmental regulations. These topics deserve consideration for increased emphasis in the veterinary school curriculum as veterinarians become more active in practice and service in these areas for their clients.

Veterinary student debt and associated cost of veterinary education combined with lower than expected starting salaries continue to be discussed by professional organiza-

Table 14. Descriptive data about clinical skills for beef cattle veterinarians pertaining to clinical field examination and diagnostic work up for different types of cases commonly seen in beef cattle practice by practicing veterinarian survey respondents (n=489).

Clinical Skill	Exposure to clinical skill*			
	Excellent	Adequate	Poor	None
Abortions	27.64%	57.54%	12.56%	2.26%
Diarrhea	34.00%	55.00%	9.00%	2.00%
Pink eye	24.18%	49.37%	21.91%	4.53%
Lameness	29.40%	46.98%	21.11%	2.51%
Respiratory disease	35.34%	54.64%	8.27%	1.75%
Digestive disorders in feeder cattle	15.08%	46.23%	26.38%	12.31%
CNS disorders in cattle	24.69%	52.64%	19.40%	3.27%
Vaccination program development	24.94%	46.25%	23.97%	4.84%
Anthelmintic program development	19.17%	48.79%	27.18%	4.85%

*Values are presented as percentage of total respondents.

Table 15. Descriptive data about clinical skills for beef cattle veterinarians pertaining to topics associated with beef cattle veterinary practice and expertise by practicing veterinarian survey respondents (n=489).

Clinical Skill	Exposure to clinical skill*			
	Excellent	Adequate	Poor	None
Judicious antibiotic usage and antibiotic stewardship programs	21.91%	37.53%	21.91%	18.64%
Pre-harvest food safety	16.16%	36.62%	25.00%	22.22%
Animal welfare and guidelines	20.25%	41.77%	21.52%	16.46%
Beef sustainability and environmental regulations	5.58%	20.05%	32.99%	41.37%
Field research design on beef operations	6.06%	14.65%	32.58%	46.72%
Foreign animal disease preparation	25.19%	45.84%	23.17%	5.79%
Traceability services	8.35%	26.84%	30.63%	34.18%
Beef Quality Assurance	18.94%	33.84%	18.43%	28.79%

*Values are presented as percentage of total respondents.

tions and veterinary college administrators. Veterinarians overwhelmingly indicated that more business exposure is necessary (Table 16). Over 70% of veterinarians surveyed indicated poor or no exposure to veterinary employment contracts, how to set prices on clinical services, how to set prices on consultative services, product pricing or dispensing, return on investments, and rebate program opportunities working with drug or distribution companies. It is imperative that veterinary schools work with their students on small business and personal finance management. Significantly decreasing the cost of veterinary education does not seem to be in the future; therefore, working with students to be entrepreneurial and business-minded veterinarians is essential for the future of the profession.

Perhaps some bovine medicine clinical skills are not being taught because veterinarians are not needed to perform them in practice today; however, veterinarians indicate otherwise. Over 80% of the veterinarians surveyed think that a technical teaching center, not affiliated with a veterinary school, that provided hands-on training for clinical skills competency similar to the ones mentioned above would be beneficial (Table 17). Almost all veterinarians felt there is monetary value if new graduates have these skills on the first day of veterinary practice. Overall, 1 in 4 veterinarians was looking to hire a veterinarian for their clinic at the time of this survey; however, 25% of the veterinarians indicated that they were not employed in private veterinary practice. Accounting only for private practitioner responses, 34% of veterinarians indicated they were planning to hire a veterinary associate, but over 60% felt there are not enough qualified beef cattle veterinarians being produced today by veterinary schools, and 78% of veterinarians surveyed did not believe veterinary schools are devoting enough resources to development of food animal veterinary medicine.

Veterinarians in the survey were asked 4 questions about veterinary associate compensation. They indicated that mean starting annual salary for a veterinarian in their practice area is $64,627, and the median annual salary is $65,000. The lowest annual salary was $40,000, and the highest annual salary was $100,000 for a new associate (Figure 2). The mean and median total compensation packages for new veterinary associates reported by veterinarians in this survey were $78,310 and $75,000, respectively. The lowest total annual compensation packages for new veterinary associates was $45,000 per year, and the highest total annual compensation package for a new veterinary associate was reported as $150,000 per year (Figure 3). When veterinarians were asked about the value of an associate having competency in clinical skills on their first day of practice, they indicated a mean value of $11,550 per year more to the salary and a median of $10,000 per year in additional annual salary compensation (Figure 4). Twelve veterinarians indicated that there was no

Table 16. Descriptive data about clinical skills for beef cattle veterinarians pertaining to routine business practices or concepts by practicing veterinarian survey respondents (n=489).

Clinical skill	Exposure to clinical skill			
	Excellent	Adequate	Poor	None
Contracts	4.56%	21.52%	35.44%	38.48%
Clinical skills prices (Expenses vs Profit)	5.05%	21.21%	35.61%	38.13%
Production medicine skills prices (Expenses vs Profit)	6.63%	22.19%	34.95%	36.22%
Product prices (Expenses vs Profit)	3.54%	19.70%	37.88%	38.89%
Return on investments (equipment real estate, vehicle, etc.)	3.04%	16.20%	38.23%	42.53%
Drug and/or distribution companies and their internal rebate programs	1.27%	8.38%	34.52%	55.84%

*Values are presented as percentage of total respondents.

Table 17. Veterinary survey responses to questions asked to beef cattle veterinarians (n=489) about the supply, demand, and training of beef cattle veterinarians.

Questions	Yes	No
Do you think a technical teaching center not affiliated with a veterinary school that provided hands on training for competency in these clinical skills mentioned above would be beneficial for the veterinary profession?	82.34%	17.66%
Do you think there is a monetary value of having competency in these skills on your first day of veterinary practice?	95.31%	4.69%
Are you currently looking to hire a veterinarian for your clinic?	24.47%	75.53%
Do you feel there are enough qualified beef cattle qualified veterinarians being produced today by our veterinary schools?	37.84%	62.16%
Do you feel veterinary schools are devoting enough resources to development of food animal veterinary medicine?	21.90%	78.10%

*Values are presented as percentage of total respondents.

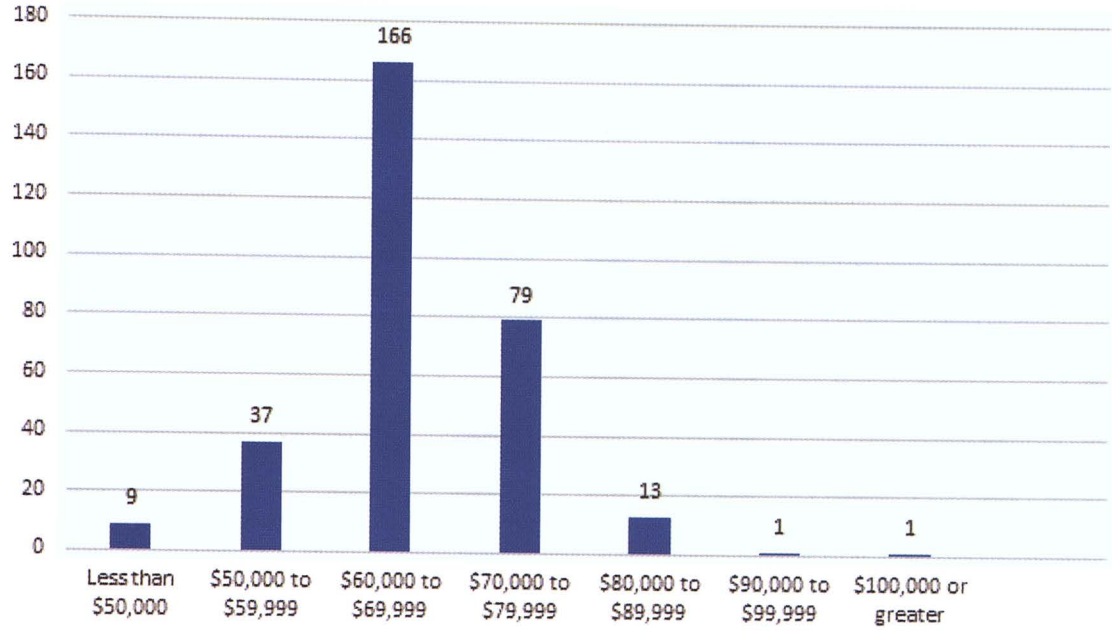

Figure 2. What is the average salary for a new veterinary graduate in your area of practice? (n=306 respondents; 62.6% response rate)
Mean = $64,627, Median = $65,000
Low = $40,000, High = $100,000

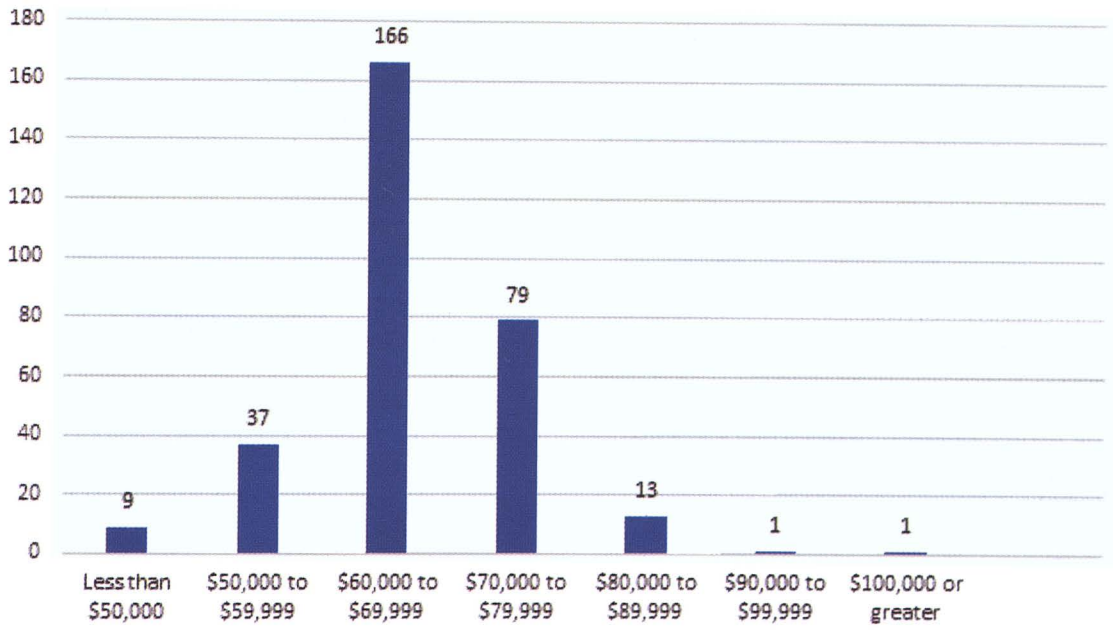

Figure 3. What is the total compensation package value for a new graduate in your area of practice? (n=231 respondents; 47.2% response rate)
Mean = $78,310.39, Median = $75,000
Low = $45,000, High = $150,000

additional value to these skills on day 1 of practice, indicating that these should be considered part of the base skillset of new graduates. Thirteen respondents indicated that there would be an additional $30,000 or more annual salary for a new associate proficient in these clinical skills on day 1 and 2 veterinarians indicated that day 1 competency in these skills would be worth $75,000 in additional annual salary. Nearly all veterinarians estimated it would take over a year or more in practice, and 61% indicated it would take 2 or more years, before a new veterinary graduate consistently makes a return on the investment to a veterinary clinic on their total compensation package.

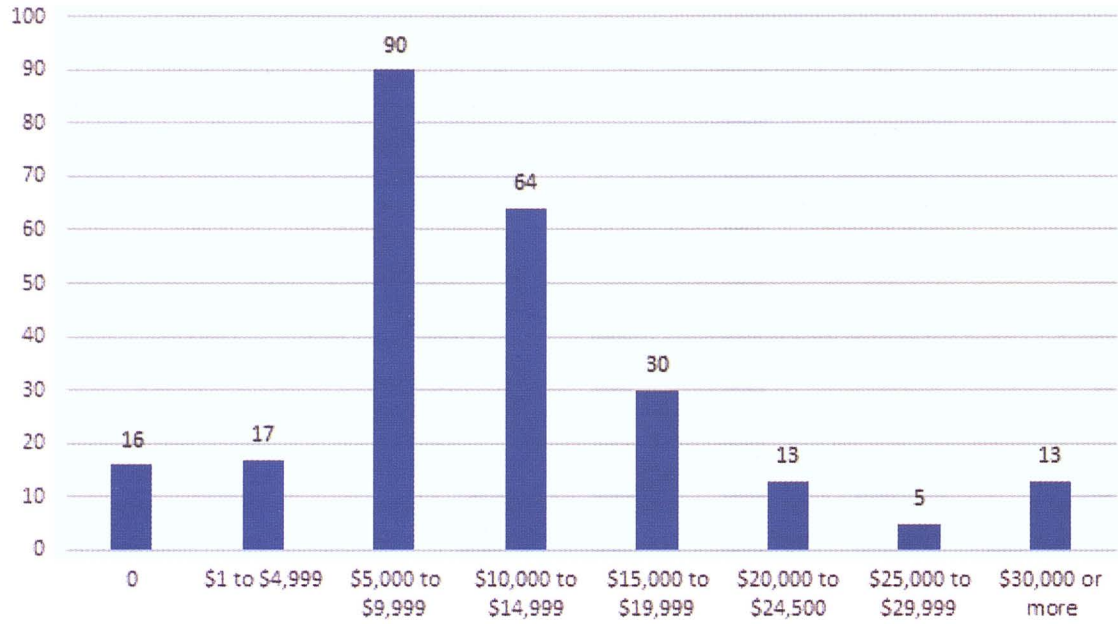

Figure 4. How much more should a new graduate that is proficient in these skills on day one of practice be paid relative to current level of veterinary student training? (n=240 respondents; 49.1% response rate)
Mean = $11,550, Median = $10,000
Low = $0, High = $75,000

Discussion

As most veterinary students today will enter either private or academic clinical practice, teaching clinical skills is extremely important. This is the first report to survey veterinarians regarding the extent to which they were exposed to or allowed to perform various clinical skills while in veterinary school. Survey respondents indicated while there are areas of training that appear adequate, veterinary schools could place more resources and effort into providing bovine clinical skills training in these areas for veterinary students. Veterinarians in this survey indicated that they would be willing to provide higher salaries for veterinary graduates able to perform these clinical skills.

The specific skills in this survey were based on previous reports by Morin et al[10,11] and Miller et al,[8] which evaluated the skills that were important to food animal practice according to veterinary practitioners. These studies addressed food animal surgery and medicine encompassing multiple species. The previous reports were written to serve as a guide for veterinary school curriculum development. Results of the current survey build upon these previous reports in determining if veterinary colleges are providing students with the exposure or opportunity to perform the procedures. There may be clinical skills that are important, but not included in this survey and, likewise, there may be clinical skills that are somewhat outdated as the reports by Morin et al and Miller et al are over 10 years old.[8,10,11]

Veterinary school tuition and fees have continued to increase over the last 30 years.[1] Veterinary schools continue to see the percentage of their budget provided by tuition increase and funding by state governments decrease. It is not clear if state governments are decreasing their absolute funding dollars or if the programs and costs associated with veterinary education are outpacing the budget shortfalls. Student debt may, in many cases, limit the ability of a graduate to accept some employment opportunities.[15] Respondents in this survey indicated they would significantly compensate a new veterinary associate competent in many of the clinical skills listed in this survey. Veterinary schools will need to find ways to help increase the value and salaries of new graduates in all areas of veterinary medicine, but especially through increasing the value of a veterinary degree for people intending to serve rural communities and food animal medicine. The current student debt load and lower starting salaries in rural areas decrease the likelihood that veterinarians will choose rural veterinary practice.

Gordon et al studied the financial implications of veterinarians taking different career tracks. The major findings reported were that specialization in a veterinary field or practice ownership early in the veterinary career had financial benefits over being a general practitioner with no practice ownership.[2] The earlier a person attains ownership in the practice the greater the financial benefit. Even a practitioner with 3 to 4 years of practice ownership prior to retirement benefited by buying into a practice rather than working as an associate. These scenarios and findings further substantiate that if veterinary student tuition and fees are going to continue to increase, veterinary schools will have to increase the value of the degree starting on day 1 if rural veterinary

practices are going to find qualified associates that can afford to go into food animal practice.

Morin et al authored tandem papers on medical skills,[10] and then on surgical skills,[11] most frequently used. Proficiency of clinical skills was positively correlated with frequency of performing the clinical skills. The most frequently performed medical skills by bovine veterinarians were injections, administration of oral medications, rectal palpation, venipuncture, treatment of pneumonia, manual extraction of a calf, treatment of diarrhea, auscultation of heart, lungs and gastrointestinal tract, IV fluid therapy, development of vaccination and anthelmintic programs, control of BRD in a herd, breeding soundness examinations, and fecal flotation. Veterinarians serving larger cow-calf herds indicated that veterinarians needed to be proficient in breeding soundness examination of bulls, pelvimetry, ultrasonography, and genetics/breeding consultation. In the second paper by Morin et al, the most frequently performed surgical skills by food animal practitioners were castration, epidural anesthesia, dehorning, IV/IM sedation, and tattooing.[11] Veterinarians serving larger cow-calf herds recommend that veterinarians be proficient in ovariectomy, gomer bull surgery, penile surgery, liver biopsy, urethrostomy, fracture repair, local anesthesia of the eye, and eye enucleation.[11]

Miller and co-workers described the highest ranked clinical and production medicine competencies for food animal practitioners in feedlot and cow-calf practices.[8] Feedlot veterinarians needed to be proficient in their ability to discuss key influencers of performance; discuss disease prevention; conduct a clinical examination; perform cytology; perform a necropsy; recognize pathology; obtain a complete history; understand injection sites; obtain a correct diagnosis; understand drug selection; recognize, treat and control common diseases; understand production unit overhead; educate clients; and create a successful business plan. They listed the most important competencies for cow-calf veterinarians as the ability to understand beef terminology; conduct clinical examinations; identify risk factors for various diseases; diagnose pregnancy; restrain cattle; provide cost effective treatments; know the attributes of a normal bovine; perform emergency obstetrical procedures; reduce prolapses; correctly administer injections and steroid implants; conduct breeding soundness exam; pregnancy determination; palpate; auscultate; select proper drugs; and measure body condition score to utilize in management decisions within the production cycle.

After comparing results from earlier studies[8,10,11] with the current survey of veterinarians, veterinary schools are doing a good job of providing core medical, surgical, and production medicine skills to veterinary students. However, skills associated with providing services to larger cow-calf and feedlot clients tends to be lacking. Herd sizes in the United States are increasing while the number of herds is decreasing.[13] The expectation for food animal practitioners to provide more specialized services will increase if we want to continue to be a valuable resource for the current and future ranchers and feedlot operators.

The expectation of the level of exposure and competency of food animal veterinary student training needs defined. Veterinary students can gain valuable experience and information on medical, surgical, and production medicine skills in lectures, in clinical skills laboratories on models, cadavers and live animals, and on clinical rotations,[5] in production animal immersion programs[4] as well as during externships in veterinary practices or in industry.[3] It can be difficult for veterinarians to answer whether they obtained excellent or average exposure to a clinical skill if they were only exposed in 1 of the manners listed above. It is clear that exposure to clinical skills is more common than students having actual hands-on experience with these procedures. Obstetrics is a crucial clinical skill usually performed under times of duress for the cow, the owner, and the veterinarian; performing these procedures for the first time under these conditions places the newly graduated practitioner at a disadvantage. Adequate experience with these techniques prior to graduation would result in more confident and competent veterinary practitioners. We often hear the terms, "see one, do one, teach one" in reference to clinical skills as a veterinarian. It seems from this survey that we are stopping our clinical skills teaching at "seeing one".

One of the weaknesses of this study is that it was a voluntary survey with unequal representation of veterinary colleges. This could have introduced unintentional bias (either positive or negative) into the results. Additionally, the survey invitation was sent through professional groups associated with food animal practice; therefore, it may exclude responses from veterinarians that desired to enter food animal practice but did not. These results may also indicate, as Moore et al[9] reported, that many veterinary schools do not have the expertise and/or caseload to provide adequate training across the variety of species and production settings that a new graduate may encounter. Therefore, some form of food animal veterinary consortia was developed to allow veterinary students to participate at designated centers of food animal emphasis. While results of this survey were not reported based on veterinary school attended, it is quite likely that a difference in opportunities for veterinary students exists across training programs.

Remsburg et al[17] has recommended a new health care system for food animals including a food animal health care system where a food animal technician would perform most of the clinical skills described by Morin et al.[10,11] The use of food animal technicians trained to perform veterinary clinical medicine and surgery have been discussed for many years. For years, the dental profession has utilized hygienists and today the medical profession is adapting with nurse practitioners to provide service in human health care.

Veterinary schools provide a general yet inflexible education that has been driven by the interest of the majority of the veterinary students in attendance. This has driven

the food animal and equine specialty training of veterinary students to a very basic level since a majority of the students have no interest in this type of practice. Radostits and Prescott described that veterinary medicine continues to push students through a "narrow and inflexible portal".[16] In a separate publication, Radostits described veterinary medicine's ability to provide core competencies while being unable to provide specialized curricular offerings to students.[15] Not allowing tracking decreases veterinary medicine's ability to expand its services, depth, and value to food animal clients. If veterinary medicine wants to expand beef cattle medical, surgical, and production medicine services and education, it will require specialized departments with students enrolled in food animal medicine similar to the expansion of engineering to specialties like mechanical engineering and others. Specializing in food animal veterinary medicine does not preclude students from learning and practicing basic, core skills in small animal or equine veterinary medicine. It is simply a way to expand veterinary medicine into more areas and provide more value to serve stakeholders.

Conclusion

Veterinarians in this survey indicated there is a need for increased exposure to and training in basic clinical skills needed to be successful in beef cattle practice. Respondents in this survey also indicated that there is a need/demand for more food animal/mixed animal graduates from veterinary schools. Proficiency in clinical skills and being practice-ready could serve as a mechanism to increase annual salaries for new veterinary associates. This survey provides some clarity as to the necessary clinical skills, production services, diagnostic medical procedures, and business management programs that would be valuable in training future food animal practitioners. Decreasing the cost of veterinary education remains a challenge. The profession should continue exploring ways to reduce the cost of education to the student while specializing the educational program to help graduates attain higher compensation starting the first day in practice.

Endnotes

[a]Qualtrics Computer Software, Seattle, WA
[b]Microsoft Excel, Redmond, WA

Acknowledgements

The authors declare no conflict of interest.

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