IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Pharmacists' Role in Veterinary Pharmacotherapy

Awantika N. kale , Sakshi S. Garad ,Madhuri S. Landge , Aditya R. Gawade
Pravara rural college of pharmacy, Loni.

➢ Abstract:

Background: To date, there is very limited data regarding pharmacists' preparation to handle animal prescriptions. No previous studies be found examining the impact of a veterinary-pharmacy–focused educational interference.

Objective: To assess pharmacists' begining knowledge of veterinary pharmacotherapy, as applicable to their professional responsibilities, and assess the impact of a controlled educational program.

Methods: Two studies were managed. The first study involved a statewide evaluation of pharmacists' knowledge of veterinary pharmacotherapy; the second study assessed the impact of an educational interferences to improve pharmacists' veterinary pharmacotherapy knowledge base. Participants in the controlled study were estimate via pretest and posttest.

Results: The statewide sample of participants (n = 602) received a mean score of 5.9 (SD = 2.6) on a 17-item questionnaire. There were no distinct differences in participants' knowledge based on the subject matter of the question (pathophysiology, dosing, counseling, compounding, validity, and toxicology). Using the same 17-item questionnaire, controlled study participants (n = 60) received a mean score of 5.2 (SD = 2.4) on the pretest and 16.6 (SD = 0.7) on the posttest.

Conclusion: The findings of this study suggest that a substantial portion of pharmacists lack the knowledge needed to process and dispense the veterinary prescriptions most commonly encountered in community pharmacies. Furthermore, this study shows that implementation of an educational intervention can increase pharmacists' knowledge of core concepts necessary to safely care for animal patients.

➢ Keywords: veterinary pharmacy, veterinary, veterinary medicine, pharmacy education

➢ Introduction:

The field of veterinary medicine is changing at a considerable pace. Veterinary therapy options have dilated. Additionally, community views on the importance of animals in our lives and homes continue to change the way we care for our pets.[1] Many households consider their animal to be a member of the family.[1]

With this increased disposition to invest in their animal's well-being, owners now spend more on prescription medications for their pets.[1] While veterinary clinics can offer clients cost-effective generic animal drug products, a majority of companion animal medications are reformulated human drug products. This has led to a significant increase in veterinary prescriptions sent to community or online pharmacies.[1] In May 2015, the US Food and Drug Administration estimated that 75 000 pharmacies fill 6 350 000 compounded prescriptions for animals annually.[2]

Having felt the effects of Direct and Indirect salary fees, community pharmacies may find the activity of additional income inviting. But this new trial comes at a significant risk. The pharmacists behind the counter are likely unprepared to safely dispense and counsel animal prescriptions. According to a 2012-2013 survey of 707 veterinarians, one third knew of a dispensing error that occurred at a community pharmacy.[3] Of those reports, one tenth resulted in harm to the animal.

Currently, the Accreditation Council for Pharmacy Education's Standards do not require veterinary pharmacotherapy education as part of any curricula for the training of Doctor of Pharmacy. Furthermore, few accredited Schools of Pharmacy in the United States offer a informative elective in veterinary pharmacy, clinical rotations, or other specialized learning opportunity. This leaves many graduating pharmacists with limited exposure to veterinary pharmacotherapy and may further put animals at risk for harm. To date, there are very limited data regarding pharmacists' preparation to handle animal prescriptions. Thus, the goal of the present study was to fill this gap in literature by investigating pharmacists' baseline knowledge of veterinary pharmacotherapy and evaluate the learning gains obtained from a veterinary pharmacotherapy training program. The authors' overall aim of this research is to achieve safe and effective care for veterinary patients and strengthen the working relationship between veterinarians and community pharmacists.

We accomplished the former goal by conducting 2 independent studies. The first study involved estimating the veterinary pharmacotherapy knowledge of a statewide sample of pharmacists in North Carolina. The second study involved assessing the begining knowledge of community pharmacists, who did not take part in the initial statewide assessment, to determine the degree to which validity proof was detectable with regard to convergence and reproducibility of findings between the 2 assessments. Participants in the second study then completed a veterinary pharmacotherapy training program and their potential learning gains were assessed via a posttest.[3]

➢ Materials and Methods

➢ Design of Veterinary Pharmacotherapy Questionnaire:

The estimation was constructed by 2 pharmacists with considerable training and full-time involvement in veterinary pharmacy. A operative of this study, a nationally recognized expert on the subject of veterinary pharmacotherapy and a mediator of the International College of Veterinary Pharmacy, served as the validating authority of the assessment. The 17-item multiple-choice assessment was intended to identify barriers to the safe dispensing of medications to animal patients. The items selected were based on dispensing errors (pharmacotherapy, substitutions, pathophysiology, and validity and compounding concepts) most commonly reported in available literature[3] and through the authors' professional experience. To score the questionnaire, individuals received 1 point for each correct answer. The maximum number of points an individual could score was 17 points. [4]

➢ Study 1: Investigation of a Pilot Veterinary Pharmacy Training Program

➢ Design :

The pilot study consisted of a non experimental design utilizing pretest and after test groups. The 17-item questionnaire was administered to participants in the controlled study. The diagnostic was administered to

pharmacists in May 2017 in an effort to measure their baseline knowledge of veterinary pharmacotherapy concepts. An educational intervention was created with the intention to improve pharmacists' knowledge of relevant veterinary concepts. This prerecorded, self-paced webinar was provided to all participants following the pretest. The training program began on May 15, 2017, and concluded on October 15, 2017. Because participants are more likely to accurately recall information simply due to the recency of instruction ("recall effect"), and because research has noted that memory begins to fade within hours and days immediately following a learning event (the "forgetting curve"), we administered the after test no less than 5 days after completion of the training in an effort to minimize these types of measurement errors from distorting score accuracy.[5]

- Educational Intervention :

The educational program was a 3-hour session that included information on veterinary drug resources, species-specific pharmacokinetics and dispensing considerations, toxicology principles, compounding, and an overview of statutes and regulations governing veterinary pharmacy practices. The pharmacists were also exposed to veterinary pharmacotherapy training through implementation of their new veterinary pharmacy program and one-on-one training with a pharmacist trained in the field. This final training period offered pharmacists' reinforcement of the veterinary principles and opportunities for topic clarifications. Participants were also given access to numerous references, including veterinary drug handbooks.

- Participants :

A convenience sample of 60 pharmacists was drawn from all employees at a large community pharmacy group in North Carolina. Participants were informed that participation was voluntary, not required as part of their employment obligations, and no incentives would be provided. For inclusion in the study, the participants had to be employed pharmacists with access to the Internet. In an attempt to increase the response rate, a survey reminder was sent 1 week after the initial e-mail.[6]

Veterinarians and Pharmacists Discuss Challenges Around Pet Medications:

A cooperation between veterinarians and veterinary pharmacists is key for the health of pets when those pets need medicine, but it's not always a efficient Working with pet medications comes with its share of challenges.

Lauren Forsythe, PharmD, clinical assistant professor in the department of veterinary clinical medicine at the University of Illinois at Urbana-Champaign's College of Veterinary Medicine, noted that identifying numbers can be an issue.

"NPI numbers are used to indicate those that are eligible to prescribe for Medicare/Medicaid patients but since animal patients aren't eligible for Medicare/Medicaid and veterinarians are only legally allowed to prescribe for animal patients, veterinarians don't have NPI numbers," she said. "Veterinarians do have to have a DEA number if they are prescribing controlled drugs. However, if a veterinarian doesn't have a need to prescribe controlled substances in practice, they may not have a DEA number due to the high cost."

For non-controlled drugs, a state license number is the only number legally required. This can create issues with pharmacy computer systems and discount cards that are designed to work best with NPI/DEA numbers.

Another issue is when human medications are needed for animals. example, knowing what dormant inactive ingredients might be toxic and then finding out if they are there and if the concentrations are high enough for discuss.

"Xylazine is toxic to dogs, but it can be hard to tell if it's in a product because it can be listed so many different ways," Forsythe explained. "Benzyl alcohol can be toxic to cats, but small amounts may be okay, and it can be difficult to determine if the amount present is okay or not."

Dosing differences are also challenging. Forsythe explained that sometimes, pharmacists dose things in animals similar to how they are dosed in humans—and sometimes the dose is completely different.

For example, levothyroxine, phenobarbital, and terbinafine doses used in dogs may seem quite large compared to standard human dosing. Dosing between species varies greatly and there isn't a good way for pharmacists to forecast what does and doesn't anticipate from humans or other species, so looking up veterinary doses becomes essential for dose checking.

"One of the issues is that many of these meds aren't taught in pharmacy school and may or may not have comparable human versions," Forsythe said. "Therefore, the pharmacist may not be familiar with their use, mechanism, and potential adverse effects."

Julya Friedman, PharmD, president of GPS Pharmacy, a concierge pharmacy in Matthews, North Carolina, noted there are also several things that can be challenging due to different terminology and common practices.

For example , in human medicine, QD is the abbreviation for once daily. In veterinary medicine, SID is the abbreviation for once daily.

"Electronic prescribing is a very common practice in human medicine and in some states legally required for controlled substances," Friedman said. "However, veterinary health information systems don't have integrations with a DEA-compliant electronic prescribing system at this point. Therefore, this isn't something that many veterinarians know much about. The result may be a pharmacist saying something about electronic prescribing and a veterinarian assuming they are referring to printing a typed prescription from their computer system."[7]

- Veterinarians Speak:

On the veterinarian side, Jamie Whittenburg, DVM, veterinarian director at Senior Tail Waggers, and director of Kingsgate Animal Hospital, a full-service animal hospital in Lubbock, Texas, noted the biggest challenge is availability.

"The vast majority of medications we use are not veterinary specific, which I believe is not commonly understood," she said. "In recent years, out of stock have severely affected the availability of pharmaceuticals for all areas of medicine, both human and veterinary."

Like Forsythe, Whittenburg noted that there can be misunderstandings between veterinarians and retail pharmacists on DEA license numbers.

"One issue that occurs frequently is pharmacists requesting, or refusing to fill a prescription without, a veterinarian's DEA license number," she said. "Some veterinarians do not possess a DEA license. Pharmacy software in some large retail chains require the number which can lead to refusal of the pharmacy to fill the requested drug if the veterinarian cannot or will not provide one."

Lauren Witter, DVM, a veterinarian at Small Door Veterinary in Washington, D.C., noted that another challenge is ensuring accurate dosing based on the animal's weight and condition.

"We must also be aware of potential adverse reactions or drug interactions," Witter said. "Most important, we have to ensure deference with the prescribed treatment regimen, that usually means finding a palatable form so that we're not fighting our pets to give them their required medication."

Therefore, it's important that vets and vet pharmacists work together.

"Their skillfullness helps ensure that the prescribed medication is modified to the unique needs of the animal, considering factors like species, size, and any fundamental health conditions," Witter said. "Vet pharmacists can also compound custom medications when commercial formulations are unreachable or inappropriate for a specific patient's needs. This cooperation enhances the safety and efficacy of pet medications."[8]

➢ Pharmacy Law and Regulation:

Since legal drug dispensing to veterinary patients does not require the oversight of a pharmacist, a unique strong exists surrounding the retention of pharmaceutical services. Veterinary students often have little training in the regulations or legal aspects of ordering, storing, accounting for, and dispensing controlled and hazardous substances. Maintaining records and disposing of expired and hazardous drugs are not high-priority topics in most veterinary curricula. The strict standards that have been instituted in human medical practice to avoid secondary exposure of employees to chemotherapy, infectious wastes, and other hazardous products (e.g., dimethyl sulfoxide, chloramphenicol, prostaglandins, pesticides) may also eventually, and surely need to, be extended to veterinary medicine. Veterinarians stand to suffer significant financial and regulatory outcomes should they fail to follow these regulations. With greater environmental and extensive safety issues appear , it is predicted that regulatory agencies such as the professional Safety and Health Administration (OSHA) will intime play a more significant role in veterinary medicine.[9]

Regulations on the use of bulk drugs for compounding and the preparation of sterile products outside of a controlled sterile environment may also have a dramatic effect on how veterinarians currently dispense drugs to their patients. With new pharmacy regulations in most states requiring clean-room environments to prepare sterile products, the cost of therapy for patients requiring these products will rise significantly, and other treatments will have to be explored.

Following graduation, veterinarians begin to explore outside options for drug purchase. Frequently, this may involve the assistance of a human medicine pharmacist, who will typically have well-grounded knowledge about human-labeled products and the ever-changing regulations on controlled substance. It is critical to understand, however, that most community or hospital pharmacists have little, if any, background in veterinary pharmacy and may mistakenly provide information that is incorrectly extrapolated from human drug data. Without a solid background in pharmacology and pharmaceutics, an inexperienced veterinarian may assume the information provided is accurate. Therefore, it is vital that the veterinarian be familiar with the pharmacist's training and background and understand where limitations may exist in applying this knowledge to veterinary medicine.[10]

➢ TRAINING PHARMACISTS IN VETERINARY MEDICINE:

The majority of pharmacists who graduate today are trained in an concentrated clinical program designed to enclose not only a traditional dispensing role but a more active role in the human pharmacotherapeutic process that allows them to provide expertise in drug dosing, outcome monitoring, patient evaluation, and patient education. Most pharmacy curricula provide three years of intensive informative teaching followed by one year of clinical coursework. Classroom courses focus on pharmaceutical concepts of drug formulation, pharmacokinetics, and biochemistry, as well as patient assessment and drug monitoring through physical assessment, patient education, and drug information skills. Most pharmacy education programs have added components that focus on alternative and integral medicine in an effort to provide a picture of health to a population of consumers that demands a complete approach. Pharmacy educators see that pharmacists in the health care community continue to be, both physically and economically, the most accessible members in the health care team. The goal of most pharmacy curricula today is to turn out a graduate who can function in an ever-expanding variety of practice settings.[11]

Training pharmacists solely for dispensing and tracking drugs has virtually disappeared. As the practice of medicine truly encompasses an evidence-based model, pharmacists are required to have not only a mental databank of drug concepts but also the skills required to hone the wealth of drug information available into a concise, appropriate medication plan. The concept of a pharmaceutical care model of pharmacy education has been evolving since the mid-1960s. The cornerstone of this movement was a defined emphasis on the concept of pharmaceutical care, first described by Hepler and Strand in 1990:

Pharmaceutical care is the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life. These outcomes are cure of disease, elimination or reduction of a patient's symptomatology, arresting or slowing of a disease process or preventing potential drug-related problems. Pharmaceutical care involves the process through which a pharmacist cooperates with a patient and other

professionals in designing, implementing, and monitoring a therapeutic plan that will produce specific therapeutic outcomes for the patient. This, in turn, involves three major functions: 1) identifying potential and actual drug related problems, 2) resolving actual drug-related problems, 3) preventing potential drug-related problems.[12]

Like all clinical practitioners, pharmacists are trained to reduce drug-related morbidity and mortality and to balance affordable health care access with optimal health management. Many states license pharmacists as practitioners who enter collaborative practice agreements with physicians, allowing pharmacists a greater role in drug therapy and management. A 2003 study showed that of 48 states surveyed, 32 had pharmacist collaborative-practice laws, while 23 states allowed pharmacists to initiate and modify drug therapy under a protocol. Pharmacy has a clear mission in human medicine and a well-defined role in the health care team. The clinical role of pharmacists in veterinary medicine has only recently been recognized, however, and opportunities for pharmacy students and pharmacists in the world of veterinary medicine continue to evolve.

Upon graduation from a doctor of pharmacy (PharmD) program, pharmacists are increasingly likely to complete specialized residency programs. General-emphasis residencies in either a hospital or community setting can be, and often are, followed by a specialty residency in a variety of settings, from pediatrics to transplant medicine to oncology to drug informatics to pharmacokinetics and drug research.[13]

As is often the case in health care professions, there are many paths to a career in veterinary pharmacy. Traditional pharmacy education has typically offered few opportunities for most students to gain experience in veterinary medicine. Historically, many veterinary pharmacists have gained most of their knowledge from their own prior experience working with animals or from on-the-job training, with little to no didactic or clinical education in veterinary medicine. Frequently, pharmacists' training is exclusively focused on human medicine.

As the field of veterinary pharmacy has continued to evolve, however, the need for coursework and clinical experience for pharmacy students in veterinary medicine has been recognized. Didactic elective courses introducing species contrast in relation to metabolism and consequent pharmacology have emerged in a number of pharmacy schools around the United States, often in close association with a veterinary teaching hospital. Clinical elective rotations specializing in veterinary medicine have also evolved in some locations, often at pharmacy schools in close proximity to a veterinary teaching hospital and with a veterinary pharmacist as preceptor. Time, administrative, and financial constraints placed on many veterinary pharmacists by their academic institutions have hindered the time remaining to donate toward establishing a veterinary pharmacy elective course or precepting pharmacy and veterinary students.[14]

Despite the fact that there are only a handful of established didactic and clinical courses in veterinary pharmacy, there are a number of emerging and evolving training opportunities. At the Veterinary Medical Teaching Hospital at the University of California, Davis, a clinical veterinary pharmacy residency program has been established to further educate pharmacists in this specialized field. Creighton University has a well-established online course for pharmacists designed to cover pertinent veterinary therapeutics, pharmacology, and dosing topics.[10] Additionally, there are specialized training programs that provide experience in the basic skills needed to compound drugs for veterinary patients. Additional training opportunities continue to emerge for pharmacists with an interest in veterinary medicine.[15]

➢ UNDERSTANDING THE ROLE OF VETERINARY PHARMACISTS:

The key to better utilizing pharmacists in veterinary medicine is finding mutually beneficial roles for the two professions. Historically, job opportunities in the field of veterinary pharmacy have been limited. Pharmacists were first employed in academic veterinary hospitals in the early 1970s. Here, the role of a pharmacist frequently involved overseeing pharmaceutical operations such as drug distribution, controlled drug accountability, maintenance of inventory, compounding of drugs, and provision of drug information services. Commonly, pharmacists were sought for employment in veterinary hospitals for cost-containment and licensing purposes. The first pharmacists in veterinary medicine had an important role that reflected the standard of pharmacy

education and practice at that time. As veterinary medicine has evolved, so has pharmacy education. Pharmacists trained today have skills that differ in some ways from those of their predecessors.

As the role drug therapy plays in veterinary medicine expands, the relationship and communication between veterinarians and pharmacists are continuing to grow. Veterinarians are seeking out specialized pharmacy practices with greater frequency, for several reasons. Veterinarians often seek a pharmacist to provide information on drugs of choice in antibiotic-resistant cases, toxicology of human drugs ingested by animals, the use of drugs in renal failure, unfamiliar human drugs, and regulatory protocols. Given both the growth in both fields, veterinarians are seeing pharmacists more involved at an academic as well as a community level. It is clear that, although veterinarians and pharmacists are more visible to each other than ever before, there is still a significant disconnect between how they view each other and how each field may best interact with the other on an academic level. Veterinary medicine and pharmacy, while never exclusive of one another, have only recently begun interacting on a more formal level.[16]

Many pharmacists employed at large academic veterinary hospitals have influence not only on dispensing drugs but on teaching and research. Most pharmacists in this setting have the ability to guide clinicians and students on many issues of drug therapy, from pharmacokinetics to drug regulation. Pharmacists are now commonly seen playing several roles in veterinary medicine. The initial contact veterinarians may have with a pharmacist is during their education. More progressive schools of veterinary medicine employ a pharmacist not only to oversee the pharmacy but also to teach courses in pharmaceutics, pharmacology, toxicology, antibiotic therapy, chemotherapy, total parenteral nutrition, and pharmacy law.

Clinically trained veterinary pharmacists can also be part of the veterinary clinical faculty, where they are an integral part of the veterinary team. Some of their contributions include reviewing patient drug profiles, identifying symptoms that may be adverse effects of drugs, and assisting in drug therapy choices. Pharmacists can also assist in drug therapy decisions based on renal function, hepatic function, adverse effects, cost, and efficacy; clinical pharmacists can provide advice on medication overdoses or toxic chemical ingestions. When therapeutic options are limited by commercially available pharmaceutical preparations, pharmacists may also assist the veterinarian in formulating an alternative compounded product that is both stable and clinically efficacious.[17]

Often pharmacists in a veterinary setting are met with many misunderstanding concerning their practice, their training, and their unique set of skills. As discussed, few academic pharmacy curricula offer classes that cover veterinary physiology, pharmacology, and therapeutics. Outside of the elective classes taught, an average pharmacy student is not versed in many of the basic issues surrounding veterinary therapeutics. These misunderstanding may often lead to harmful effects in animals. One common error involves the fact that pharmacists are not educated to recognize some of the nomenclature that is unique to veterinary medicine. For example, the common veterinary abbreviation SID (for “once daily”) is not recognized in human medicine and therefore may be misunderstanding as QID (“four times daily”). This mistaken frequency could easily result in toxicity.[18]

Formal academic training in the unique drug compounding skills required to assist veterinary patients is also lacking in most academic pharmacy curricula. The practice of compounding is now, realistically, a specialty within pharmacy rather than the antiquated cornerstone of pharmacy education.[19] Compounding is no longer a common part of the syllabus in most pharmacy schools. Often pharmacists who wish to practice in veterinary medicine or veterinary compounding must use distance education programs, professional membership training, or traineship/mentor education modalities that differ greatly in the quality of the training they provide.[20]

One of the most controversial misunderstanding veterinarians have about pharmacy is that pharmacists who have come from a strictly human medicine pharmacy training will have undergone sufficient training in chemistry, pharmaceutics, and veterinary physiology to provide a safe and effective product for veterinary use and can safely make compounded medications for veterinary patients Unfortunately, this is not always the case.[21] Excipients, solvents, and preservatives that are easily allow in the compounding of human formulations may result in toxicity when used in small animals or exotic species. In an attempt to formulate products with greater palatability or easy drug delivery for human use, active ingredients can be inactivated or altered enough to decrease their clinical utility for veterinary use. [22]Because of a significant lack of regulatory

oversight of compounded formulations, veterinarians must understand the innate risks of using compounded medications and the legal responsibility of the prescriber.[23]

➢ CONCLUSION:

It appears clear that veterinary medicine and pharmacy will continue to grow together. There is a clear lack of formal academic programs that foster the growth of this relationship. It is crucial that veterinary academic administrators support programs that provide pharmacy students with sufficient training in veterinary medicine. While growth and innovation are rarely easy, a lack of advancement will leave both fields lacking a clear vision and purposeful interaction. The most readily available way for veterinarians to advance the field of pharmacy is to demand interaction with qualified, animal patient–oriented, trained pharmacists. Conversely, veterinarians must have a broad enough background in pharmaceutics, drug information, and critical evaluation of drug therapy to ask the correct questions of pharmacists who have been trained in human medicine and are providing drugs for their animal patients. On many levels, a higher level of practice will evolve if veterinary medicine demands it. Veterinarians must not settle for an inferior compounded product or a pharmacist who does not have an appropriate understanding of their patients. It is pharmacy education's authority to turn out an adequate number of pharmacists to meet the growing demands from veterinary medicine. A united focus on pharmacy and veterinary medicine will prove advantageous for both professions.

➢ REFERENCE:

1AmericanVeterinary Medical Association [AVMA]. U.S. (2001).*Pet Ownership and Demographics Sourcebook*.Schaumburg, IL:AVMA **Google Scholar**

2Animal Health Institute [AHI] (2005).US consumers spend nearly $5 billion to protect health of pets and farm animals..Washington, DC:AHI(news release) <**http://www.ahi.org/Documents/MktSales2004.pdf**>. Accessed 08/10/05. **Google Scholar**

3Merrit, AM, Sanchez, LC, Burrow, JA, Church, M, Ludzia, S (2003).Effect of Gastrogard and three compounded oral Omeprazole preparations on 24h intragastric pH in gastrically cannulated mature horses.*Equine Vet J.35*,691-695 **Medline**, **Google Scholar**

4Mealey, KL, Peck, KE, Bennett, BS, Sellon, RK, Swinney, GR, Melzer, K, Gokhale, SA, Krone, TM (2004). Systemic absorption of Amitriptyline and Buspirone after oral and transdermal administration to healthy cats.*J Vet Intern Med.18*,43-46 **Medline**, **Google Scholar**

5Ciribassi, J, Luescher, A, Pasloske, KS, Robertson-Plough, C, Zimmerman, A, Kaloostian-Whittymore, L (2003).Comparative bioavailability of Fluoxetine after transdermal and oral administration to healthy cats.*Am J Vet Res.64*,994-998 **Medline**, **Google Scholar**

6Karriker, M, Wiebe, V, Parsons, K, Stanley, S (2005).Plasma concentration of Enrofloxacin in cats after transdermal administration of a PLO gel formulation.*J Vet Intern Med.19*,444 **Google Scholar**

7Lust, E (2004).Veterinary information for pharmacists.*US Pharmacist.29*,(1):,1-8 **Google Scholar**

8Hepler, C, Strand, L (1990).Opportunities and responsibilities in pharmaceutical care.*Am J Hosp Pharm.47*,533-543p7 **Medline**, **Google Scholar**

9Punekar, Y, Lin, S, Thomas, J (2003).Progress of pharmacist collaborative practice: status of state laws and regulations and perceived impact of collaborative practice.*J Am Pharm Assoc.43*,503-510 **Google Scholar**

10. Federal Register. Compounding animal drugs from bulk drug substances; draft guidance for industry; availability; withdrawal of compliance policy guide; section 608.400 compounding of drugs for use in animals. https://www.federalregister.gov/articles/2015/05/19/2015-11982/compounding-animal-drugs-from-bulk-drug-substances-draft-guidance-for-industry-availability. Published May 19, 2015. Accessed June 9, 2018.

11. Cima G. Substitution errors: surveys describe harm from differences between prescriptions and drugs dispensed. *J Am Vet Med Assoc*. 2014;245:462-482. [PubMed] [Google Scholar]

12. Karriker M, Wiebe V. Pharmacists in veterinary education: bridging the gap. *J Vet Med Educ*. 2006;33:248-252. [PubMed] [Google Scholar]

13. May K. April board of directors meeting wrap-up. http://atwork.avma.org/2015/04/12/april-board-of-directors-meeting-wrap-up/. Published April 12, 2015. Accessed February 22, 2018.

14. National Association of Boards of Pharmacy. Veterinary pharmacy education (resolution 110-5-14). https://nabp.pharmacy/veterinary-pharmacy-education-resolution-110-5-14/. Published May 30, 2014. Accessed February 22, 2018.

15. Ceresia ML, Fasser CE, Rush JE, et al. The role and education of the veterinary pharmacist. *Am J Pharm Educ*. 2009;73:16. [PMC free article] [PubMed] [Google Scholar]

16. Theberge CR, Sehgal I. Bringing more veterinary pharmacy into the pharmacy curriculum. *Am J Pharm Educ*. 2016;80:89. doi: 10.5688/ajpe80589 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

17. Animal drug compounding update: North America in the lead. *PCAB Today*. February 28, 2018. [Google Scholar]

18. Arnish CE, Davidson GS, Royal K. Veterinary pharmacy education: prevalence and perceptions. Poster presented at: Society of Veterinary Hospital Pharmacists, 34th Annual Meeting; June 14-17, 2015; Portland, ME. [Google Scholar]

19. Grimes DA, Schulz KF. Bias and causal association in observational research. *Lancet*. 2002;359:248-252. [PubMed] [Google Scholar]

20. Ebbinghaus H. *Über das Gedächtnis: Untersuchungen zur experimentellen Psychologie*. Leipzig, Germany: Dunker & Humblot; 1885. [Google Scholar]

21. Murre JMJ, Dros J. Replication and analysis of Ebbinghaus' forgetting curve. *PLoS One*. 2015;10:e0120644. doi: 10.1371/journal.pone.0120644 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

22. Rea LM, Parker RA. *Designing and Conducting Survey Research. A Comprehensive Guide*. 4th ed. San Francisco, CA: Jossey-Bass; 2014. [Google Scholar]

23. Linacre JM. Winsteps® (Version 3.92.0) [Computer software]. Beaverton, OR: Winsteps.com; 2017. [Google Scholar