Anatomy in practice: how do equine and production animal veterinarians apply anatomy in primary care settings?

Ben Homfray; Mifeddygon Dolgellau Veterinary Surgery, Bala Rd, Dolgellau, LL40 2YF; BVetMed MRCVS, Mixed Veterinary Surgeon

Ali Attwood; Department of Comparative Biomedical Sciences, The Royal Veterinary College, London NW1 0TU, UK; BVetMed MRCVS, Veterinary Surgeon

Sarah B Channon; Department of Comparative Biomedical Sciences, The Royal Veterinary College, London NW1 0TU, UK; BSc, MSc (Vet Ed), PhD, FHEA; Associate Professor in Veterinary Anatomy; schannon@rvc.ac.uk ORCiD 0000-0003-0134-4908

Abstract

To successfully prepare veterinary undergraduates for the workplace, it is critical that anatomy educators consider the context in which developing knowledge and skills will be applied. This study aimed to establish how farm animal and equine general practitioners use anatomy and related skills within their daily work. Qualitative ethnographic data in the form of observations and semi-structured interviews were collected from 12 veterinarians working in equine or farm animal first-opinion practice. Data underwent thematic analysis using a grounded theory approach. The five themes identified were relevant to both equine and farm animal veterinarians and represented the breadth and complexity of anatomy, its importance for professional and practical competence, as well as the requirement for continuous learning. The centrality, and broad and multifaceted nature of anatomy was found to challenge equine and farm animal veterinarians highlighting that essential anatomy knowledge and related skills are vital for their professional and practical competence. This aligns with the experiences of companion animal clinicians which have been described previously. In equine practice, the complexity of anatomical knowledge required was particularly high, especially in relation to diagnostic imaging and assessing normal variation. This resulted in greater importance being placed on formal and informal professional development opportunities. For farm animal clinicians, anatomy application in the context of necropsy and euthanasia was particularly noted. Our findings allow anatomy educators to design appropriate and effective learning opportunities to ensure that veterinary graduates are equipped with the skills, knowledge and resources required to succeed in first opinion veterinary practice.

Key Words

Anatomical knowledge; anatomy education; lifelong learning; clinical relevance; professional skills; graduate attributes; veterinary anatomy; visual imagery; complexity.

Introduction

The vastness of anatomical knowledge, across multiple regions and species not only challenges veterinary medicine students[1,2] but also those that teach them[3,4]. Whilst anatomical knowledge is relatively unchanging, the work of a veterinarian has transformed and expanded in many ways over the last 100 years. Eyre questioned '*Why do we still expect a new veterinarian to have mastered all the science and medicine of 'all creatures great and small' and be able to enter any branch of our diverse profession with the same level of competence?*" [5]. Mastering the detailed anatomy of all species within a modern veterinary curriculum would be an unrealistic aim, since the time available for teaching basic sciences is substantially reduced compared to within traditional curricula[6–8]. Despite this, anatomy educators still need to ensure that students are adequately prepared with a sound fundamental understanding of the structure and function of the 'normal' animal[4]. An evidence base is currently lacking regarding what key anatomical knowledge is most needed for veterinary practice and how this is applied in different settings. Without this, there remains a risk that veterinary anatomy curricula may not be relevant and applicable to modern veterinary practice, and that today's veterinary graduates will be unprepared for the workplace.

Aside from developing knowledge, anatomy teaching strives to develop vital relevant professional, procedural and cognitive skills[9–11]. Modern anatomy teaching has been shown to help enhance spatial skills for example[12–17] which are important to a clinician for success in surgery [18,19] as well as for tasks such as interpreting diagnostic images. Anatomy practical teaching, including handling/dissecting cadavers and sessions with live animals, provides opportunity to develop palpation skills (eg haptic perception) [20–22] and to practice clinical skills commonly used in first opinion practice (e.g. instrument handling) [23–25]. Anatomy teaching is often team based [26–29] and provides opportunity to develop communication and group work skills [30–33], vital professional attributes. Identifying the skillsets required by veterinarians in the workplace, and the circumstances in which they are used can help educators integrate appropriate opportunities to develop these skills within anatomy teaching. A focus on 'how' as well as 'what' we teach will guide educators to select teaching approaches and methodologies that best support skills development, not just knowledge acquisition.

Previous work has investigated how companion animal veterinarians use anatomy knowledge and skills within their daily roles in primary care practice. It identified several key areas where anatomy education could enhance the application of anatomy within this common first-opinion species speciality[34]. However, the diversity amongst species-specific general practice settings means that the findings are not necessarily transferable to all graduate destinations. A good proportion of graduates work in mixed practice (13 – 28 % dependant on source), equine (6 - 8 %) and farm animal (4 -5 %) species specialities [35–37], which feature very different workplace characteristics to companion animal work. The required knowledge and skillsets of individuals working within these fields are likely therefore to be divergent from their companion animal equivalents. An understanding of how anatomy knowledge and anatomy-relevant skills are utilised in equine and farm animal practice is still thus

required if veterinary educators are to be able to create the most relevant and applicable anatomy curricula.

This study aimed to establish how farm animal and equine general practitioners use anatomy and anatomy-relevant skills in their daily work. As an exploratory ethnographic study, there was no specific hypothesis, moreover the aim was to provide a rich and thorough account of the settings and culture, and the actions and interactions of the veterinarians during their daily work.

Materials and methods

Ethics

All participants signed a consent form approved by the Royal Veterinary College Social Sciences Research Ethical Review Board, reference URN SR2019-0122. All participant identities are anonymised.

Participants

Data for this study were collected at two equine first opinion practices in North-West England and one mixed species practice (predominantly farm and equine) in the East of England. In total eleven veterinarians across the three settings participated in the study (7 from equine only practices and 4 from the mixed practice). Veterinarians were selected based on convenience (working and available whilst the observer was based at the practice) and were from a mixed demographic (Table 1).

Observations

Observational data were collected over the period of one week at each practice from veterinarians during their daily work. A minimum of one full day of observations were collected for each veterinary surgeon participant. Participants were shadowed during their normal working hours, and direct observations were noted by hand. These field-notes focused on a range of topics related to how the participant used their anatomy knowledge and relevant skills during their working day and included quotes, notes of the veterinarians' actions, case discussions between clinicians and in some cases, background information for context. Voice recordings (made with consent using the observer's mobile phone voice recording app or a dictaphone) of discussions with the veterinarians were collected where the author felt an explanation was required or had questions regarding their approach. Throughout data collection respondents were encouraged to talk through their thought processes when approaching clinical problems, interpreting information gained through diagnostic tests/ imaging, and when administering treatment, with a particular emphasis on anatomy.

In all cases the observer and interviewer was a final year veterinary medicine student at the Royal Veterinary College [RVC]. This gave the investigator the appropriate insight to be able to link anatomical learning to its application in a clinical environment. It also ensured the investigator had sufficient clinical knowledge to be

able to understand the relevance of the observed cases to the study question and aims.

Interviews

Semi-structured individual interviews were undertaken with all participating veterinarians which were audio recorded using a voice recording application on a mobile phone. Interviews occurred once respondents had contributed to the field data, giving them an opportunity to understand the study purpose to improve the meaningfulness of their answers. The interview questions focused on: background of the clinician, e.g. undergraduate education, including their own experiences of anatomy teaching; perceived daily use of anatomy knowledge; preparedness as a new graduate; changes in anatomy knowledge since graduation; perceived importance of anatomy knowledge for veterinary practice. Further follow up questions were used where more detail or clarification was desired.

Due to the immersive and time-consuming nature of the study, data collection ceased at the end of the six-week period allocated for this phase of the research, not when data saturation was deemed to have occurred. In total over 120 hours of observational data were collected, with an additional 8 hours of interview data recorded. Observational data were initially collated by hand in Microsoft Excel. Interview data along with any other audio recordings from observations were transcribed into Microsoft Word.

Data analysis

Interviews and observational data were examined using thematic analysis through a constructivist grounded theory approach[38]. This involved an iterative approach to analysis, in parallel with observations and interviews, allowing initial data to inform subsequent data collection.

Transcripts and observational data were coded manually by the investigator (who was also the observer and interviewer during the study). Initial ‘open’ codes were assigned which were subsequently refined into more focused codes, following an iterative process of comparison, defining and refining codes. Later, axial coding took place to identify patterns and explore the relationships between codes, resulting in identification of broad concepts and ‘themes’. Data and associated codes and themes were subsequently reviewed and confirmed by a second person, who was not present for data collection.

Data relating to equine practice/ practitioners and farm practice / practitioners were analysed both separate from each other and combined. This allowed identification of themes and subthemes which were common to both specialisations, but also those which featured in only one domain to be highlighted.

Data were also analysed quantitatively, for context, by assessing the types of clinical cases observed, and the anatomical body systems involved. Quantitative data were compiled in Microsoft Excel, and GraphPad Prism used for graphical representation of the data.

Results

Demographic information

Participants ranged in gender, experience (the least time post-graduation being less than one year, and the greatest over 20 years), and species focus. Table 1 provides a breakdown of this information.

Contextual data

Consultations observed were a mixture of single animal and multi-animal consults. Consultations involving 43 farm animals occurred during the period observed: animals involved were predominantly cattle, but also sheep and goats (Figure 1). Clinical presentations of cases included pregnancy, weight loss and traumatic injury. Examples of procedures observed included intramuscular injection, intravenous injection, clinical examination, and partial digit amputation. Issues featuring the reproductive system were most commonly observed on farm visits (61 %) followed by musculoskeletal issues (30 %; Figure 2).

Ninety-seven horses were observed being assessed/ treated (Figure 1). The most common reason for a visit was for vaccination/bloodwork (43 %) followed by lameness/ musculoskeletal issues (22%; Figure 3). Examples of procedures observed included intramuscular injection, intravenous injection, dental treatment, nerve blocks, imaging (ultrasound and radiography), lameness examination and gastroscopy.

Overview of Main Themes

The main themes identified were common to both farm and equine general practice, with variation only in the sub-themes. The main themes were: Breadth of Anatomy; Continuous Learning; Anatomical Complexity; Professional Competence; Practical Competence. These themes and their subthemes are shown in Figure 3.

Breadth of anatomy

Veterinarians described anatomy as having ‘no boundaries’ and acknowledged that their knowledge was necessarily incomplete because of this. In some areas, where relevant to common procedures or tasks, clinicians had a detailed understanding of a particular anatomical structure/ region. Most participants felt they had good ‘big picture’ understanding and foundational knowledge and referred to ‘windows of anatomy’ to describe the clinically relevant anatomy which they used on a more regular basis.

> “It’s more of an understanding rather than a discrete erm, memory of complete anatomy. It’s an understanding of the way anatomy is put together” [V8, interview]

> "You learn the bits you need to know like I know the nerves running down the legs because I inject into it every week. But if you asked me on the other nerve pathways, I probably wouldn't have a clue" [V2, interview]

> "Knowing the important things about the important parts of the body for example knowing the extremities of the tendon sheaths, joint margins, location of major blood vessels, nerves. Knowing where they are so that you can avoid compromising them if you are doing surgery or if you can anticipate what an injury may have interfered with" [V8, interview]

However sometimes detailed knowledge was lacking, and clinicians suggested this was due in part to 'clinical attrition'.

> "My anatomy then was far better than it is now" [V8, interview]

> "You had to know your landmarks of intercostal space 5, or whatever, or its behind left 12 or whatever. I can't remember now, that's really bad!" [V11, interview]

> "It has been such a long time…you don't remember that much…its so much to do and so many structures that it's impossible and obviously all of the species as well. You're not going to remember all of them" [V9, interview]

Continuous learning

Related to the boundless breadth of anatomy as a subject, veterinarians all engaged in on-the-job learning in this area. All referred to using common and preferred reference texts and many used web sources routinely to find anatomical images and information, especially in the field.

> "You open up a book. You don't have another choice, you have to open a book and you actually have to have more than one because each book will cover another angle" [V9, interview]

> "If I want a quick answer, it'll probably be Google. That's a good place to start, you know when I'm out in the middle of a field" [V11, interview]

Veterinarians highlighted experience as being important in defining their relationship with anatomy, as well as their cultural background and lifestyle outside of the profession. For example, those who grew up in rural areas, or with more hands-on experience of horses noted that anatomical knowledge was part and parcel of being an equestrian.

> "I grew up on a farm, so I was all the time having to handle horses, calves and cattle. Er and as a matter of daily course you'd have to consider…one's animal's anatomy…constant exposure outside of the profession to having an appreciation of anatomy" [V8, interview]

Equine practitioners especially highlighted the importance of their colleagues and formal continued professional development [CPD] in furthering their anatomical

knowledge. These subthemes did not feature amongst the farm animal practitioner cohort.

> "Going to BEVA [British Equine Veterinary Association congress] … this is case based teaching and this sticked with me well. Because you remember stories better than you remember facts" [V5, interview]

> "I think your colleagues teach you a lot, it's very useful to have a colleague who can point to bits and go 'yeah you're in the right place' before you go in" [V6, interview]

Anatomical complexity

It was evident that an ability to navigate complex 3D relationships was an important skillset for veterinarians, and that they had a firm appreciation of this.

> "If you are presented with a wound…you need to think what structures lie underneath the wound or are likely to be involved…" [V6, observation, wound treatment]

> "Calving…so basically working out whether its going to fit through the hole…" [V11, interview]

> "A three-dimensional imagination of the anatomy that you're about to inject into is quite useful to have. So, we use it every time we go and see an animal" [V8, interview]

For equine veterinarians specifically, obtaining and interpreting diagnostic images, including complex radiographic views was a requirement of their day-to-day work. Equine clinicians also cited newly available technology such as gastroscopy as contributing to the need for them to be able to deal with highly complex anatomical relationships.

> "X-rays are 2D and therefore you want as many angles as possible because this gives you a better idea of it [the region] in 3D and making your chances of spotting lesions more likely" [V5, observation, taking x rays of lame horse]

> "We did two oblique x rays looking for a fracture and damage to the periosteal surface. And did a DMPLO [dorso-medial palmaro-lateral oblique] view and medio-lateral, and latero-medial – but these two couldn't see much…" [V1, observation, wound on limb]

> "My anatomy definitely did help me with the positioning of my tube. I think when I was learning [at university] scopes and things like that were less frequently done and the technology now makes them more widespread and readily available" [V5, observation during gastroscopy]

Many participants alluded to using strong visual imagery to utilise/access their anatomical knowledge, and some were observed drawing or sketching to convey

their knowledge to others. V5 for example was observed drawing out pictures with her finger on the stable walls when conversing with clients and the observer.

> "You actually just need to visualise the picture in front of you so you will know where and what you are going to do…good anatomical understanding means that you can visualise, in your mind, the structure that you are dealing with" [V9, interview]

Veterinarians were observed dealing with dynamic changes in anatomy, for example during motion of an animal (lameness assessment), assessing changes over time, or comparing healthy/ diseased structures on opposite sides of the body. They reported a clear comprehension of normal versus abnormal as critical to their success, and in addition equine veterinarians required a good working knowledge of natural anatomical variation, especially with respect to the conformation of feet and limbs.

> "In everything you do you need to understand the repercussions of what you're touching and compressing, and what effect it's having on joints and soft tissues around the body" [V8, interview]

> "It's all about predicting how what you do/ change will influence the horse's teeth in the future ie if I rasp this it will stop the other side getting sharp" [V3, observation during dental work]

> "What am I expecting it to look like if its normal? If its not normal, then why not? If it's a hock, does it have OA [osteoarthritis] changes?... does it have a fracture?" [V5, observation]

> "It's important to know where things should be, compared to when they're not " [V10, farm, interview]

> "I also always ultrasound both limbs for comparison for a better reference of what's normal in that horse" [V3, observation, ultrasound of distal limb]

Professional competence

The theme of professional competence resonated strongly for both farm and equine clinicians, who felt that their anatomical knowledge and skills were essential for them to be able to ensure a trusting relationship with clients.

> "Its very important because if you get it wrong, clients will lose faith in you. You're only as good as your last job" [V8, interview]

Veterinarians, especially equine clinicians, described that the ability to communicate to clients and colleagues using anatomical terminology was vital for their work. Additionally, they shared that it was important to them to have a foundation of knowledge and the ability to communicate this information in order to be effective teachers and mentors within their roles. This was relevant for those hosting veterinary students on placement or working with junior colleagues.

> "You need to be able to describe where exactly the markings or the whirls are using the correct anatomical language" [V1, during microchip/ passport consultation]

> "…so I can describe it correctly in my clinical notes, so when other vets read it, they can understand, that is something I enjoy doing" [V6, interview]

> "I took out a student and we did de-horning on three cattle, and I could just about remember my nerve blocks…. I was able to go out and recall everything and actually be succinct and be like, right, OK, so we need to inject here, and do this, do that. And for me, its being able to do that confidently without having to refer on that particular day" [V11, interview]

Practical competence

Veterinarians relied on their anatomical knowledge to ensure they were safe and competent in performing practical and clinical skills. Both equine and farm veterinarians used anatomical knowledge for performing surgery and clinical procedures.

> "A good anatomical understanding isn't so much the specifics of the names of the muscles… it's knowing the area of safety or the areas of potential problems" [V8, interview]

A number of individuals could recount stories or experiences where safety was compromised due to deficient anatomical knowledge.

> "I had one case where a farmer had actually injected a cow…as he was coming in or out he'd injected the nerve, the sciatic nerve, and the cow went down. So I think it's quite important even to know where to inject and also obviously its important when you're doing your caesareans or anything like that, LDAs to know where everything should really be, in order to put it back in the right place kind of thing" [V10, interview]

> "It wasn't until I was actually giving IV injections and vaccines when I really stated to think of the structures I need to avoid. You hear horror stories of when new graduates inject into the carotid and these kinds of things make you really start thinking twice, even now I double check these things" [V6, observation during vaccine consult]

> "You need to be aware of the important structures which the sarcoid may be associated with. If they are on the face you need to be aware of the transverse facial nerve. I've seen it done and it's an absolute classic where you hit it and paralyse the horse's face" [V3, observation during sarcoid removal]

> "I don't think I learned about it [palatine artery] in vet school. I did my first few sets of wolf teeth with V3 [experienced clinician] and it was with him when I hit the palatine artery. The horse had a blind one which was fine" [V1, observation, tooth extraction]

The ability to locate external landmarks through observation and palpation was considered key to performing clinical examinations. Palpation skills and a good working anatomical knowledge were also required for internal (rectal) examination in equine and farm species. Farm clinicians commented that they used their anatomy knowledge for necropsy.

> "We do postmortems on the 'largies' as well which does require a fairly good recollection of anatomy but anatomy that we're not going to be faced with on a daily basis" [V8, interview]

Discussion

This study establishes that a strong core foundation of clinically relevant anatomy knowledge, and the requisite skills to navigate complex anatomical information and seek out the unknown, are vital for the practical and professional competence of equine and farm veterinarians. Due to the boundless nature of knowledge within this discipline, it is an unrealistic, and unnecessary requirement for veterinarians to know it all. Instead, core knowledge, professional, practical, psychomotor, and lifelong learning skills should be considered as threads, which interweave to allow veterinarians to use and apply anatomy knowledge within their daily work. These findings have implications for how undergraduate veterinary anatomy education is designed, delivered, and integrated with the rest of the curriculum to ensure that teaching represents an authentic and adequate preparation for veterinary graduates.

Both equine and farm animal clinicians identified that essential anatomy knowledge and related skills are vital for their professional and practical competence, and that gaps in essential knowledge can compromise safety during clinical procedures. Despite the differing species and emphases of equine and farm veterinary practice, there is clear synergy in the themes and subthemes that were identified during this study. Both equine and farm veterinarians shared common views and experiences relating to the anatomically relevant knowledge and skills required to succeed in their daily roles. The themes identified within this study are also similar to those identified in previous work that focused on companion animal veterinarians [34], further emphasising that a focus on developing key core foundational knowledge, together with a broad understanding and transferrable skills may be a better educational aspiration than imparting detailed knowledge of the anatomy of *all* creatures great and small.

Breadth and complexity of anatomy

Anatomy educators face the competing demands of reduced curriculum time available for anatomy learning[6–8] versus the need to teach sufficient breadth and depth of anatomy to allow omnicompetence[39] . This appears to be acknowledged and accepted by the veterinarians in this study who recognised the breadth and complexity of anatomy as a subject. They described utilising relevant windows of

403 ‘working’ anatomy knowledge as a coping strategy, similar to clinicians in small
404 animal practice [34], though it follows that for differing species specialities these
405 windows will not necessarily be alike. This suggests that for anatomy learners
406 studying veterinary curricula, a focus on core foundational knowledge and generating
407 a big picture understanding coupled with emphasis on lifelong learning skills [40] is
408 likely to be a more valuable aim than aiming to achieve both breadth and depth of
409 coverage of information.

410 Aside from the core knowledge required to carry out their roles, veterinarians
411 emphasise the criticality of key psychomotor skills. Principally, they report a need to
412 navigate spatial and 3-dimensional relationships within their work and to utilise visual
413 imagery. These were deemed important for dealing with complex diagnostic imaging
414 views and carrying out clinical procedures and examinations. There is an increasing
415 body of work suggesting that novices and experts move their eyes in different gaze
416 patterns during visual based tasks, including when learning anatomy and histology
417 [41,42], pathology [43], when interpreting diagnostic images [44] and when in the operating
418 theatre [45]. The ability to employ quality memories of visual exemplars may be an
419 important part of making sense of visual information in clinical practice [46,47]. In fact
420 ‘noticing’ and discriminating between different qualities, visual or otherwise, may be
421 a key aspect of a clinician’s role [48]. This meaning making through sensory cues is
422 suggested to be critical in the ability to make comparisons and identify normal from
423 abnormal [49,50] - recognised in this study as being one of the deeply dynamic facets of
424 anatomy that veterinarians must cope with. Consequently, teaching students to ‘see’
425 and ‘feel’ should be central components of undergraduate veterinary anatomy
426 curricula [34,40]. These skills need not be developed exclusively within anatomy
427 teaching, paving the way for more integrated interdisciplinary teaching which carries
428 with it other well established benefits [51–54]. Art-based teaching approaches, and
429 many extracurricular interests and hobbies for example allow students to utilise their
430 observation skills, practice using visual imagery and deal with objects in 3D space [55–
431 57].

432 The need for veterinarians to apply anatomy in a dynamic context poses challenges
433 for anatomy educators. Traditional anatomy teaching using cadavers alone may not
434 be sufficient for enabling students to gain an appreciation of dynamics; a cadaver,
435 particularly when formalin-fixed, is by its nature rather static. Participating in
436 dissection of a single animal also limits the available opportunities for experiencing
437 anatomical variation. Anatomy educators have for some time been concerned about
438 the challenge of sufficiently exposing undergraduate students to variation, in an era
439 of reduced time available for anatomy teaching [58–61]. Teaching methods involving live
440 animals and involving comparisons of multiple animals/specimens are likely to be
441 beneficial supplements to dissecting cadavers and may promote appreciation of
442 difference and dynamics. Whilst many studies have looked to compare the learning
443 benefits of dissection versus prosection [62–65] as well as evaluating the efficacy of
444 other static approaches such as anatomical models [66], none to our knowledge have
445 fully considered whether and how more dynamic approaches to teaching might
446 augment the traditional offering.

447

Professional and practical competence

Anatomy proficiency was integral to the perceived professional and practical competence of veterinarians in this study. Safety was a strong theme that was identified, with clinicians highlighting anatomy proficiency as key to correct and safe performance of procedures. Others have previously highlighted that patient safety, care, and treatment are strongly linked with client trust [67]. Veterinary medical education, much like human medicine[68,69] is moving towards a competency based approach [70] with the introduction of Entrustable Professional Activities (EPAs) – units of professional practice requiring multiple integrated competencies [67,71–73]. The current study highlights the importance of foundational and relevant anatomical knowledge for veterinary students and graduates within the EPA framework, in ensuring true competence in key professional activities.

Like in companion animal clinicians[34], anatomy knowledge facilitated successful communication between equine/ farm veterinarians, and equine/farm veterinarian and client. However, previous work noted that poor anatomical terminology use was a barrier to effective communication[34] which was not a theme that was identified from the farm and equine clinicians. This might reflect differing communication requirements, and/ or timescales within the different segments of the profession. For example, small animal clinicians may have a high number of personal interactions in a working day with members of the practice team (other veterinarians, nurses, and reception staff), as well as often seeing a high case load within a single day. The principally ambulatory nature of equine and farm animal first opinion practice might provide clinicians with time to consolidate and reflect ahead of any communication requiring anatomical language with close colleagues or with a referring practice. Alternatively, equine/ farm clinicians may undergo more streamlined team interactions making communication less complex. Studies considering communication between colleagues in veterinary practice are sparse[74,75], however there is some evidence highlighting the critical importance of communication between referring veterinarians and specialists in the outcomes of referral care [76] and in the context of errors in clinical practice [77]. Further work is required to fully explore communication within various types of veterinary team.

Species Specific Requirements

Only 5 subthemes (complex views, natural variation, colleagues, CPD, and imaging) were identified as important for equine clinicians, but not farm veterinarians, and one subtheme as unique for farm clinicians alone (necropsy and euthanasia).This perhaps reflects the high level of anatomical detail required of some limited body regions by equine clinicians (principally the distal limb) but also the increasingly common use of advanced diagnostic technology in the field in first option equine practice (e.g. radiography, ultrasonography, endoscopy[78,79]). Whilst a new graduate is unlikely to be expected to be competent in performing such diagnostic procedures at Day One[80], it is clear that proficiency in such procedures is increasingly part and parcel of a role within first opinion equine practice. This may explain the greater importance placed upon the support of colleagues and formal CPD opportunities by

equine clinicians compared with colleagues in other species specialities. They saw clear and undisputable value in working with experienced colleagues and external training opportunities; perhaps the relatively more solitary nature of daily ambulatory practice acts as a driver to seek out and relish these types of opportunity in equine first opinion clinicians.

Limitations

Qualitative studies such as this share common limitations; often they study small populations, a trade-off for being able to study individuals and their environments in greater depth than broader sampling allows. Similarly, they focus on a restricted number of study settings. This study used three first opinion practices, one mixed practice and two equine. Generalisability of the results of this study to other types of setting is not guaranteed but through careful selection of practices to be as representative as possible, and by studying a range of participants of varied demographic characteristics, we have maximised the applicability of our findings. It is notable that we chose to use a mixed practice rather than pure farm animal practice. This was based on convenience as well as a desire to sample a range of farm animal cases, rather than exclusively, for example, dairy work such as might be encountered in some larger exclusively farm animal practices. However, the specific context should be considered in interpreting our findings. Similarly, the data for this study were collected over a two-week period. Farm and equine practice do include an element of seasonality to the case load, and clinician activities. The data for this study were collected in late Spring/ early Summer, and so may not reflect challenges and experiences of veterinarians at other times of the year, especially during key periods such as lambing time. The finite period available for data collection means that theoretical saturation is not guaranteed to have been reached.

One inherent limitation of ethnographic studies is bias [81], either of the study participants or the investigators. Conformation bias within the study participants in relation to their past/present experiences of anatomy is a possibility however difficult to remediate against. Investigator bias may have influenced the observations taken, and subsequent thematic analysis. This was minimized as much as possible via dual coding of the data during analysis, once by an investigator who had been present during observations and interviews, and secondly by an independent researcher who was not involved in data collection.

Further Work

The results of this study provide a foundation to carry out further work needed to fully understand how best to prepare veterinary graduates for the workplace. A key component of this work will be determining what the core foundational anatomical knowledge should be for a new veterinary graduate and how this can be best taught within the curriculum. Similarly, a better understanding of how integrated teaching and assessment approaches can optimise the development of information literacy, psychomotor and professional skills in veterinary students is required.

Conclusion

This study finds that a strong core foundation of clinically relevant anatomy knowledge, and the requisite skills to navigate complex anatomical information and seek out the unknown, are vital for the practical and professional competence of equine and farm veterinarians. Sufficient working anatomy knowledge was essential for communication, trust, and confidence, and for undertaking clinical activities proficiently. Where requirements were outside of their working window of anatomy knowledge, clinicians relied on multiple sources of information and support to continually learn and develop in this area. The three-dimensional, visual, and dynamic facets of anatomy were particularly important to veterinarians as they navigated complex spatial problems and structures. This aligns with the experiences of companion animal clinicians. Species specialisms provided distinct challenges regarding anatomy use, especially in equine practice where the complexity of anatomical knowledge required was particularly high, especially in relation to diagnostic imaging and assessing normal variation. This resulted in a greater degree of importance attributed to formal and informal professional development opportunities in equine clinicians. Our findings have implications for how anatomy educators design and integrate anatomy learning opportunities within veterinary curricula so that core anatomical knowledge and anatomically relevant skills are appropriately developed for application in the first opinion veterinary workplace.

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Author Contributions

Conceptualization: S Channon
Data curation: B Homfray, A Attwood
Formal Analysis: S Channon, B Homfray, A Attwood
Investigation: B Homfray, A Attwood
Methodology: S Channon
Project Administration: S Channon
Supervision: S Channon
Visualisation: S Channon
Writing – Original Draft: B Homfray, A Attwood, S Channon
Writing – Review & Editing: S Channon

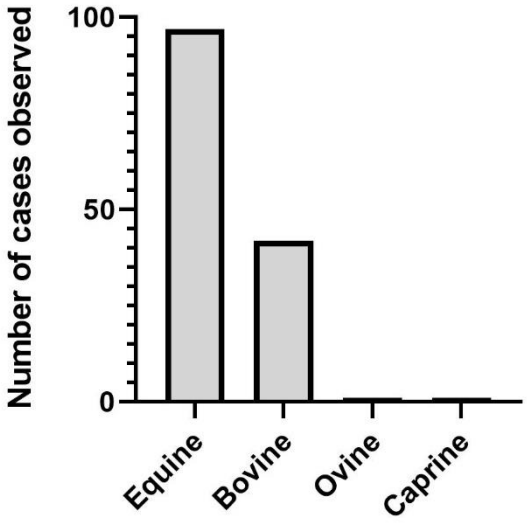
Tables

Participant number	Practice number	Species Focus	Experience (years)	Gender
V1	1	Equine	2.5	F
V2	1	Equine	5	F
V3	1	Equine	15	M
V4	1	Equine	>20	M
V5	2	Equine	9	F
V6	2	Equine	18	F
V7	2	Equine	<1	F
V8	3	Farm	10	M
V9	3	Farm	5	M
V10	3	Farm	2	F
V11	3	Farm	2	F

Table 1. Demographic breakdown of participants

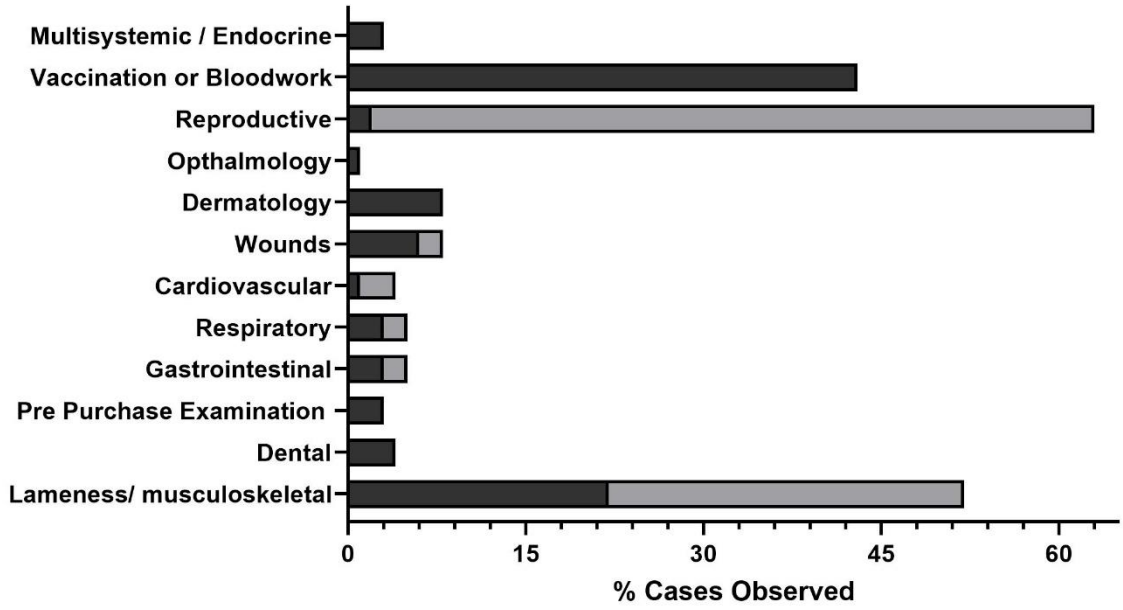
Figure legends

Figure 1. Number of cases observed during this study, by species



858

859 Figure 2. Breakdown of types of clinical case observed in a) equine and b) farm
860 animal practice. Numbers are a percentage of total cases observed.



861

862 Figure 3. Themes (left) and subthemes (right) identified through observations and
863 interviews with veterinarians in first opinion equine and farm animal practice.
864 Subthemes in red were identified only in equine clinical settings and those in purple
865 only relevant to farm animal practice. Themes and subthemes in black text were
866 relevant to both farm and equine settings.


Breadth of Anatomy
No boundaries; Incomplete knowledge; Big picture understanding; Basic foundation; Clinical relevance; Clinical attrition
Anatomical Complexity
3D relationships; Complex views; visual imagery; dynamic; Making comparisons; observing; natural variation
Continuous learning
Reference text; Web sources; Experience; Culture; Colleagues; CPD
Professional Competence
Communication; Trust; Teaching/ mentoring; Demonstration; Confidence
Practical competence
Safety; Clinical procedures; Surgery; Clinical exam; Landmarks; Imaging; Palpation; Problem solving; Necropsy and Euthanasia

867