



# Are Swedish vet students ready to use antibiotics?

Characterizing the confidence and preparedness of final-year veterinary students around antimicrobial use

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Swedish University of Agricultural Sciences, SLU  
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Veterinary Medicine Programme

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## Abstract

Increasing antimicrobial resistance (AMR) is a global crisis, and veterinary antimicrobial use (AMU) plays an important role. As much of the available literature on this topic focuses on the working veterinarian, this study chose to focus on the future professionals of the field: the veterinary students. A few international studies have recently set out to assess veterinary students' knowledge around AMU, but these studies have not focused on how the students see themselves putting their knowledge into practice. Because of this, the aim was to gain an in-depth understanding of the process around prescribing antimicrobials as understood by Swedish veterinary students in their final year. This was accomplished through a qualitative study in which in-depth interviews framed by social practice theory were conducted with 11 final-year veterinary students. The interviews focused on four clinical scenarios (mastitis and metritis in dairy cows; pyoderma and pyometra in dogs) to highlight the materials, competencies and meanings framing their future practice around AMU. The resulting data were subjected to a reflexive thematic analysis, which incorporated a comparison with Swedish antibiotic treatment guidelines and conversations with Swedish experts in the four clinical scenarios.

The interviews revealed that the students had a strong critical approach to AMU, and their reasoning in the clinical scenarios showed a clear alignment with the guidelines in several areas. As a result, the students did not appear to be particularly lacking in knowledge; instead, they lacked confidence in their ability to prescribe antimicrobials when deemed necessary, most likely due to a perceived lack of hands-on training. Other practices vital to combatting AMR also did not appear to be heavily featured in the clinical training, such as follow-up practices or consideration of a herd perspective also in individual cases. Assumptions present in both the students' answers and the guidelines similarly did not seem to be discussed in teaching; for example, the varying reasons why different species get different treatment are often connected to assumptions of meanings, such as the economic value of an animal or the human-animal bond.

These deficiencies could be addressed by future revisions to the veterinary program, such as incorporating more external training, distributing practical exercises throughout all years of study, or extending the program.

*Keywords:* Antimicrobial Stewardship, Veterinary Education, Social Practice Theory, Mastitis, Metritis, Pyoderma, Pyometra



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## Abbreviations and glossary

AGP	Antibiotic growth promoter
AMR	Antimicrobial resistance
AMS	Antimicrobial stewardship
AMU	Antimicrobial use
Antibiotic	A substance destroying or inhibiting the growth of bacteria
Antimicrobial	A substance destroying or inhibiting the growth of microorganisms
FAO	Food and Agriculture Organization of the United Nations
One Health	An integrated, unifying approach to balance and optimize the health of people, animals and the environment
SLU	Swedish University of Agricultural Sciences
TA	Thematic analysis
TUVET	Additional training for veterinarians with degrees from countries outside the EU/EEA and Switzerland
WHO	World Health Organization
WOAH	World Organisation for Animal Health

# 1. Introduction

Increasing antimicrobial resistance (AMR) is a global crisis that threatens health-care as we know it, in both human and veterinary medicine. Organizations and governments worldwide are constantly trying to combat this crisis with the help of action plans and new legislation. Veterinarians and their use of antimicrobials are a critical part of the problem as well as the solution, and many efforts are being made worldwide to improve the knowledge and protocols for veterinary antimicrobial use (AMU). However, much of the available literature on this topic focuses on the working veterinarian, leaving out the future professionals of the field: the veterinary students.

In recent years, a number of international studies have been undertaken to assess veterinary students' knowledge in regard to AMU. These have focused on measuring the students' knowledge levels in subjects related to appropriate use of antimicrobials, for example, their knowledge of pharmacology and whether they are aware of any local/national AMU guidelines. What is missing from these studies is a focus on the students' sense of preparedness and how they see themselves handling cases in practical terms when they go out into veterinary practice. Thus, allowing for the identification of the key components that will form their practice, as well as any potential mismatch of skills or routines between them and their future working environment. This master's thesis, therefore, responds to this lack of research.

## 1.1 Aims and objectives

The primary aim of this study was to gain an in-depth understanding of the process around prescribing antimicrobials as understood by Swedish veterinary students in their final year.

The objectives were to identify:

- The materials, competencies, and meanings (i.e., material arrangements, social norms, and work structures) considered by the students.

- The theoretical or practical experiences present or absent from their training, and how this affects their confidence around AMU/AMR.

A secondary aim of the study was to contribute to an overarching project, that aims to increase knowledge of AMU practices across contrasting species and countries and to develop contextualized routines for reducing AMU.

## 2. Literature review

### 2.1 Antimicrobial resistance: What is it?

Antimicrobial resistance is present in all parts of the world and the increasing prevalence is a crisis that threatens both human and animal health (WHO 2015). The overuse of antimicrobial drugs has recently led to the emergence and spread of antimicrobial resistance at an accelerated rate (O'Neill 2016). As bacteria multiply and adapt in the presence of an antibiotic, they may develop resistance to it, which can then lead to resistance to an entire class of antibiotics, as many of them are related (WHO 2015). The resistant bacteria can circulate between humans, animals, and the environment, which means that overuse or misuse of antibiotics in animals also may influence antibiotic resistance patterns elsewhere. Because some of these characteristics are the same for antiviral, antiparasitic, and antifungal drugs, the more general term antimicrobial resistance is commonly used.

### 2.2 The role of the veterinarian

Without access to effective antimicrobials in agriculture, the world's population will not have an adequate supply of safe food (FAO 2021), so ensuring good animal health is essential for human health. The veterinary profession has a vital role to play in the challenge of AMR as veterinarians have contact with both animals and their owners, and their prescriptions are often instrumental in providing animals with antimicrobial treatment. The role of the veterinary professional is not limited to activities related to food production; it also includes companion animal populations as well as wildlife. It is a common practice that certain antibiotics that are critical for human medicine are used in pets or zoo animals if veterinarians deem this pertinent. Yet, the context of this judgment-based practice is seldom monitored, thus the impact of it is somewhat unknown (Committee for Medicinal Products for Veterinary Use 2015) yet equally relevant to the challenge of AMR.

In 2015, the World Health Organization (WHO) published a global action plan to tackle the growing AMR crisis, calling for a One Health approach to deal with it

(WHO 2015). When it comes to the contribution of the veterinary sector to AMR, the action plan highlights the problem that antibiotics are given to healthy animals in many countries, both for disease prevention and as antibiotic growth promoters (AGPs). It also highlights that, in most countries, antibiotics are readily available without a prescription from a veterinarian (or other health professional).

To underline the One Health nature of the AMR crisis, the WHO is also working with the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (WOAH, formerly known as OIE) on this issue (WOAH 2016). Each has its own published plan to tackle the AMR crisis, and the WOAH strategy specifically notes that veterinary antimicrobials are readily available in many countries and that their use is largely uncontrolled.

## 2.3 Plans to improve

The WHO global action plan details five objectives to combat AMR:

1. “to improve awareness and understanding of antimicrobial resistance through effective communication, education and training;
2. “to strengthen the knowledge and evidence base through surveillance and research;
3. “to reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures;
4. “to optimize the use of antimicrobial medicines in human and animal health;
5. “to develop the economic case for sustainable investment that takes account of the needs of all countries and to increase investment in new medicines, diagnostic tools, vaccines and other interventions. (WHO 2015, p. VII)

With regard to the fourth objective, the WHO discuss the importance of countries implementing antimicrobial stewardship programs to support the optimization of AMU and help assure that AMU at the national level is evidence-based according to international standards (WHO 2015). The term antimicrobial stewardship (AMS) was coined in the context of human healthcare but has recently been increasingly used in the context of animal health (Dyar *et al.* 2017). A study aimed at defining the term proposed the following definition of AMS: “A coherent set of actions which promote using antimicrobials responsibly” (Dyar *et al.* 2017, p. 796). As examples of such actions, as a veterinarian in the role of prescriber, the study cites following the local guidelines for AMU, making correct diagnoses, and regularly reassessing whether therapy is needed.

Within the second objective of the global action plan, the WHO (2015) address the need for scientific studies to inform the design of AMS programs for them to be truly effective, and identify academia as one of the bodies with a responsibility to generate and translate knowledge on methods to combat AMR. Universities also have a responsibility to train the next generation of veterinary professionals. The first objective in the WHO plan speaks of improving awareness and understanding of AMR, and the WHO specifies that they want AMR to be a core component of education and training in the health and veterinary sectors (WHO 2015). The WOAHA (2016) also emphasize that we need to create a working culture that supports sound veterinary AMU and that the way to do this is to increase the knowledge of AMR, mainly through veterinary regulatory bodies and educational institutions.

However, prudent AMU is not just about having the proper training; professionals also need to be able to access and afford rapid and effective diagnostic tools (WHO 2015). Definitive diagnoses are essential to ensure evidence-based antimicrobial prescribing. Therefore, having appropriate diagnostic tools integrated into veterinary practice should be the standard of care (Bruce *et al.* 2022). By extension, this should be equally applied to veterinary education; without learning how to use these tools during veterinary training, the likelihood of them being used by future veterinary professionals is reduced, alongside the potential benefits to the fight against AMR.

## 2.4 The veterinary role in Sweden

Sweden has a long-standing tradition of prudent use of antimicrobials and associated high animal welfare standards (Grundin *et al.* 2020). In 1986, Sweden was the first country in the world to ban the use of all AGPs in production animals. At the same time, all antimicrobials classified as veterinary medicines were made available only on veterinary prescription (Ståhle 1996 in Grundin *et al.* 2020). To this day, pharmacies are required by Swedish law to dispense veterinary medical products only on prescription by a veterinarian (HSLF-FS 2021:75).

In both human and veterinary medicine, the total antibiotic use in Sweden has decreased in recent decades (Grundin *et al.* 2020). This has been accompanied by a decrease in the use of broad-spectrum antibiotics and a gradual increase in the use of narrow-spectrum antibiotics. However, Grundin *et al.* argue that the situation in Sweden today may be favorable due to a reduced spread of infection and a higher resilience in livestock. They attribute this to the Swedish animal welfare legislation (which is the most comprehensive in the EU) as well as the country's long-established work to eradicate infectious diseases and prevent their introduction. As

a result, some infectious diseases that cause problems and escalate the AMU, and thus AMR, in other countries do not exist in Sweden. Another reason for the low AMU that Grundin *et al.* address is that Swedish veterinarians get no financial return by prescribing antimicrobials, as they cannot sell drugs directly to animal owners, but must refer them to a pharmacy to pick up the prescription. In contrast, many other countries have radically different economic structures where the sale of medicines is highly linked to the veterinarians' income or professional economic model. All of these factors imply that veterinarians work within a greater context, and that the success of Swedish veterinarians with regard to AMU is partly due to the work of farmers and the greater society; meaning, Swedish veterinarians have a favorable environment with few limiting factors preventing a rational AMU.

### 2.4.1 Stewardship of antibiotics in Sweden

The Swedish government (2020) has a national strategy for the efforts directed to combat AMR. This strategy is framed around One Health and consists of seven objectives. One of which calls for increased knowledge and awareness in society about AMR and how to fight it, detailed as:

- good knowledge and awareness exist among all concerned, including the general public, about preventive measures for the spread of infections and the risks of resistance development in the use of antibiotics
- knowledge is translated into behaviors that lead to slowing down the rise of antibiotic resistance (Swedish Government 2020, p. 12)

As the strategy is framed around One Health, it touches all aspects of society. As a result, it excludes any specifics, such as what knowledge is required of veterinarians, as well as how they are meant to acquire this knowledge and translate it into the right behaviors. The prerequisite for “good knowledge and awareness” among future professionals is that the concerned education programs exist and are good enough.

### 2.4.2 Legislation and guidelines: Framing AMU for veterinary professionals

To provide context to the veterinary AMU in Sweden, it is important to review the rules and guidelines available to Swedish veterinary professionals as these serve as a foundation to the efforts against AMR. EU regulations on this subject were revised in 2022, and currently prohibit preventive use of antibiotics in groups of animals and of antimicrobials in medicated feed (Regulation (EU) 2019/6 of the European Parliament and of the Council). They also include possibilities to reserve certain antimicrobials to be used only in human medicine. Swedish regulations state that for veterinarians to prescribe quinolones or third/fourth generation cephalo-



sporins, microbiological investigation and sensitivity testing need to establish that such prescription is absolutely necessary (SJVFS 2022:1), as these antibiotics are critical to human medicine and should be reserved for this purpose to the greatest possible extent (Swedish Veterinary Society, Section for Production Animals 2017).

In Sweden, antibiotic treatment guidelines are available as support for veterinarians to be able to make treatment decisions based on the risk of emerging resistance. The general theme in the guidelines is to never use antibiotics routinely or for preventive purposes (Swedish Veterinary Society, Section for Production Animals 2017). Therefore, they recommend obtaining a bacteriological diagnosis to support the clinical one before deciding on antibiotic therapy, ideally there should also be a sensitivity test to consider (Swedish Veterinary Society, Section for Production Animals 2017; Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022). When antibiotic prescription is needed, the rule is to always opt for the effective antibiotic with the narrowest spectrum, as a broader spectrum drives resistance in more bacterial species (Swedish Veterinary Society, Section for Production Animals 2017). For production animals in Sweden, penicillin is often the drug of choice as it has a relatively narrow spectrum, and many pathogens are sensitive to it. The type of antibiotic is not the only factor to consider in order to reduce the spread of resistance; aspects such as dosage and treatment duration are also addressed in the guidelines, as they too affect the spread.

## 2.5 The veterinary student

The aforementioned action plans and other initiatives to combat AMR tend to focus on things like regulations, guidelines, and practicing veterinarians. The only organization that specifically targets veterinary students is the WOAHA, as they have issued a call to action for the students to help combat AMR (WOAHA 2018). In this plea to veterinary students, the WOAHA asked them to include seven specific practices in their future line of work, such as learning what the first-line choice antimicrobials are, determining whether antimicrobial treatment is needed, and always performing culture and sensitivity testing. In their own words: *“Your future work with animals, farmers and policy makers means that you will be at the frontline in the battle for antimicrobial resistance”* (WOAHA 2018, "WE NEED YOU").

### 2.5.1 How are Swedish students trained to use antimicrobials?

The literature from Sweden only mentions veterinary education in passing, for example, a report on the Swedish efforts towards prudent AMU in animal production (Grundin *et al.* 2020). The report was published by the Swedish University of

Agricultural Sciences (SLU), which is the country's only university with a veterinary program. This report briefly states that field veterinarians are taught about disease prevention and proper AMU. Similarly, the Swedish Government (Swedish Government 2020) mentions education as part of the Swedish AMR strategy, but states only that relevant education should include elements like AMR as well as infection prevention and control. There are no reports describing what Swedish veterinary education looks like or how it is delivered. In response to this gap in the literature, this thesis highlights the role of Swedish veterinary students as the future professionals in the field.

The current structure of the veterinary program at SLU is the same for all students admitted from 2017 to 2022 (SLU n.d.b). On a superficial level it is divided into a pre-clinical (years 1–3) and a clinical part (years 4–5), in addition to the final semester which consists of the master's thesis. The main introduction to AMR starts with the course “General mechanisms of disease” in year 2, where the students are first introduced to bacteriology, virology and parasitology (SLU n.d.c). This knowledge is then further applied in the clinical part of the program. The course in “Clinical veterinary medicine” is worth 95 credits and takes place during years 4–5, during which the students are introduced to a wide array of clinical practices – including AMU – under the operation of the university. The course objectives state that the students should be able to “describe how drugs affect resistance development as well as their ecotoxicological consequences from a sustainability perspective” (SLU n.d.d). This course is divided into many smaller parts, one of which is “Veterinary external auscultation”. This part is worth 3 credits, which translates to two weeks of the course. For these two weeks, the students must choose a veterinary workplace to visit and observe a practicing veterinarian; this is the only time during 5.5 years' worth of studies that the students are sure to observe veterinary practices outside of the university as a part of the program. This can be compared to the veterinary nursing program at SLU, which is 3 years long but includes a total of 20 weeks of external placement where the students are spread out in clinics throughout the country (SLU n.d.a).

### 2.5.2 Knowledge of antimicrobial use among international students

Studies on the role of veterinary students have been conducted in Australia (Hardefeldt *et al.* 2018), South Africa (Smith *et al.* 2019), and Europe (Espinosa-Gongora *et al.* 2021). The researchers involved have broadened the question of how to tackle the AMR crisis by focusing not only on the role of the practicing veterinarians, but also on the knowledge and perceptions of future prescribers in relation to AMR. All three studies were predominantly quantitative conducted through surveys measuring factors such as the students' knowledge of pharmacology, satisfaction

with their training, or perceptions of AMR. However, none of them have looked at how the students see themselves putting their knowledge into practice, or how their veterinary education is helping them to do this.

#### *Australia*

Hardefeldt *et al.* (2018) noted that it is important to uncover how veterinary students perceive teaching of AMS and resistance to understand why inappropriate AMU occurs in new graduates, to be able to guide future education in this area. Therefore, they performed a survey of nearly 500 participants from all veterinary schools in Australia, assessing the quality of the education as well as the students' perceptions and attitudes around AMS and biosecurity. In the study, almost half of all participants expressed that clinical training around AMU differed from what was taught in pre-clinical teaching, and a third of the students indicated that the clinical training was more valuable. Interestingly, the students who had had the most clinical training were less likely to adhere to the antimicrobial treatment guidelines compared to the students who had not yet begun their clinical training. This indicates that the pre-clinical teaching was better at conveying appropriate AMS strategies than the clinical training, necessitating work to align these two parts of veterinary education to make them more consistent.

#### *South Africa*

Smith *et al.* (2019) highlighted that although they saw in their study that AMR was being taught to veterinary students at the university in question, learning theoretical concepts is not the same as applying them in the clinic; therefore, there could be gaps in the translation from theory to practice. They also saw a significant gap between the students' levels of knowledge and the needed knowledge to prescribe antimicrobials. However, this may be somewhat explained by the study design, as they included participants from various stages of the veterinary education, so not all participants would have had much clinical experience. Most importantly, they noted that it is understandable that students who have yet to complete their training are not certain of everything, arguably it is healthy to not overestimate one's abilities as it keeps the mind open to learning. Ultimately, the confidence of graduates tends to grow with more practice. Students did, however, seem to overestimate their knowledge in some respects. They rated their overall knowledge of antimicrobials as high but were at the same time significantly uncertain about several crucial aspects, such as resistance mechanisms or the spectrum and indications of the most frequently used antimicrobial classes. The gaps found in this study indicated a need to review the university's veterinary education to focus more heavily on antimicrobial prescription and stewardship training.

## *Europe*

The study on European veterinary students was a result of PREPARE-VET, an initiative originating from the European Society of Clinical Microbiology and Infectious Diseases (Espinosa-Gongora *et al.* 2021). They wanted to find out whether veterinary students in Europe needed further AMS training, therefore, the study targeted most European countries. This made it very comprehensive, in addition to opening the door to the topic for European veterinary education. This study also provides a window into how Swedish and Scandinavian countries are viewed internationally; outside perspectives that may differ from the inside analysis present in this master's thesis.

Espinosa-Gongora *et al.* (2021) asked the students about the perception of their preparedness with respect to the pharmacology of antimicrobials, clinical AMU, as well as AMR. Contrary to the findings in the South African study, on average, European veterinary students rated their preparedness quite low. Swedish students, however, rated their preparedness the highest among all participating countries; in all three categories, their average perception was above “sufficiently prepared”. They also stood out from the crowd regarding the awareness of antimicrobial treatment guidelines; only 30 percent of European students were aware of any guidelines, but in a few countries, including the Scandinavian ones, that number was close to 100 percent.

The students' perception of preparedness had a direct correlation to their knowledge scores, meaning that measuring the students' perceptions can be a useful, although not perfect, estimate of their actual preparedness (Espinosa-Gongora *et al.* 2021). Additionally, teaching strategies were positively associated to both factors, and the study proposed having frequent lectures as well as discussions of clinical cases as critical to preparedness regarding AMS. However, having gone through clinical rotations had a positive effect on the students' knowledge levels and perceptions of preparedness around clinical AMU, but that effect was absent on their preparedness regarding pharmacology and AMR. This bears resemblance to the results of Hardefeldt *et al.* (2018), as students felt more prepared after clinical training but were not more knowledgeable around AMS. Therefore, similar to the Australian study, Espinosa-Gongora *et al.* (2021) concluded that topics related to pharmacology and AMR are not covered enough in clinical training in European veterinary programs, hence the need to coordinate with pre-clinical teaching to ensure that theory is consistent with practice.

## 3. Materials and methods

### 3.1 Project overview

In this study, in-depth interviews were conducted with 11 final-year veterinary students between June and September of 2022, focusing on four clinical scenarios. Interviews were framed by the social practice theory (Shove *et al.* 2012). Thus, the study used a qualitative methodology; a tool for providing descriptions and explanations of social phenomena. In this type of study, the aim is not to have a sample that is necessarily proportionally representative of the target group, so relative measures of frequency are not relevant (Pope *et al.* 2000). Reflexive thematic analysis was used, an approach that emphasizes the role of the researcher (Braun & Clarke 2013 in Braun *et al.* 2019). This is a particular approach of thematic analysis (TA) that focuses on interpreting the rationales of the participants of certain events, in this case, behaviors and practices. Unlike in quantitative research or other forms of TA, the researcher's subjectivity is the analytical resource. This means that the researcher's unique perspective, together with their reflexive engagement with the theory and data, is used to shape the interpretation of the data.

As this study also contributes to an overarching project, the interview outline was pre-designed by those involved in the greater study. Yet, a final version was discussed and agreed upon prior to the start of this project. In preparation for the interviews, audio recordings of five experts with Swedish experience of the four clinical scenarios, obtained from the greater study, were reviewed. These experts were involved in determining the antibiotic treatment guidelines, as well as in the pre-clinical and clinical training of veterinary students; reviewing this facilitated the reflection on what is expected of practicing veterinarians in relation to the students' conceptions. The following steps were to recruit participants, conduct the interviews, and have the interviews transcribed. All of this was done on an ongoing basis as participants joined the study. Once data collection was complete, the interviews were analyzed for themes to develop into the findings. During the analysis, there was a need for reviewing the national antibiotic treatment guidelines regarding the four clinical scenarios. This was done to allow for comparisons

between the participants' answers and what is written in the guidelines, in addition to the possibility to reflect on the impact that the contents of the guidelines have on the students' training. The treatment guidelines for dogs and cats were undergoing revision at the time of writing, thus the temporary version (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022) was used.

## 3.2 Participants and recruitment

The aim of the study was to gain insight into how final-year veterinary students apply their acquired knowledge on AMU, thus the target group was limited to those students closest to graduation. These included (as of fall 2022) veterinary students at SLU in years 5-6, those graduated in January 2022, as well as students currently in the TUVET program (additional training for veterinarians with degrees from countries outside the EU/EEA and Switzerland) at SLU. Although some were already graduated, in this thesis, participants are referred to as 'students'. In total, the target group consisted of a closely knitted community of approximately 250 students. All students in year 6 had completed, or were near completion of, clinical training, whereas students in year 5 were about halfway through their clinical rotations. Recruitment was carried out via email, social media, and by taking advantage of personal knowledge of the veterinary student community, the lead researcher being part of this group. Participation in the study was voluntary and participants' identities remained anonymous. Although this study did not collect sensitive personal information, and therefore did not require ethical approval, all participants were asked to sign a form of consent.

A total of 11 interviews were conducted, and each student was given a random number between 1 and 11 to make it possible to see which quotes were given by the same person without identifying them. In qualitative studies, the quality of the sample is not determined by size but by the recruitment process. This is an iterative process, which for this study was based on the following aspects: Study aim; Specificity of the participants in regard to the questions; Use of established theory; Quality of dialogue; Analysis strategy (Malterud *et al.* 2016). As such, the sample size and distribution of participants was evaluated during the data collection process.

## 3.3 Interviews

This study used semi-structured in-depth interviews, meaning that the interviews consisted of conversations centered around specific themes rather than a set of pre-

determined questions. They also allowed the participants to elaborate on the subjects they felt they wanted to talk about more. Interviews were conducted individually, either face-to-face or via Zoom video calls. The audio was recorded, and the recordings were sent off-site for transcription verbatim. On average, the interviews lasted for about 1.5 hours each (92 minutes). All interviews were conducted in Swedish, except one led in English. Quotes in Swedish were translated to English before they were included in the final text.

The framework and focus for the interviews were influenced by Shove's social practice theory (Shove *et al.* 2012), as exemplified by Blue *et al.* (2016). In designing this study, veterinary AMU was viewed as a social practice; a practice can be defined as a routine behavior composed of several interdependent components (Reckwitz 2002). To understand how a social practice evolves and to be able to change its course, one needs to understand what other practices it is linked to, and how these 'sets' of practices grow together. For example: Veterinarians may understand what kinds of AMU practices are appropriate to address AMR, but because it is a practice that is connected to other routines and habits in their daily work, it may not be easy to change (Blue *et al.* 2016). In order to gain understanding of these practices, the interviews were designed to elicit information on three elements which according to Shove *et al.* (2012) are the key interdependent components that constitute a practice:

- a) **Materials:** Objects, consumer goods and infrastructures, tools, devices, bodies (the animal itself).
- b) **Competencies:** Includes understanding of the situation; practical know-how.
- c) **Meanings:** Includes embodied understandings of the social significance of the practice and previous experiences of participation.

To explore these elements, a large part of the interviews consisted of questions about how the participants saw themselves dealing with specific case scenarios. These scenarios consisted of four diseases that are relatively common in Sweden, and involved two different species in order to allow comparisons between practices within what is commonly known as small and large animal medicine (differences such as size of the animal and type of clinical setting), or alternatively, companion animals and production animals (differences in the social relationship with the animals). For example, dogs always fall into the category of small animal and companion animal, cows fall into large animal and production animal, whereas horses generally fall into the large animal and companion animal categories. The following species and scenarios were included in the study:

- Dairy cow:
  - *Escherichia coli* mastitis
  - Metritis
- Dog:
  - Pyometra
  - Pyoderma

For these case scenarios, the methodology was anchored around four points which were incorporated into the interview structure:

- 1) Problem Observation Stage
- 2) Formal Diagnosis Process
- 3) Treatment Decision
- 4) Outcome (e.g., Success/Failure/Else)

In their entirety, the interviews were structured into three parts:

- 1) Gathering the background of the participant whilst building rapport
- 2) Exploring known practices via clinical scenarios, have they experienced the scenarios and routines firsthand
- 3) World views around antibiotics/antimicrobials, and how they see themselves as future veterinary professionals

### 3.4 Data analysis

For this study, a reflexive TA was used (Braun *et al.* 2019). Following this school of TA, the lead researcher – in collaboration with other members of the research team – took an active role in shaping the output of information. This was then presented in the form of themes derived from the coding process; a process that continuously evolved as the research team reflected on the data. Coding is essentially making notes that characterize specific aspects of the dialogue, which were applied to the transcript as it was read. The research team then used their own unique perspective to transform these codes into broader themes that tell a coherent story in relation to the research question.



Braun and Clarke (2006) outlined the following phases of TA:

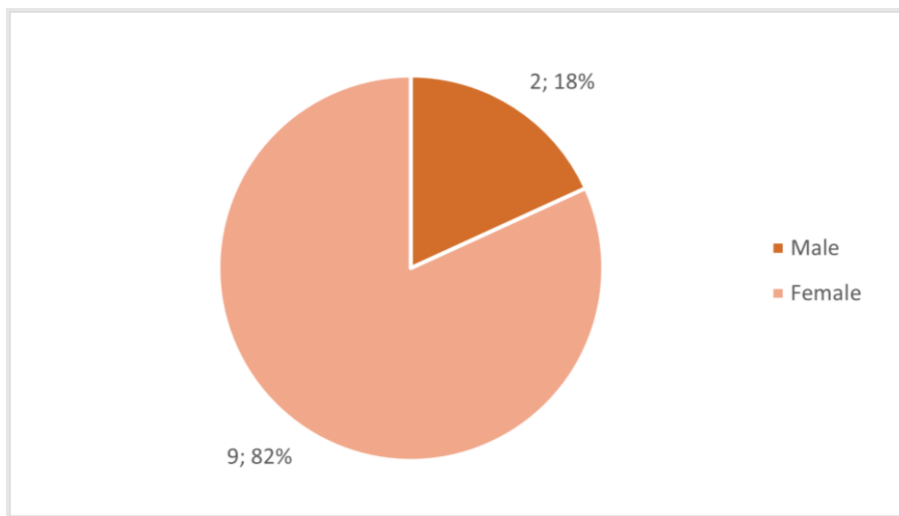
1. Familiarizing yourself with your data:
2. Generating initial codes:
3. Searching for themes:
4. Reviewing themes:
5. Defining and naming themes:
6. Producing the report: (Braun & Clarke 2006, p. 87)

For this study, the resulting procedure was as follows: After receiving the transcripts of the interviews, they were imported into a thematic analysis software (Dedoose Version 9.0.86). Each interview was then read in full while listening to the recording simultaneously in order to correct any errors in the transcript, the coding process started while the interviews were being read and listened to several times. The coding process established a categorization of the topics that were discussed and included jotting down initial reflections in the form of short memos. The familiarizing and coding process was partially parallel with conducting the final interviews. When this process was completed for all the interviews, themes were sought out by summarizing each participant's answers regarding the four clinical scenarios and comparing these to the current treatment guidelines in Sweden (Swedish Veterinary Society, Section for Production Animals 2017; Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022). Any notes of ideas or reflections written during the coding process were also incorporated in the analytical process; this allowed for the discovery of themes that were not directly related to the clinical scenarios. Iterative discussions with the research team led to the initial ideas getting streamlined into a more cohesive and concise set of themes. The final names for the themes were determined during the writing of the results and discussion section, and representative quotes were collected by the lead researcher. As Braun and Clarke (2006) explain, the process of analysis is not linear but in fact circular, as writing starts during the first phase and evolves through the various stages; going back to previous steps is an inevitable part of the process.

## 4. Results and discussion

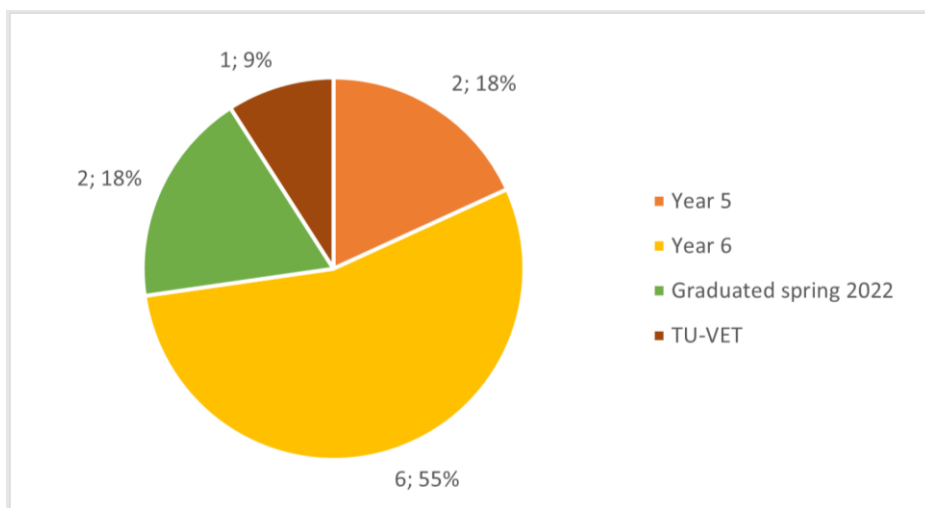
### 4.1 Overview of participants and interviews

Eleven students and recent graduates participated in the interviews. Distribution of the participants across different characteristics are shown in Figures 1–3. A table of the characteristics of each of the participants was not possible to include with respect to anonymity, as the target group is a relatively small population that is part of a close-knit community.



*Figure 1. Gender distribution of Swedish veterinary students (n=11) interviewed about knowledge and confidence levels around antimicrobial use in veterinary practice.*

Most of the participants were female (Figure 1), which is also the case for the population of students in the veterinary program overall. In 2017 – the year that the students graduating in 2023 began their studies – the statistics show that out of those who were accepted to the program in the final round, 85 percent were women and 15 percent were men (Swedish Council for Higher Education n.d.). The sample was therefore considered proportional to the target population.



*Figure 2. Distribution of students in different stages of the Swedish veterinary education, during the fall semester of 2022, interviewed about knowledge and confidence levels around antimicrobial use in veterinary practice.*

The specificity of the sample was deliberated during the recruitment process, the aim being to include an even distribution of participants from each “subgroup” of the target group, on the assumption that the experiences of these students would vary sufficiently. In the end, 6 students from year 6 were interviewed, 2 students from year 5, 1 student from TUVET, as well as 2 graduates from the most recently graduated class (Figure 2). The focus on year 6 students was partly due to availability as these students had completed their clinical training and were in the process of writing their master theses, and partly because they were the most representative target group for veterinary students in Sweden who had completed all their courses but had not yet graduated and therefore had not gained much working experience outside the university. Despite the focus on this subgroup, it was felt that the group of participants was sufficiently distributed across the entire target group to provide some insight into each subgroup.

Both participants who graduated in spring 2022 were at the time of their interviews working in clinical veterinary practice. All participants had professional experience from veterinary clinics outside of their university studies, obtained either from working as a veterinary assistant, veterinarian, or both. In Sweden, veterinary students who have completed year 5 and passed all their courses can apply for a special permit from the Swedish Board of Agriculture, allowing them to work as veterinarians temporarily before completing their master’s thesis and obtaining their veterinary degree (Swedish Board of Agriculture 2021). Because of this, the majority of participants already had some experience working as veterinarians by the time of their interview.

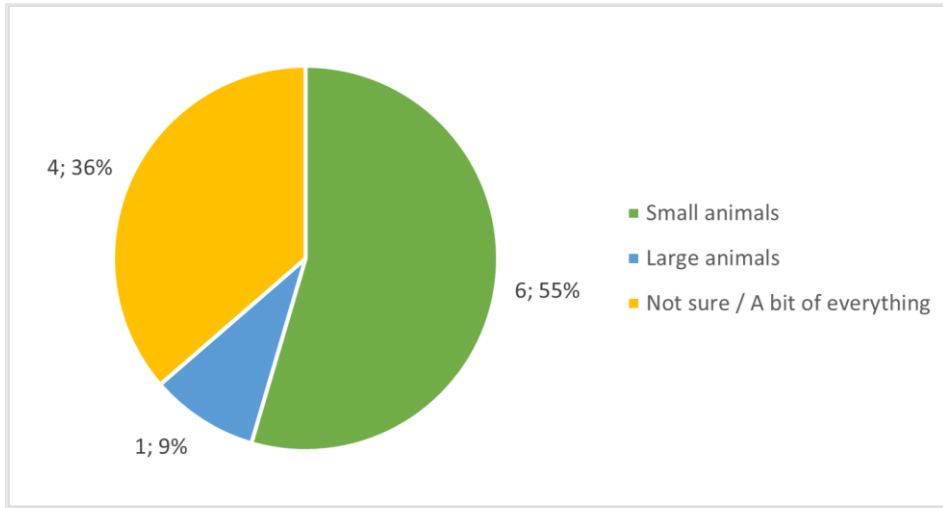


Figure 3. Proportion of preferred species/clinical practice to work with stated by Swedish veterinary students in interviews about knowledge and confidence levels around antimicrobial use in veterinary practice.

When the students were asked what species and type of practice they preferred to work with, the answers were given in relation to the small or large animal categories to signify the type of clinical setting; large animals included production animals and horses, though no student specified they would like to work exclusively with equine medicine. Most of the students that were interviewed preferred working with small animals (Figure 3). This should be kept in mind when interpreting the answers given by the participants pertaining to the clinical scenarios, as their level of knowledge is inevitably influenced not only by the teachings within the university but also by the participants' own interests and experiences.

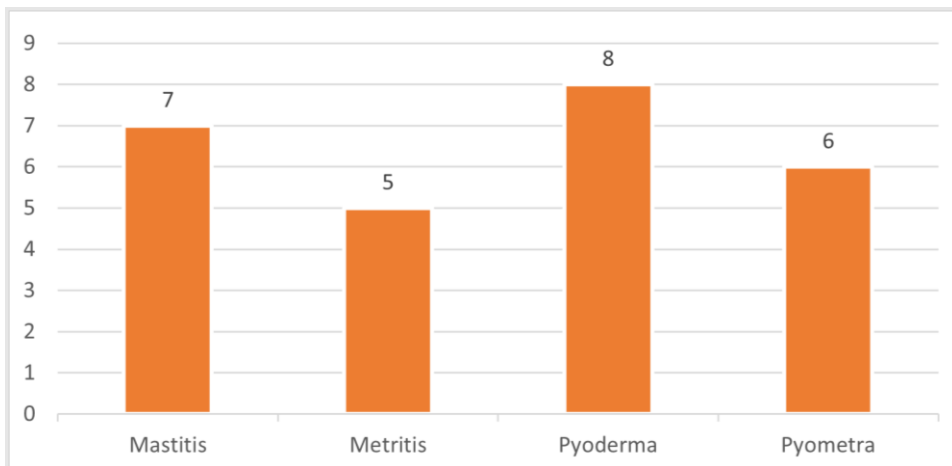


Figure 4. Number of interviews with Swedish veterinary students that explored each of the four included clinical scenarios in detail (more than two scenarios were explored in detail during some of the interviews) during interviews about knowledge and confidence levels around antimicrobial use in veterinary practice.

Figure 4 shows the spread of cases that were brought up in the interviews, which were relatively evenly distributed. Pyoderma was discussed in detail more often than metritis, which was mainly due to the fact that some participants were not sure what metritis is or how it is presented in cows. As the idea was for the interviewer to thoroughly explore at least two clinical scenarios per interview – one for each species – and to pick one that came easier to the participant as well as one that seemed more difficult, this chart roughly reflects the interviewer’s perception of participant knowledge. The general impression was that mastitis and pyometra came easier to many, while metritis and pyoderma were more difficult. Many participants stated they had practical experience of mastitis cases, and although the practical experiences were not as common for pyometra cases, the theoretical knowledge was evidently there. For metritis and pyoderma, very few participants had any practical experience to speak of, and the definitions of the problem/disease given were sometimes very different between participants. This made these cases interesting to speak about, which led many interviews to include a discussion on pyoderma, whereas metritis was not explored as much. Although it may be interesting, there is a limit to the value of discussing a subject where one is mainly making guesses.

For further insight to the results, the comparison that was made between the antibiotic treatment guidelines and the students’ responses to the four clinical scenarios is included in Appendix 1.

## 4.2 Analysis

By interviewing veterinary students, the objectives for this study were to identify the three components that make up the practice of veterinary antimicrobial use – the materials, competencies, and meanings – as well as the theoretical and practical experiences present or absent from their training, and how that affects their confidence around AMU/AMR. During the analysis, the research team solidified 8 themes that relate in different ways to the study objectives. An overview of the relationship between the themes and the objectives is provided in Figures 5–6.

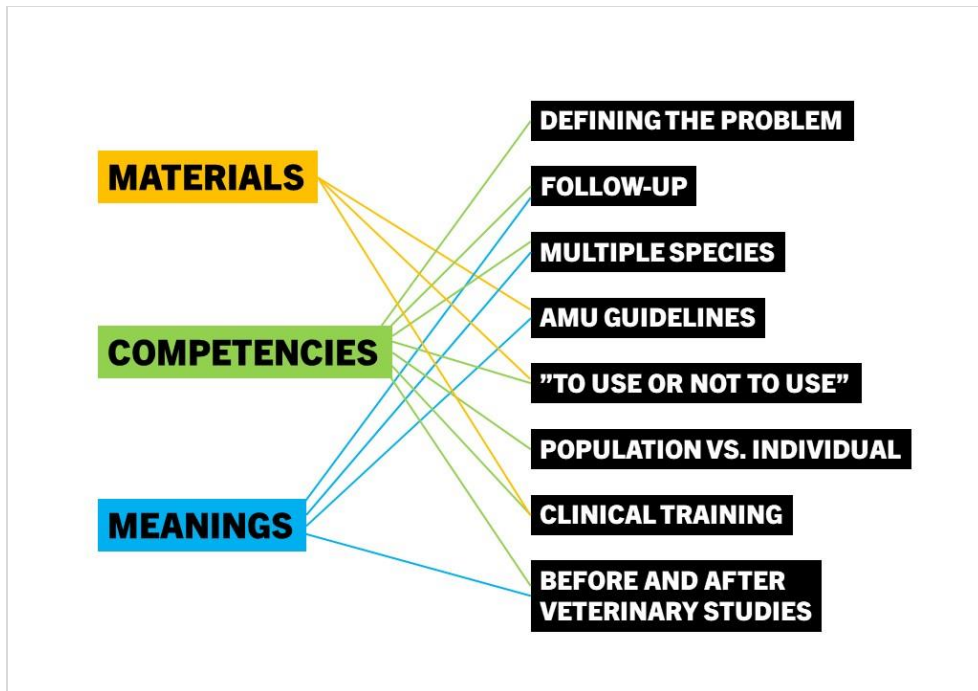


Figure 5. Overview of how the study objectives aiming to characterize the practice of veterinary antimicrobial use relate to the themes that were produced during the analysis of interviews with Swedish veterinary students.

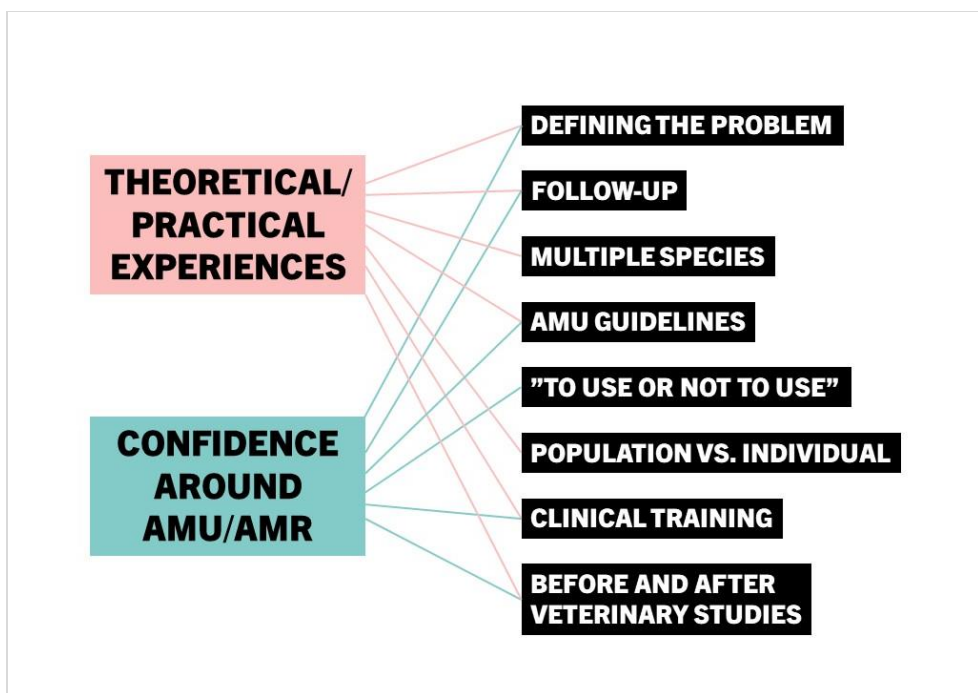


Figure 6. Overview of how the study objectives aiming to identify the present or absent theoretical and practical experiences of the students, as well as their confidence around AMU/AMR, relate to the themes that were produced during the analysis of interviews with Swedish veterinary students.

#### 4.2.1 Defining the problem: Crucial to arriving at the correct treatment

When discussing the treatment of these case scenarios, it became apparent in a few instances that how the participant had defined the problem (i.e., the etiology of the disease) was reflected in their continued clinical reasoning and impacted their choice of diagnostic methods as well as treatment. This became obvious when the students were uncertain about etiology and therefore changed their minds one or a couple of times, resulting in them changing the treatment along with it. Here, the student is replying to the question of what defines a pyoderma, while discussing treatment options: *“it's supposed to be so deep down, this infection, now that I think about it, I don't know if the shampoo will reach all the way down”* (Participant 11). The student was then asked to backtrack to the definition: *“that there are bacteria in the dermis, I thought. Yes, and that there is a bacterial infection in the dermis then. Well, no, then I might change my mind. Maybe that shampoo won't be enough. ... I think I'll change my mind. It's actually a proper pyoderma, then I think I'll actually put antibiotics in as well”* (Participant 11). This student had previously defined pyoderma as a bacterial infection in the skin, which had them wanting to treat it with a shampoo, but as they changed the definition to “bacterial infection in the dermis”, this resulted in them wanting to add antibiotics to the treatment. This shows that different definitions of a disease will have the implication of changing the treatment options apparent to the clinician once they have diagnosed an animal with the disease.

When one is certain about the etiology of a problem, this affects one's confidence and allows one to properly make use of the “library” of one's previous knowledge, meaning one can deduce where to look for information about the next step of the process if one does not know exactly what to do. This is the connection between the students' pre-clinical and clinical learning; if one is able to identify the situation correctly in practice, one can then apply the correct procedure that was learned in theory.

Another example of the necessity to be able to define the problem correctly is the metritis scenario. The students generally did not seem to know how promptly metritis needs to be handled, and several could not clearly define the disease. The Swedish expert in cattle reproduction who was consulted for the mastitis case for the over-arching project stated that acute metritis is one of the few true emergencies in reproduction medicine outside of the calving itself, and that the treatment incidence for acute metritis in Sweden is 0.6 percent per year. This indicates that it does occur every now and then, and that as a veterinarian for production animals, one should be able to suspect this disease already over the phone as it needs urgent treatment. Knowing the etiology of the disease and how it normally presents makes

it more likely that one comprehends the urgency of the situation (as well as knowing when one can prioritize other cases before it), thus, also increasing one's understanding of it and how it relates to AMU.

#### 4.2.2 Follow-up: An integral part of veterinary practice at risk of being overlooked

One important part of the resolution of any clinical scenario – and thus included in the conversations with the students – is the outcome; i.e., how would they follow up this case after their chosen treatment? This did not often come up organically in the interviews but needed to be prompted for the participants to discuss. When reading the treatment guidelines, it appeared that they did not emphasize follow-up practices either, as they were generally very sparse on details regarding this. When asked what their experience was regarding how to judge the “success rate” of cases, one participant said: *“No, but I don't know if I really know that. I think the follow-up has been a little bit lacking sort of. It's been a bit like ‘let me know if it doesn't get better’ and stuff like that”* (Participant 2). To use a clear example, the antibiotic guidelines state the following for acute clinical mastitis: *“Results of treatment regarding somatic cell count and clinical signs should always be evaluated after a month. At this evaluation a preliminary long-term prognosis for the animal is determined. The result is also a part of the evaluation of the likely effect of treatment if mastitis re-occurs in the animal, and if cases of mastitis occur in other animals within the herd”* (Swedish Veterinary Society, Section for Production Animals 2017). These instructions were not reflected in any of the interviews, as no one suggested following up after the initial check-up a few days later to see if the treatment had worked.

This poses the additional question of how follow-up is practiced by veterinary professionals in general, as it seems the education is not very detailed regarding outcome. Neglecting to properly follow up cases – maybe due to time constraints or concern for the owner's economy – can result in preventable relapses or simply mean that the veterinarian is not able to properly assess the efficiency of their prescribed treatment. One student talked about the issues trying to motivate owners to come back for a follow-up visit: *“if you really know that you're like: ‘But I want to see this again after a week’ ... at that visit that I just look at this animal and say, Ah, looks good. ... Good. You'll pay a thousand crowns for this”* (Participant 4). For the veterinarian, it may feel like they are not doing anything useful with that visit, while in reality it could be essential for them to see for themselves how the treatment played out. Such feedback would be crucial to foster AMS, since the efficacy of AMU is an important aspect. The owner is technically not just paying for the care of their animal; they are also paying for the competence increase of the veterinary clinician. So even when it seems like the owners do not need a follow-



up for their own sake, that follow up is an investment in the future of the animal healthcare available to them: *“So that I can continue to give good care... I need to get, get evidence of what works and what doesn't work”* (Participant 4).

Judging from the interviews, the outcome of a case seems not to be discussed to the same extent during the education as diagnostic methods and treatment options. This presents an opportunity for the Swedish veterinary education to revise teachings to focus increasingly on follow-up practices.

#### 4.2.3 Multiple species: Both an asset and a liability

Unlike medical doctors, veterinarians have to study multiple species and their sometimes very varied anatomy, physiology, diseases, and so forth. This can be a challenge, but also beneficial in circumstances where one encounters a problem in one species that one does not know how to handle, as one can then compare this to similar problems and how they are handled in other species. This became clear in several of the discussions about metritis, as none of the students had practical experience with this in cows, and many were not sure how to treat it. Something many did have experience with, however, was endometritis in horses. Naturally, they made comparisons between the species and suggested treating the cow the same way they would the horse: *“Spontaneously I do think of treatment the same way you would treat an endometritis in a mare, that you want to flush it. Make the uterus contract”* (Participant 9). However, the treatment for endometritis and metritis is in reality very different, in addition to the difference in treatment of a cow versus a horse. This type of extrapolation could potentially become a problem in circumstances where the condition is the same or similar for two species, but where the correct course of treatment is vastly different. On the other hand, this application of knowledge from other situations exhibits resourcefulness and a problem-solving skill that is imperative in the veterinary profession.

One participant said of the differences in treatment of metritis between cows and horses: *“if you were to treat, I don't think there would be much of a difference how you handle it, except that it might be good if the horse is in an animal hospital”* (Participant 6). Aside from the treatment comparison, this also points to the contrast between how these species are valued by society. Today, horses mainly have the role of a companion or sports animal, whereas cows are seen as production animals; this results in them being valued differently, both socially and economically. Veterinarians provide certain resources for companion animals that generally do not extend to production animals.

Continuing the comparison of cows and horses with metritis, one student said: *“Because on a horse if they have metritis you might want to do an ultrasound and*

*a full vaginal exam. Sure, you could do that on a cow too!"* (Participant 9). This illustrates that sometimes the practical possibilities are the same for two species; but in reality, is it done the same way? *"Maybe you do not have the same resource capacity on a cow as on a horse so you can go out and flush or put in a clinic for flushing, or something like that. So then it might be more of a maintenance type of treatment until you can put down the cow"* (Participant 9). This indicates a practical approach for production animals, where the student assumes that the means and the will to keep the individual alive is different for a horse and a cow. It is a reality in veterinary practice that different species are often treated differently, but the reason for this distinction may greatly vary from one occasion to another. Sometimes this may be, for example, because a cow needs to physically be handled differently from a dog because of its larger size, and sometimes it may be because the dog is valued higher as an individual compared to the cow. The question that comes with this is, are these reasons discussed in veterinary training, or simply learned passively by the students as a set of "unwritten rules"?

Another example of how the treatment of companion animals differs from that of production animals is pyoderma; regarding treatment of pyoderma in dogs, one participant said: *"and then the owner has to have time every day to shampoo it and well, they probably won't think that they do. And then you have to say 'this week you will have to have the time'"* (Participant 11). This level of commitment and time allocation might not be considered if it were a cow, as chances are the veterinarian might not ask the farmer. For the farmer, managing the cows is their job, so practicality has to be heavily factored into the advised treatment. For the companion animals, however, veterinarians often seem to expect that the owners will want to do whatever it takes for their pet to recover. Clearly, this distinction between species is strongly connected to assumptions and pre-conceptions; from the interviews, it appears that the veterinary community (including students) assume that most pet owners will want to save their pet at all costs, but that farmers will want to be practical about it. This implies that farmers are practical people who put societal and herd welfare first, and that pet owners only care about the wellness of one specific individual. This causes veterinarians to not consider the owners who fall outside of these categories, which can lead to miscommunication and consequently dissatisfaction on the part of the caretaker (namely farmer or dog owner).

To bring this back to veterinary education, these assumptions do not appear to be discussed in training. This is another distinct opportunity for improvement of veterinary education; discussing these assumptions explicitly and teaching the students – in practice, in the clinic – to not presume the owner's position before they get to know them. This could be instrumental for the next generation of veterinarians to build well-functioning relationships with animal owners, conse-

quently improving compliance and thereby treatment success; which, by extension, prevents AMR.

#### 4.2.4 AMU guidelines: An essential resource embedded with assumptions

Antimicrobial guidelines are a tremendous asset for clinicians; they constitute a toolbox for the profession. They are, however, very dependent upon context, hence the guidelines that are appropriate in Sweden may not work at all for countries where the conditions are very different. Guidelines are designed to fit the context they are used in, while being as short and concise as possible, and as a result they rely on many built-in assumptions of certain practices and knowledge. In this project, the treatment guidelines for the four clinical scenarios were compared to the students' answers; a comparison that highlighted certain such assumptions.

The interviews included asking the students about how they thought the different cases would present – how they, as veterinarians, would come in contact with the case – to which most answers were along the lines of “the farmer will call” or “the dog owner will come to the clinic”. None of the treatment guidelines specified anything about initial problem observation for these cases, but were written from the perspective that the veterinarian is already on the farm or in the clinic with the animal. This presupposes that the owner will have the required knowledge to identify the problem, and that they will call a veterinarian or go straight to an emergency room.

The students generally displayed high faith in the capabilities of farmers: *“it seems to me that most farmers are pretty good at recognizing what it might be”* (Participant 3), *“farmers in general are quite used to treating their cows”* (Participant 5). Meanwhile, for the dog owners, the estimation of their capabilities was quite divided between the two cases. Pyometra was seen as something that owners of an intact female were aware of and would have in mind if their dog became sick, while for pyoderma, the owners would only notice it if it was very visible, or the dog was itching a lot. Therefore, it could sometimes be discovered by the veterinarian while the dog was there for a different reason: *“Itching is common, well, very, that they come in for ... but otherwise it may well be some, unaware pet owner who comes in with their bulldog, ... pug might be more common, for something completely different and then it turns out they have a lot of dermatitis or pyoderma”* (Participant 6). The amount of common knowledge in the community of animal owners obviously varies between these diseases, making some of them easier to detect than others; this is also related to the different ways diseases manifest. However, the predominant perception among the students seemed to be that farmers have more knowledge and experience identifying sick animals than dog owners do.

This could be connected to the perception that farmers – unlike most dog owners – are professionals in animal husbandry, they also see a larger volume of animals and therefore a greater spread of health issues.

Another assumption embedded in the guidelines is that the veterinarian has a good relationship with the owner, allowing them to proceed according to the guidelines for diagnostics, treatment and follow-up with the owner happily obliging. If this relationship does not already exist, or the owner for example does not want to spend money on the proper diagnostics, the veterinarian may not be able to follow the outlined procedure. Additionally, some health issues tend to be very acute – such as metritis – which puts a great emphasis on the owner’s ability to identify the problem correctly and in time, as well as them calling the veterinarian straight away and the veterinarian responding immediately. If any of these steps are delayed, treatment will take longer to commence, and the outcome will be directly affected; this is before the veterinarian even comes in contact with the animal. So apart from the veterinarian’s ability to diagnose, treat and follow up the case, the interaction and relationship between veterinarian and owner majorly affects the outcome. This is not something that is thoroughly discussed in veterinary education but instead the students seemingly assume that the owners – farmers in particular – will handle their part “correctly”. For example, one student described how they would come in contact with the mastitis case: *“Well, farmers are often quite aware that it is mastitis. ... it's always acute - I mean, E. coli can't be chronic, can it? I don't think so. I've never heard of it, so they call right away”* (Participant 10).

There are also examples of assumptions in the guidelines that work well within the context. The recommended treatment for pyometra is surgery (ovariohysterectomy), with no perioperative antibiotics unless the dog’s general condition is moderately to severely impaired (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022); this assumes that the surgery room will be sterile so that antibiotics will not be needed to prevent infection. This position on antibiotic treatment was reflected well in the interviews as none of the participants said they would like to use perioperative antibiotics for pyometra, although there were no detailed discussions on variations in the severity of cases. One student answered the question of how they would determine whether or not to use perioperative antibiotics for a pyometra with *“Why should you use ... I think like this. In case that ... not infected ... maybe you just put Onsior [Robenacoxib – anti-inflammatory/analgesic drug] and stuff like that. Yeah. So it will be fine, I think, after surgery, because you do it in an aseptic way anyway”* (Participant 8). This shows that the students are so used to the fact that surgery can always be done with optimal sterile conditions, that they do not regard surgery itself as a risk factor that makes them consider antibiotic treatment. It makes sense for the students’ perceptions to align well with the guidelines here, as access to sterile working

conditions is the prevailing context for clinics in Sweden. If one veterinarian does not have the resources or the right conditions to operate, they will refer the patient to a clinic that does. Therefore, the students' choice of treatment is not just grounded in their knowledge but in the materials, i.e., access to facilities with a sterile environment and the availability of these facilities to animal owners. This is, however, a good example of why treatment guidelines are very dependent on the prevailing context in the community. In other countries, where the resources available may be different and the clinics cannot guarantee optimal sterile conditions, the Swedish guidelines would not work, as veterinarians may feel obliged to use antibiotics for preventive purposes (Gómez-Poveda & Moreno 2018). The assumptions embedded in the guidelines are there because they are deemed to fit the context; without this, the text would become long and impractical to read. This shows the complexity of creating multi-contextual guidelines, where everything would need to be specified in much greater detail.

One takeaway from comparing the guidelines to the students' chosen courses of action for the cases is that in those places where their knowledge does not align with the guidelines, maybe these things are not done according to the guidelines even by experienced veterinarians. One participant expressed worry about clinicians not always updating their use of antibiotics according to new recommendations: *"I feel a great concern for resistance, and I think there's been a big shift between the new vets coming out and the ones who have been out for a good while. With the ease of prescribing and how long"* (Participant 6). It would be beneficial for the profession to cross-examine the guidelines for what the community practice should provide and revise them accordingly (i.e., be more specific if certain steps are skipped). Like the idea of increasing the focus on follow-up practices in the veterinary program, this would also be a welcome addition to the treatment guidelines.

#### 4.2.5 "To use or not to use": Students want to confirm the validity of their treatment choices

A strong overall sense gained from the interviews was that the students wanted to confirm their treatment choices – especially when considering antibiotic prescription – usually with the guidelines, or with a colleague, for example. In all four clinical scenarios it was apparent that the students were critical of their own use of antibiotics; they wanted to validate when to use them and when not to. This was especially prominent in the mastitis case, where all participants said they would culture the bacteria to decide on a treatment or to confirm/change their initial treatment, and many mentioned they would be advised by the guidelines to make these choices. When discussing treatment options for *E. coli* mastitis, one participant said: *"it does say in, like, the treatment guidelines, that in very severe*

*cases you can give fluoroquinolones, I think, but it feels scary*” (Participant 10). The students themselves did not reflect on this behavior as positive or negative, instead it appeared to be something they simply considered necessary. From an AMR perspective, it is very positive that veterinary students are critical of their antibiotic use, but are they sometimes too critical? When prompted to describe what a good use of antibiotics looks like, one student said: *”you should be sparing in use but ... you should use it when it's needed ... But sometimes I can also experience that you are almost a little too scared ... You almost feel unsure about prescribing it even though it's actually indicated ... Because it almost feels like something a bit forbidden*” (Participant 2). This gives the impression that prescribing antibiotics is regarded by the students almost as a failure; it is a last resort. This way of thinking bears resemblance to euthanasia, which can be viewed in the same way (Knesl *et al.* 2017; Grimm *et al.* 2018).

The following example of needing to confirm a treatment decision came from discussing when they would consider antibiotic treatment for a pyoderma case: *“Maybe partly if it doesn't get better with topical treatment, if you give it a chance and they've really washed ... Then I could consider antibiotics, but otherwise if ... I would probably quite rarely initiate it the first time, unless I had a colleague behind me saying that: ‘Oh my God, this one is really going to need it’ ... I would definitely go and look that up: What was it again? ... Like, when are you allowed to initiate it?”* (Participant 4). Though it may seem indecisive, students wanting to validate their thinking should be seen as an asset; in particular when it comes to antimicrobials. This implies that they do not consider AMU by a rule or formula, instead they try to gain confirmation that it is correct to use antibiotics in the current scenario before acting. This critical approach is not as self-evident in all countries, in some places clinicians may be accustomed to more of a “recipe approach”. As previously mentioned, if the students were more accustomed to follow-up practices, they may gain further confidence in their AMU due to the continuous feedback of treatment results.

#### 4.2.6 Population vs. individual: The importance of maintaining a herd perspective

Although the treatment guidelines for both mastitis and metritis say that the veterinarian should look into the history of infective agents in the herd to make their treatment decision (Swedish Veterinary Society, Section for Production Animals 2017), this perspective was left out by all but one of the participants. When discussing how they would decide whether or not to initiate antibiotic treatment for a mastitis, this student reasoned: *“Maybe what you ... what you usually have in this herd, if you have any knowledge of it ... That here it's actually usually E. coli mastitis*” (Participant 4). The fact that only one student used this type of reasoning

indicates that population thinking is partially absent from clinical teaching; and by extension, as students learn to do what they see, it may also be lacking among veterinary professionals. This is not to say that the veterinary program does not teach population medicine, however, the way something is taught matters. A way to describe it is the difference between “reading or living the concept”; the veterinary students may have not “lived” the concept, i.e., they have not seen this way of using a herd perspective in practice. Instead, population medicine is seen as something more planned, not directly related to the acute situation for an individual who is part of a herd. Showing in practice that there is great benefit to involving the herd perspective – even in acute individual cases – is an important task for veterinary education, one that most likely would aid the profession as a whole. A version of this thinking might even be a welcome addition for small animal medicine, if one can figure out how to implement it.

#### 4.2.7 Clinical training: Lacking in amount or execution?

One question that was asked of most participants was how they felt their experience of the veterinary program had been, in comparison to the expectations they had prior to beginning their studies. The responses were relatively mixed, with some saying the program matched up pretty well with their expectations and some who thought it did not quite reach theirs. However, a majority did question whether they had received enough practical training during their time in the program. One student had the following reflection of the “end result”: *“you have learned a lot. But I think I felt at the end... felt of course at the end of the training that: Have I really learned things ... that are worth five and a half years? I mean... that I felt somewhere that you should know more.”* (Participant 4). This is of course a common feeling for anyone about to graduate and go out into the “real world”, but as many of the students had concerns related to practical skills, this appeared to be a relevant theme to further explore. One participant touched on the fact that it is difficult to reach a level of “enough” training: *“absolutely that you would have liked to have more practice. And then, like, in a way I think you would have felt that way no matter how much practice you had. ... because it's so easy to say ‘well, we should definitely have had more of the clinical’, and to some extent I definitely think so, but then it's also so hard to say what there would have been less of then, because that time has to be taken from somewhere”* (Participant 10). Another assessed their own preparedness for going out into clinical work: *“considering that I feel so scared to start working, I can't feel very satisfied, quite honestly. I would probably have wished I didn't feel as unprepared as I do. And... It's not... It's not primarily the theoretical knowledge. ... But it's the practical parts that really, really, really feel lacking, and that you understand are really important. And that like... well, are a very big part of the profession, that, like, I don't feel at all that I grasp in the way*

*I'd like to*” (Participant 11). To properly study the general preparedness for clinical work at the end of training, one would have to use some form of “day one competences” to compare the students’ skill set to. There is such a list adopted by the European Association of Establishments for Veterinary Education (ECCVT 2019), the organization that accredits the veterinary teaching at SLU. However, neither this list nor any other is advertised to the students, and judging from the interviews, they do not appear to be aware of what exactly is expected of them when they graduate.

As an example of an area where the students expressed lack of confidence, one point that came up spontaneously in two of the interviews was a lack of exploration of the specifics when it comes to treatment. In response to what they would like to see changed in the program, one student said: *“I probably would have changed it to have more of, like, basics somehow. We pretty much go with a lot of specialists who are super good at their stuff ... but what's missing there is maybe that foundation and really being confident in the foundation. Knowing what to do, like, on the simple cases, ... Yeah, a little bit more of quantity training on the simple things somehow. I've missed that”* (Participant 2). They developed further: *“Also kind of more hands on- ... maybe you talk more about the big picture, like ‘well, let's give NSAIDs’, and then maybe you don't get any further in that discussion. ‘Which NSAID? How much? How often? How many days? In what way?’”* (Participant 2). The other participant who brought up a similar concern said: *“Well, areas for improvement I feel are when you're standing there trying different drugs, how to treat things, especially because I feel I can recognize diseases and things like that and know roughly how to diagnose them, but then, like, this next step – what do I do now? How do I treat this?”* (Participant 6). They continued by reasoning: *“So in the lectures we've had, I think it feels like maybe in all these years we've been going, there's a skewed distribution of recognizing symptoms and how to diagnose compared to how to treat, because then, for example, what I remember being on slides like “this and this drug”, but then maybe nothing more”* (Participant 6). Going further into specifics is of course difficult to do in lectures, as there can be very different ways to handle different cases. This, again, is what separates pre-clinical and clinical training; in the clinical training, students should arguably get to become more familiar with the specifics of treatment in different cases, thus improving their confidence around AMU/AMS.

If the lack of clinical skills is in reality considered a problem by many students, it becomes important to figure out whether the cause is that there is not enough training, or simply that the training they receive is not optimally executed (alternatively, a combination of both). One student described that they had expected there to be more practical training and that it would be spread out more over the course of the program: *“I think you expect more quantity training before you start, but you*



*also realize that it's not going to be like that. ... I've heard it from the older students when one has still been in the theoretical courses, but also this thing that you basically have three years that are just theory, and you don't have any exercises. ... there's nothing stopping you from learning how to stick a horse [with a needle] in year one. The theory you learn in three years has nothing to do with the actual needle handling ... I thought the practice would be more woven in from the beginning and that there would be more theory running through the whole training”* (Participant 1). Judging from this, the problem appears to be both the quantity of training as well as students not being able to make the most of the training when it is received. Perhaps having all of it within a relatively short time period at the end of the program is not conducive to accomplishing the gradual development of clinical skills that would allow the students to be more confident upon graduation.

When discussing the design of the training, one student explained the way clinical rotations work, and brought up the underuse of external practice: *“because we have all of the practice at the school, where we're always in groups of like five or six people ... the clinical training you get is basically ‘watch someone else do it’ ... there should be more external practice. So, we had two weeks of external practice in five and a half years ... maybe you could just do a thing like ... you have more external practice, but the- if you're going to be a supervisor for external practice you have to have attended like, like, two- a two-day course or something. ... so that you're still like ‘this is what the students should get out of their internship’”* (Participant 10). Several others also brought up the addition of more external practice as a solution to the lack of hands-on clinical training. The question of whether they would like to see the program be extended to 6 years was also discussed with most participants; here, one of them expresses the wish for a combination: *“I would have liked another six months because many schools have six-year programs and I don't think five and a half years is enough, and I would have liked more external placement during the rotation and the opportunity to be in several different places, because I think then you get more individual teaching compared to having more people here and the patients not being enough”* (Participant 1). Confidence in clinical handling of cases, including knowing when and how to prescribe antibiotics, is essential to AMS. As several students expressed the feeling that their clinical training had not properly prepared them well enough for clinical work, suggestions like these should arguably be considered in any future modifications to the veterinary program.

#### 4.2.8 Before and after veterinary studies: The transformation

Students begin the veterinary program with varying starting points, arguably the most common one that people think of is that one loves animals and that this

profession has been a lifelong dream: *“I guess, like most people [in the program], I've always dreamed of becoming a veterinarian ... always had a fondness for animals, grew up in the countryside and have owned most animals!”* (Participant 9). Others, however, did not always dream of this and began their veterinary studies for other reasons: *“I have always had a great interest in medicine”* (Participant 6), *“I like, like, physiology and generally how the body works, or, I've been fascinated by how everything works”* (Participant 10). No matter where they started, the general perception from the students was that they all feel they have transformed during the course of their veterinary education. Maybe their original idea changed as they got to know the profession – and themselves – better: *“I figured this was more clear-cut. And then, you come into the program, and you realize it's not clear-cut at all what you're going to do afterwards”* (Participant 7), *“I have realized that the veterinary profession is much broader than I first thought. ... I thought it would be more small animals, but it turned out to be a lot of other animals too. A lot of food producing animals, for example”* (Participant 5). Or, they gained new motivations to support their choice of going into veterinary medicine in the first place: *“I understand the importance of having a profession where you can still feel when you come home from work every day, that even if it was a pain in the ass and heavy and all that, that you still feel that 'well, maybe I helped someone today, animal or human. Maybe I've made a difference to someone at least.' And then maybe it was worth it even though it feels hard.”* (Participant 11).

Several other new perspectives come from the knowledge and experience the students receive, but that they might not be aware of themselves. While many may have gone into the veterinary program because they wanted to save animals, the program teaches students to be pragmatic and consider surrounding aspects aside from doing everything to bring an animal back to health due to its own intrinsic value. One student hypothesized around metritis, that for cows, you might rather treat this conservatively until the animal is well enough to go to slaughter: *“Dinalgen [Ketoprofen – anti-inflammatory/analgesic drug] has zero withdrawal period so it can be given as pain relief”* (Participant 9). Withdrawal period in this context refers to the time that needs to elapse between the last administration of a medication and the slaughter of the animal; evidently, the student immediately considers what would work for the farmer in terms of cost and amount of work, rather than solely focusing on healing the animal in question. Talking about getting the cow back to full health, the same student reasoned *“I think the cost/benefit is too, that it will cost too much and it will take too much time, that it is not profitable”* (Participant 9). This perspective is essential, as veterinarians have to balance the owners' wishes and resources against animal welfare. That is not to say that veterinarians should ever sacrifice the welfare of the animal; there needs to always be a discussion on how to minimize an animal's suffering, whether it be by euthanasia or by nursing it back to health. However, balance is the key word; it is

crucial that the education as well as the role models that students and new graduates meet in clinical practice teaches them this balance in a sustainable way.

What ends up sticking, in terms of knowledge, for the students commonly reflects their practical experiences. In the interviews, the students' level of experience was indicated for example by the alignment seen between their answers to the mastitis scenario. This made sense with most participants also describing their practical experiences of mastitis cases; having seen a case handled in real life makes it easier to remember the correct course of action. In contrast, the alignment was not very clear in the metritis scenario, as the responses had notably more variation between them. This can most likely be explained by how few of the students had seen a case like this. In the end, what cases the students have been able to observe during their clinical rotations becomes important, as well as the way they have seen them be handled. What the students see is usually what they will end up doing themselves, which is why – again – within the veterinary community as well as in teaching, it is vital that there is good modeling of how to do things correctly. This allows for a positive alignment between pre-clinical and clinical teaching as well as professional practice, directly impacting the students' skills and confidence around AMS. In order for the students or new graduates to go against what they see in clinical teaching, they would need to be extremely critical of their own learning. Doing this is very difficult as one often wants to show respect for professionals with more experience than oneself, while at the same time being humble to one's own inexperience, never expecting to know better than the experienced professionals.

The importance of good role models becomes apparent in several aspects of the veterinary education, not least when it comes to maintaining a sustainable work-life balance. Mental health is a very topical discussion in the veterinary community, and the students are no exception. In the interviews, there were several mentions of students not being able to maintain a balance between their studies and personal lives, as well as them seeing the pressured reality of the teachers and working veterinarians, indirectly teaching the students what to expect when they begin their careers. There were some concerns that the environment in the veterinary program is not always healthy: *"I sometimes think that the university might be rewarding this 'good girl' syndrome ... 'That's so good, you've been up all night reading, and God, it's good that you've been reading about these cases!' ... And that they say 'that's great that you did this' instead of saying 'maybe it's not so healthy to sit up all night reading about a case'"* (Participant 9). Teaching the students how to set healthy boundaries between work and private time could arguably be equally important to the actual curriculum. Neglecting to prioritize this could factor into future veterinary professionals overworking themselves in their career, which may result in them leaving the profession. One participant discussed the mental health issues met by many veterinary students: *"the more you go, the more you realize*

*how much this program takes a toll on people's mental and... health. It's probably not something you thought about when you first started. Then you thought, 'This is going to be great fun', this is your dream, and 'We're going to work with animals, what fun', and you do feel that, but then there are a lot of things in the program that make that part not feel so fun either, because there is so much stress that you might not have thought of when you started"* (Participant 3). It is vital that the university visibly prioritizes mental health and provides support for students going through this, and that it informs a continuous reflection on how the program can be improved to achieve well-balanced graduates. If society wants the new generation of veterinarians to be properly prepared to take on the challenge of fighting AMR, it needs to not only teach them all of the essential knowledge; but make sure that they have the tools to last in this field for the rest of their careers.

### 4.3 Evaluation of the study

The quality of the data is directly linked to the quality of the sample. There is no perfect way to determine an ideal sample in qualitative research; however, using the idea of information power (Malterud *et al.* 2016) was helpful to have a rationale against which to weigh the final decision as the interviews progressed. Information power is the idea that the more relevant information you get from each interview, the fewer interviews you need. At the same time, a larger number of interviews and participants does not necessarily make a study more relevant; instead, the depth of the analysis can be lost if there is too much data to analyze at a satisfactory level (Hammarberg *et al.* 2016). Information power is impacted by study aim, which was quite broad for this project as it relates to the whole of the veterinary students' education at university and the skills they have acquired, yet it remained specific with its focus on AMU. The use of a social practice theory framework also gave the analysis a foundation of existing knowledge to support the conclusions, reducing the necessary sample size. Quality of dialogue is another aspect, which varied between interviews and progressed as the novice researcher gained experience of interviewing. A key factor was that the lead researcher was an 'insider' to the target group (a veterinary student at SLU in year 6) (Gair 2012). This allowed for greater depth of dialogue as both the researcher and the participants shared a familiarity with the topic (Kanuha 2000), which in turn was considered to increase the quality and argued the case for a smaller sample size. Conversely, it should also be said that an insider researcher faces the challenge of misinterpreting the participants as the researcher is assumed to have the same understanding of certain things, and the participant may therefore fail to elaborate on things that could have been crucial for the analysis (Perry *et al.* 2004). The analytical strategy is also an aspect in information power, and as the study used a reflexive thematic analysis, which high-

lights an open and exploratory analytical process (Braun *et al.* 2019), a larger sample size was indicated to allow for more variation.

Looking back, if this study had incorporated much fewer interviews, it would have been difficult to see patterns in the students' responses and make comparisons, making it challenging to draw conclusions. On the other hand, the amount of interviews that were conducted, combined with the depth of the conversations, led to a vast amount of data that contained far more information than this master's thesis could include due to scope and time constraints.

Another aspect to consider when evaluating the quality of data is enrolment bias; as those who participated in the study did so by their own choice, this may have been a selection of students who were particularly interested in the topic or concerned about AMR. As such, it is important to be careful to attribute the views expressed in these interviews to the whole target group.

During the analysis, the questions asked during the interviews were inevitably scrutinized as it became clear when clarifications or additional information would have been desired. This was especially apparent for the four clinical scenarios, as making comparisons between the different responses and the treatment guidelines was not always simple due to participants understanding the questions and going about their answers in different ways. Some examples of additional questions or clarifications that could have been helpful to the analysis are:

- What is the definition of [the disease]? (*Contrary to “describe [the disease]”*)
- What are the underlying causes/risk factors for contracting [the disease]?
- Do you think cases of [the disease] ever go unnoticed? How easy is this disease for the animal owner to spot and identify?
- How soon would you go to the farm/ask the owners to come to the clinic?
- When would you use bacterial culturing? Could sensitivity testing be necessary at any point in this case?
- How does your knowledge of the farm and its recent history matter in this case?
- Could there be cases where you would not wait for the culture to prescribe an antibiotic, and how would you then decide which one to prescribe?
- If an antibiotic is prescribed, how long would you continue the treatment?

- What would your next course of action be if the animal did not respond to your treatment (upon the follow-up in the way you already described)?
- What is the prognosis for [the disease], or what factors do you consider when determining a prognosis?

The original idea for this project was to perform a mixed-methods analysis by including a survey that would have provided a quantitative aspect to the research question, but due to time constraints this idea was abandoned in favor of a downright qualitative method. Going forward, the themes discussed in this thesis and the additional data gathered in the interviews could be used as a basis to create a survey for a quantitative study with a larger sample size. This might add further weight to the claims made in this analysis, as well as uncover additional aspects that did not have enough support in this sample or that were not identified here. Another suggestion is to expand the study by including educators and course directors to add their perspective on the training of veterinary students, in order to continue the conversation and see what is feasible in terms of changes to the education. This study, as well as a possible quantitative one, could also be used to compare the knowledge and confidence around AMU/AMR identified in Swedish veterinary students with similar studies in contrasting countries.

## 4.4 General discussion

The current route to solve the AMR crisis is entwined with the ability of relevant professionals to rationalize AMU, in which the veterinary profession holds a key role. Currently, the focus regarding this is generally on the active professional, and little on the formation of the future professional: the student. Here, the themes presented from the interviews have shown that the preparation of future veterinarians is key to their confidence; that the students know what to do, how to do it and when to do it.

It is vital to have a good alignment between the pre-clinical knowledge and the clinical experiences. Because the clinical training in Sweden is mainly limited to in-house experiences – although these are valuable – there are limits to what the training can accomplish. However, the interviews showed an evident alignment between pre-clinical and clinical training with respect to the critical approach and validation of AMU, as the students seem to consistently question whether or not antimicrobials are needed in any given scenario. On the other hand, the students displayed little confidence in their own ability to actually prescribe antimicrobials when they prove to be necessary. Additionally, a recurring perception seemed to be that antibiotics are somewhat “forbidden”, and needing to use them is regarded

almost as a failure. The question is whether these are issues resulting from the way the students have been taught, or if they simply require more experience to gain confidence in their decisions.

Pre-clinical teaching gives the students vital theoretical knowledge. Clinical teaching allows them to apply this knowledge, however, if there are not enough cases for the students to see, they will not have applied knowledge and will not be aware of how these cases look in practice and how to deal with them. Some cases are easier to get experience with; the frequency and nature of the disease will matter to how much you will see of this as a student (for example, no participant had experience of metritis in cows, while almost everyone had seen a mastitis in the ambulatory clinic). This puts great emphasis on clinical teaching, as the students need to be able to see enough cases to gain applied knowledge of the most essential things before going out into clinical work for themselves. The way cases are handled by teachers in practice is also a very important factor in what students end up doing themselves.

Throughout the conversations with the students, it became apparent that they transform during the process of preparation to become veterinary professionals. Many complexities are encountered in this process, but they do not fully reflect the complexities of the veterinary profession; one example is the balancing of animal welfare against practicality and economy. These complexities are not always possible to include in guidelines but are equally important to how the students will use antimicrobials.

To ensure that future veterinary graduates are prepared for the responsibility to prescribe antimicrobials, it is essential that they have knowledge of:

- The definition and etiology of common diseases;
- Specifics on how to treat these diseases;
- How to follow up the effect of different treatments.

As the students appear to experience a lack of practical training and subsequent clinical skills, this could be addressed by a long-term revision of the program with a focus on evaluating potential solutions such as:

- More external training;
- Practical exercises spread throughout all years of study;
- Extending the program to 6 years.

Other specific things that veterinary education needs to prioritize are:

- Teaching the students how to balance practicality against animal welfare and other sustainability aspects;
- Discussing common assumptions made about animal owners, to make a non-biased communication more likely, contributing to increased compliance and subsequent decreased AMR;
- Showing the students (in practice) the benefits to applying follow-up practices and to involve a herd perspective also in acute individual cases;
- Ensuring the students' mental health, as it can be a deciding factor in whether or not they go on to build a functioning work-life balance and ultimately whether they stay in the profession.

Additionally, the current antibiotic treatment guidelines would benefit from a revision specifically focused on:

- Which parts need clarification or added emphasis, based on what the actual practices are among veterinary professionals;
- Increased emphasis on follow-up practices.

## 4.5 Conclusion

The in-depth interviews with future veterinary professionals revealed that they have a distinct critical approach to AMU: students consistently displayed the desire to anchor their treatment choices in the materials, competencies, and meanings related to the practice of veterinary AMU. Examples of materials are available laboratory tests, clinical environments, or antibiotic treatment guidelines. The students' answers detailing their hypothetical actions in four clinical scenarios clearly aligned with the Swedish guidelines in several areas, such as the use of perioperative antibiotics in small animal surgery: both assuming the material context of a clinical environment with sterile conditions. At the same time, many assumptions that did not appear to be discussed during training were prevalent in the students' answers as well as in the guidelines. For example, different species are often treated differently, but the reasons for this vary and are frequently linked to assumptions of meanings, such as the economic value of an animal or the human-animal bond.

The clinical experiences that the students get within the veterinary program appear to be of a good quality, as there is evident alignment between the pre-clinical and clinical teaching and the guidelines. As such, the students do not appear lacking in



terms of competency or knowledge, but instead in terms of confidence in their ability to prescribe antimicrobials. This connects to a lack of materials: as the clinical training is mainly limited to in-house experiences, the students do not have enough clinical cases to practice on, therefore, they may require further support. Some important aspects of clinical practice that are crucial to AMS also did not seem to be heavily featured in the students' clinical training, such as follow-up practices and consideration of a herd perspective also in individual cases. Overall, a majority of the students questioned whether they had received enough practical training to prepare them for clinical work. Judging from the interviews, they appeared to lack an adequate quantity of hands-on training, while at the same time seeming too overwhelmed to take advantage of the training available to them.

## References

- Blue, S., Shove, E., Carmona, C. & Kelly, M.P. (2016). Theories of practice and public health: understanding (un)healthy practices. *Critical Public Health*, 26 (1), 36–50. <https://doi.org/10.1080/09581596.2014.980396>
- Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Braun, V., Clarke, V., Hayfield, N. & Terry, G. (2019). Thematic Analysis. In: Liamputtong, P. (ed.) *Handbook of Research Methods in Health Social Sciences*. Singapore: Springer Singapore. 843–860. [https://doi.org/10.1007/978-981-10-5251-4\\_103](https://doi.org/10.1007/978-981-10-5251-4_103)
- Bruce, A., Adam, K.E., Buller, H., Chan, K.W. (Ray) & Tait, J. (2022). Creating an innovation ecosystem for rapid diagnostic tests for livestock to support sustainable antibiotic use. *Technology Analysis & Strategic Management*, 34 (11), 1249–1262. <https://doi.org/10.1080/09537325.2021.1950678>
- Committee for Medicinal Products for Veterinary Use (2015). *Reflection paper on the risk of antimicrobial resistance transfer from companion animals*. (EMA/CVMP/AWP/401740/2013). European Medicines Agency. [https://www.ema.europa.eu/en/documents/scientific-guideline/reflection-paper-risk-antimicrobial-resistance-transfer-companion-animals\\_en.pdf](https://www.ema.europa.eu/en/documents/scientific-guideline/reflection-paper-risk-antimicrobial-resistance-transfer-companion-animals_en.pdf) [2023-02-15]
- Dyar, O.J., Huttner, B., Schouten, J. & Pulcini, C. (2017). What is antimicrobial stewardship? *Clinical Microbiology and Infection*, 23 (11), 793–798. <https://doi.org/10.1016/j.cmi.2017.08.026>
- ECCVT (2019). *List of subjects and Day One Competences*. European Coordinating Committee on Veterinary Training. [https://eccvt.fve.org/cms/wp-content/uploads/Annex-2-DIC-and-list-of-subjects-draft-post-ECCVT-meeting-17-01-2019\\_rev.pdf](https://eccvt.fve.org/cms/wp-content/uploads/Annex-2-DIC-and-list-of-subjects-draft-post-ECCVT-meeting-17-01-2019_rev.pdf) [2023-02-22]
- Espinosa-Gongora, C., Jessen, L., Dyar, O., Bousquet-Melou, A., González-Zorn, B., Pulcini, C., Re, G., Schwarz, S., Timofte, D., Toutain, P.-L., Guardabassi, L., The PREPARE-VET Working Group, ESCMID Study Group for Veterinary Microbiology (ESGVM), & ESCMID Study Group for Antimicrobial stewardshiP (ESGAP) (2021). Towards a better and harmonized education in antimicrobial stewardship in European veterinary curricula. *Antibiotics*, 10 (4), 364. <https://doi.org/10.3390/antibiotics10040364>

- European Parliament and Council (2022). *Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC*. <http://data.europa.eu/eli/reg/2019/6/oj> [2023-02-19]
- FAO (2021). *The FAO Action Plan on Antimicrobial Resistance 2021–2025*. Food and Agriculture Organization. <https://doi.org/10.4060/cb5545en>
- Gair, S. (2012). Feeling their stories: Contemplating empathy, insider/outsider positionings, and enriching qualitative research. *Qualitative Health Research*, 22 (1), 134–143. <https://doi.org/10.1177/1049732311420580>
- Gómez-Poveda, B. & Moreno, M.A. (2018). Antimicrobial prescriptions for dogs in the capital of Spain. *Frontiers in Veterinary Science*, 5, 309. <https://doi.org/10.3389/fvets.2018.00309>
- Grimm, H., Bergadano, A., Musk, G.C., Otto, K., Taylor, P.M. & Duncan, J.C. (2018). Drawing the line in clinical treatment of companion animals: recommendations from an ethics working party. *Veterinary Record*, 182 (23), 664–664. <https://doi.org/10.1136/vr.104559>
- Grundin, J., Blanco-Penedo, I., Fall, N. & Sternberg Lewerin, S. (2020). “The Swedish experience” – a summary on the Swedish efforts towards a low and prudent use of antibiotics in animal production. *SLU Framtidens djur, natur och hälsa*, (Rapportnummer 5)
- Hardefeldt, L., Nielsen, T., Crabb, H., Gilkerson, J., Squires, R., Heller, J., Sharp, C., Cobbold, R., Norris, J. & Browning, G. (2018). Veterinary students’ knowledge and perceptions about antimicrobial stewardship and biosecurity—A national survey. *Antibiotics*, 7 (2), 34. <https://doi.org/10.3390/antibiotics7020034>
- Kanuha, V.K. (2000). “Being” native versus “Going native”: Conducting social work research as an insider. *Social Work*, 45 (5), 439–447. <https://doi.org/10.1093/sw/45.5.439>
- Knesl, O., Hart, B.L., Fine, A.H., Cooper, L., Patterson-Kane, E., Houlihan, K.E. & Anthony, R. (2017). Veterinarians and humane endings: When is it the right time to euthanize a companion animal? *Frontiers in Veterinary Science*, 4. <https://doi.org/10.3389/fvets.2017.00045>
- Malterud, K., Siersma, V.D. & Guassora, A.D. (2016). Sample size in qualitative interview studies: Guided by information power. *Qualitative Health Research*, 26 (13), 1753–1760. <https://doi.org/10.1177/1049732315617444>
- O’Neill, J. (2016). *Tackling drug-resistant infections globally: Final report and recommendations*. Government of the United Kingdom. <https://apo.org.au/node/63983> [2022-11-03]
- Perry, C., Thurston, M. & Green, K. (2004). Involvement and detachment in researching sexuality: Reflections on the process of semistructured interviewing. *Qualitative Health Research*, 14 (1), 135–148. <https://doi.org/10.1177/1049732303255853>

- Pope, C., Ziebland, S. & Mays, N. (2000). Qualitative research in health care: Analysing qualitative data. *BMJ*, 320 (7227), 114–116. <https://doi.org/10.1136/bmj.320.7227.114>
- Reckwitz, A. (2002). Toward a theory of social practices: A development in culturalist theorizing. *European Journal of Social Theory*, 5 (2), 243–263. <https://doi.org/10.1177/13684310222225432>
- Shove, E., Pantzar, M. & Watson, M. (2012). *The dynamics of social practice: everyday life and how it changes*. Los Angeles: SAGE.
- SLU (n.d.a). *Djursjukskötare*. Sveriges lantbruksuniversitet. <https://www.slu.se/utbildning/program-kurser/program-pa-grundniva/djursjukskotare/> [2023-01-25]
- SLU (n.d.b). *Veterinär*. Sveriges lantbruksuniversitet. <https://www.slu.se/utbildning/program-kurser/program-pa-grundniva/veterinar/> [2023-05-28]
- SLU (n.d.c). *Veterinärprogrammet*. Sveriges lantbruksuniversitet. <https://student.slu.se/studier/kurser-och-program/program-pa-grundniva/veterinarprogrammet/> [2023-05-21]
- SLU (n.d.d). *VM0131 Klinisk veterinärmedicin*. Sveriges lantbruksuniversitet. <https://student.slu.se/studier/kurser-och-program/kurssok/kurs/VM0131/20150.2122/Klinisk-veterinarmedicin/> [2023-01-25]
- Smith, P.W., Agbaje, M., LeRoux-Pullen, L., Van Dyk, D., Debusho, L.K., Shittu, A., Sirdar, M.M., Fasanmi, O.G., Adebowale, O. & Fasina, F.O. (2019). Implication of the knowledge and perceptions of veterinary students of antimicrobial resistance for future prescription of antimicrobials in animal health, South Africa. *Journal of the South African Veterinary Association*, 90. <https://doi.org/10.4102/jsava.v90i0.1765>
- SocioCultural Research Consultants, LLC (2023). *Dedoose Version 9.0.86, web application for managing, analyzing, and presenting qualitative and mixed method research data*. Los Angeles, CA. [www.dedoose.com](http://www.dedoose.com)
- Swedish Board of Agriculture (2021). *Veterinärer och veterinärstudenter*. <https://jordbruksverket.se/djur/personal-inom-djurens-halso--och-sjukvard/att-arbeta-inom-djurens-halso--och-sjukvard/veterinarer-och-veterinarstudenter> [2023-01-24]
- Swedish Board of Agriculture (n.d.). *Föreskrifter om ändring i Statens jordbruksverks föreskrifter (SJVFS 2019:32) om läkemedel och läkemedelsanvändning*. [https://jvdoc.sharepoint.com/sites/sjvfs/Shared%20Documents/2019\\_32/SJVFS%2022-001.pdf?ga=1](https://jvdoc.sharepoint.com/sites/sjvfs/Shared%20Documents/2019_32/SJVFS%2022-001.pdf?ga=1) [2023-02-19]
- Swedish Council for Higher Education (n.d.). *Veterinärprogrammet*. <https://www.uhr.se/studier-och-antagning/antagningsstatistik/detaljsida/> [2023-02-06]
- Swedish Government (2020). *Svensk strategi för arbetet mot antibiotikaresistens 2020-2023*. Regeringskansliet, Socialdepartementet. <https://www.regeringen.se/globalassets/regeringen/dokument/socialdepartementet/fok>

halsa-och-sjukvard/svensk-strategi-for-arbetet-mot-antibiotikaresistens-2020-2023\_ny.pdf

Swedish Medical Products Agency (n.d.). *Läkemedelsverkets föreskrifter om förordnande och utlämnande av läkemedel och teknisk sprit.*

<https://www.lakemedelsverket.se/4a5686/globalassets/dokument/lagar-och-regler/hslf-fs/hslf-fs-2021-75-konsoliderad.pdf> [2022-11-02]

Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals (2022). *Tillfälliga riktlinjer antibiotika hund & katt.* [Under revidering].

<https://www.svf.se/media/fyrnlvxq/ab-hundokatt-rev-2022-klar-24-okt.pdf> [2023-01-19]

Swedish Veterinary Society, Section for Production Animals (2017). *Guidelines for the use of antibiotics in production animals.* <https://www.svf.se/media/vd5ney4l/svfs-riktlinje-antibiotika-till-produktionsdjur-eng-2017.pdf> [2023-01-19]

WHO (2015). *Global action plan on antimicrobial resistance.* Geneva: World Health Organization. <https://apps.who.int/iris/handle/10665/193736> [2022-10-28]

WOAH (2016). *The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials.* World Organisation for Animal Health.

<https://www.woah.org/app/uploads/2021/03/en-oie-amrstrategy.pdf> [2022-11-05]

WOAH (2018). *OIE Antimicrobial Resistance : We need you.* <https://oie-antimicrobial.com/veterinary-students/> [2023-02-14]

## Popular science summary

Antimicrobial resistance is a very current topic all over the world, and it's changing healthcare as we know it: without access to effective antimicrobial drugs, infections that used to be easily treated can become life-threatening for both humans and animals. This crisis is fueled by overuse and misuse of antimicrobial drugs, meaning drugs that kill or inhibit the growth of bacteria, viruses, parasites, or fungi. We often hear about the growing antibiotic resistance: this is because when bacteria multiply and adapt in the presence of an antibiotic drug, they may develop resistance against it. These bacteria can then circulate between humans, animals, and the environment, which causes the resistance to spread. The same thing can happen with other microorganisms, leading to the more general term 'antimicrobial resistance' (AMR). Because of this ability to spread, the antimicrobial use (AMU) in animals can also generate resistance in humans; therefore, veterinarians have an important role to play in this fight.

Previous research has focused mainly on AMU among working veterinarians, so in this study, we decided to look at a less researched group: the veterinary students. Because they will soon be out practicing on their own, it's important that they have the required knowledge and confidence in their ability to prescribe antimicrobials correctly, to help fight AMR. To investigate this, we performed a qualitative study based around in-depth interviews with 11 final-year veterinary students in Sweden. In the interviews, we asked the students how they would go about handling four different clinical scenarios. These were relatively common diseases that veterinarians can expect to come across in clinical practice: udder inflammation (mastitis) and inflammation of the uterus (metritis) in dairy cows, and skin infection (pyoderma) and uterine infection (pyometra) in dogs. By comparing the students' answers to the Swedish antibiotic treatment guidelines, we could see that the students had a good level of knowledge as their responses often matched the instructions in the guidelines. It was also clear that they have a strong critical approach to AMU, which is very positive as this reduces the likelihood that new graduates will prescribe antimicrobials unnecessarily. However, the students appeared to lack confidence in how to actually prescribe these drugs in practice. We concluded that this was most likely due to the perceived lack of hands-on training in the veterinary program: in the interviews, a majority of the students

questioned whether they had received enough practical training to prepare them for clinical work.

The Swedish veterinary program is 5.5 years long and includes a pre-clinical part (years 1–3) where the students learn the theoretical knowledge, and a clinical part (years 4–5) which allows them to apply this knowledge in practice. The students' knowledge levels indicated that the clinical experiences that they get are of a good quality that aligns the pre-clinical and clinical teaching. However, if there aren't enough clinical cases for the students to see, they won't have applied knowledge when they graduate, which ultimately affects their preparedness and confidence for clinical work, including AMU. Because the clinical training includes almost no external practice but is mainly limited to experiences within the university, the students don't always have enough cases to practice on and may therefore need further support. At the same time, many students also expressed a sense of being overwhelmed and not being able to take advantage of the training that is available to them. In the veterinary community, mental health is a very current topic, and the students are no exception. Several students mentioned having difficulty maintaining a balance between their studies and personal lives, but also that they see the pressured reality of teachers and working veterinarians and that this indirectly teaches them what to expect when they begin their careers. We argue that it's vital that the university focuses on educating well-balanced future veterinarians, as neglecting to prioritize mental health could result in them overworking themselves and ultimately leaving the profession.

Other observations included the number of assumptions we saw in both the interviews and treatment guidelines, that did not seem to be discussed in the veterinary training. For example, different species are often treated differently, but there are many varying reasons for this. Oftentimes, the reasons are connected to assumptions of things like the economic value of an animal (i.e., a horse may be more expensive than a cow) or the social bond between an animal and a human (i.e., a common assumption is that a dog means more to its owner than a cow does to the farmer). Good communication between veterinarians and animal owners is connected to higher treatment success, which can mean that the need for antimicrobial treatment decreases. Discussing these types of assumptions in order to prevent miscommunication is therefore important to maintaining a proper AMU. Other practices that seemed to not be heavily featured in the clinical training were how to follow up treatments with the owner, and the use of a herd perspective in individual cases for farm animals. Following up a treatment is important for the veterinarian to see if the treatment succeeded or not, which helps them evaluate their AMU for future cases. Using a herd perspective for farm animals – even when only one animal is visibly sick – is important as it can show the veterinarian what

pathogens a farm has had problems with in recent history. This can then inform their choice of antimicrobial drug, reducing the risk for AMR.

The improvement points we identified in this study could be addressed by future revisions to the veterinary program, for example by including more external training, spreading out the practical training throughout all years of study, or extending the length of the program. We would also prefer that the university considers adding more discussions on common assumptions made about animal owners, and showing the students (in practice) the benefits to applying follow-up practices and involving a herd perspective also in acute individual cases. Finally, we want to urge veterinary education to prioritize the mental health of veterinary students: if society wants the next generation of veterinarians to be properly prepared to take on the challenge of fighting AMR, we need to make sure that they have the tools to last in this field for the rest of their careers.



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# Appendix 1

Four tables containing the analysis of the students' answers related to the clinical scenarios and the comparison with the antibiotic treatment guidelines are provided in this appendix. Each table outlines one clinical scenario, the tables are listed the following order:

- A) *Escherichia coli* mastitis (Dairy cow)
- B) Metritis (Dairy cow)
- C) Pyoderma (Dog)
- D) Pyometra (Dog)

No individual answers are included with respect to anonymity, as the target group is a relatively small population that is part of a close-knit community. Instead, a summary of the students' answers to each point of interest is shown next to excerpts from the guidelines, to illustrate the comparison.

A) *E. coli* mastitis (Dairy cow)

Points of interest	Antibiotic treatment guidelines ( <i>Swedish Veterinary Society, Section for Production Animals 2017</i> )	Summary of student answers and comparison to the guidelines
<b>Etiology</b> <sup>1</sup>	Udder infection with micro-organisms (usually bacteria), multifactorial disease. Cow factors as well as management and environmental factors may markedly increase the risk. In most cases of acute clinical and subclinical mastitis Gram-positive bacteria are isolated, while Gram-negative bacteria (such as <i>E. coli</i> ) are less common.	Not every participant included a definition, as they were not always asked to specify exactly what a mastitis is (and it was probably assumed that this was obvious information in the conversation between two veterinary students). It was evident that the participants knew what they were talking about, without them always providing a full definition.
<b>Problem observation</b> <sup>2</sup>	- <i>Nothing</i> - ( <i>The assumption in the text is that the veterinarian is already at the farm</i> )	Everybody who were asked how they would come in contact with the case of a clinical <i>E. coli</i> mastitis concluded that the farmer would be the one to spot the sick cow and call the vet. Almost everyone agreed that the farmer will "diagnose" it as a mastitis (there were some mentions that <i>E. coli</i> mastitis specifically can look like a paresis) before calling. The guidelines do not mention how the vet comes in contact with the case, instead the instructions assume that the veterinarian is already on the farm. This presupposes that the farmer will have the required knowledge, that they will look at all the animals every day, and that they do call the vet when they notice something. The students displayed a high faith in the capability of farmers.
<b>Diagnosis process</b> <sup>3</sup>	Anamnesis, clinical examination of the udder and the cow, bacteriological examination of milk samples. An evaluation of the history of the somatic cell count of the cow should always be included in the anamnesis. Based on the diagnosis, the prognosis is evaluated, which in turn decides the choice of treatment. <b>In cases of clinical mastitis</b> it is common practice that bacteriological culturing of milk samples is performed by the field veterinarian.	Everybody who were asked about diagnostics mentioned milk sample/bacterial culture; some specified they would do the culturing themselves, some did not specify, and someone said they would send the sample for culturing externally. Some specified they would perform a clinical examination of the cow and udder, while some displayed the perception that it might not be common to do a full clinical examination for a mastitis. Almost everyone mentioned performing a CMT (California Mastitis Test - cell count in the milk), but no one talked about

<sup>1</sup> How do they define the problem?

<sup>2</sup> How does the problem present?

<sup>3</sup> What are the symptoms to look for, what diagnostic methods can be used, do they identify what tools they need (i.e., farmer, animal, lab, etc.)?

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Society, Section for Production Animals 2017)	Summary of student answers and comparison to the guidelines
	<p>The results help the clinician to evaluate shifts in the bacterial flora on herd level and to handle cases of non-responders to therapy. In cases of subclinical mastitis the recommendation is to send the milk samples to an accredited laboratory.</p>	<p>looking at the cow's cell count history even though the guidelines state that it "should always be included in the anamnesis". Only two people mentioned <i>E. coli</i> being able to cause toxemia or checking for signs of this, which is important since the guidelines mention that these cows should be euthanized immediately for animal welfare reasons.</p>
<p><b>Treatment decision<sup>4</sup></b></p>	<p>Treatment of mastitis with antibiotics during lactation should normally only be considered in cases of acute clinical mastitis. Advice on milking technique, hygiene at milking, sectioning of the herd according to udder health, as well as cleanliness of barn, cubicles and bedding and feed hygiene is, however, important in all types of mastitis to prevent the occurrence of additional cases in the herd. <b>Acute clinical mastitis</b> should be dealt with promptly. Some cows should be euthanized immediately for animal welfare reasons (e.g. cases of severe clinical mastitis with gangrene or toxemia). If antibiotics are indicated the best effect is generally achieved in the rapid growth phase of the bacteria during the first six hours of the inflammation. Antibiotic therapy should always be supplemented with supportive measures. The choice of such measures is decided based on symptoms and expected prognosis of each case. Such measures may be frequent milkings, udder massage, administration of oxytocin, NSAID and/or fluids as well as optimizing supervision, cow comfort, hygiene of bedding and feed and provision of nutrition. <b>If the spectrum of infective agents is not known</b> in the herd, the first hand choice of treatment is benzyl-penicillin. Gram-negative micro-organisms (<i>Escherichia coli</i>) - <b>Drug choice:</b> Only supportive therapy (no antibiotics). As an exception,</p>	<p>When talking about antibiotic treatment, everyone described the case as an acute clinical mastitis. The interview did not push the students to describe supportive measures or instructions that they would give to the owner, but several people mentioned it: the most common mentions were NSAIDs/pain relief drugs, frequent milking, and fluid therapy. No one mentioned oxytocin administration. The guidelines say "Acute clinical mastitis should be dealt with promptly", which is a very vague indication of time, but two people specified that they would go to the farm the same day as they received the call. The guidelines do, however, specify that the first six hours of inflammation are when antibiotic therapy has the best effect, and counting on the fact that it probably takes some time before the farmer takes notice of the cow and calls the vet, the time frame is probably not large at all by the time the veterinarian receives the call. The guidelines do not specify what to do if one suspects <i>E. coli</i> solely based on the symptoms: is it good practice to hold off on the antibiotic treatment until one has a bacterial culture result? All it says is that one needs to know the spectrum of infective agents in the herd in order to prescribe anything <b>other</b> than benzyl-penicillin before the results are in, and only one student suggested checking the history of infections in the herd. However, in the case of <i>E. coli</i>, as an exception, the guidelines state that the veterinarian can prescribe fluoroquinolones in severe and life-threatening cases around calving when the cow is expected to have a suppressed immune system. Two students mentioned the use of fluoroquinolones, but were somewhat uncertain of when they are</p>

<sup>4</sup> What are the treatment options, how do they decide on a treatment, what factors do they need to consider in the chosen treatment?

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Society, Section for Production Animals 2017)	Summary of student answers and comparison to the guidelines
	antibiotics can be used in severe and life-threatening cases around calving when the cow can be expected to have a suppressed immune defense. In such cases, fluoroquinolones are recommended.	actually allowed to use them. The participants were divided on what to do if one had initially suspected <i>E. coli</i> based off of the symptoms: Is it still appropriate to start penicillin treatment initially, or should one wait for the bacterial culture results before considering any antibiotics?
<b>Outcome<sup>5</sup></b>	If the cow <b>does not respond</b> to antibiotic treatment regardless of apparently correct choice of antibiotics, correct dosage, days of treatment etc., the bacterial diagnosis should be verified at an accredited laboratory. The bacterial isolate should also be tested for resistance to antibiotics. Results of treatment regarding somatic cell count and clinical signs <b>should always be evaluated after a month</b> . At this evaluation a preliminary long-term prognosis for the animal is determined. The result is also a part of the evaluation of the likely effect of treatment if mastitis re-occurs in the animal, and if cases of mastitis occur in other animals within the herd.	One participant mentioned the possibility to prolong the antibiotic treatment for a couple of days if the cow had not responded within the expected time. Two students suggested they might want a sensitivity test, but in that case they would do it before choosing an antibiotic in the first place, and not to check why the treatment did not work. Most people who answered the question on how they would follow up the treatment said that they would call the owner some time in a span of 3-7 days after the first visit to check the progress, alternatively that they would not specifically call or go there for follow-up but would wait to hear from the farmer in case that the cow was not improving. No one mentioned a routine follow-up later than this, some said that they might ask the farmer about the case or look at the cow again for themselves if they happened to come to the farm on a following day for unrelated reasons. The guidelines mention that an evaluation of the treatment results, regarding cell count and clinical signs, should always be done after one month to set a long-term prognosis for the animal: this did not come up in any of the interviews. This prognosis would be used for determining treatment if the same cow gets a new mastitis, and if new cases appear in the herd. One person mentioned that if this case was a recurring mastitis in the cow, it should be euthanized. The herd perspective was not very prevalent among the students.

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<sup>5</sup> Do they know how to follow up the treatment?

## B) Metritis (Dairy cow)

Points of interest	Antibiotic treatment guidelines ( <i>Swedish Veterinary Society, Section for Production Animals 2017</i> )	Summary of student answers and comparison to the guidelines
<b>Etiology</b>	<p>Acute metritis is a serious infection that involves endometrium, sub-mucosa, muscularis and serosa, i.e. also the deeper layers of the uterus.</p> <p><b>Reproductive organ infections:</b> Bacteria invade the uterus at calving to a varying degree. Most infections of the genital canal are, however, eliminated within 4–5 weeks after parturition. In cows with a retained placenta it usually takes an extra 1–2 weeks. Management to enhance good immune status around the time of parturition is vital. Important prophylactic measures are: avoid difficult calvings by choosing a suitable bull – especially to the heifers, have good feeding and adaptation routines before calving, good hygiene at the place of parturition and to supervise calvings and be ready to intervene – but only when necessary. Overambitious help at parturition will introduce pathogenic bacteria to the uterus. Cows that contract retained placenta are at increased risk of getting metritis or endometritis.</p>	<p>Not every participant included a definition, as they were not always asked to specify exactly what a metritis is. Some were not aware of the definition, or how metritis differs from endometritis. However, all four participants who were asked to go into greater detail on this scenario provided the correct definition and/or risk factors for the disease (difficult calving, higher risk with retained placenta). It was evident that particularly the students who had not gone through the full clinical rotations, and therefore had not passed the course in reproduction, were less knowledgeable on metritis in cows. What was interesting was that several people compared it to endometritis/metritis in horses instead, something that many had seen in the clinic, while no one said that they had ever seen a metritis in a cow.</p>
<b>Problem observation</b>	<p>- <i>Nothing</i> - (<i>The assumption in the text is that the veterinarian is already at the farm</i>)</p>	<p>Every student who was asked how they would come in contact with a metritis case described that the farmer would notice the cow being sick, and call the vet. A couple of students also suggested alternative ways; maybe the vet was already at the farm assisting the complicated calving that was the cause of the disease, and urged the farmer to call if anything seemed off in the following weeks; or, if the vet was at the farm for a scheduled visit, they might have noticed the sick cow themselves. Again, students showed high faith in the capability of farmers; although, a couple of them mentioned that metritis might be a relatively easy case to notice, as there is a specific time frame for it. The farmer might notice that a cow that recently gave birth has not recovered as well as she should have, or they might</p>

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Society, Section for Production Animals 2017)	Summary of student answers and comparison to the guidelines
		keep an extra eye on a cow that had a complicated calving. The acuteness of the disease is not specified in the guidelines. The few students who addressed this said that they would handle the case as soon as possible, but at least during the same day (which is about the same time frame that was discussed in the mastitis case).
<b>Diagnosis process</b>	Symptoms of the disease are usually seen the first week after calving and often include fever (>39.5° C), disturbed general condition and often bad smelling reddish discharges from the vagina. The course of the disease depends on the bacterial infection, which in turn depends on the hygiene and bacteria on the farm. <b>Diagnostics, reproductive organ infections:</b> It is important to differentiate between the normal contamination of the uterus with bacteria at parturition, which results in mildly pussy discharges the first two weeks and a persistent infection, when the normal self-cleansing process ought to have finished.	Several students specified that symptoms start after calving, but how long after was not clear. Almost everyone who suggested symptoms that could appear said all three out of: poor general condition, fever and vaginal discharge, which are the specific symptoms for metritis mentioned in the guidelines. Other non-specific symptoms for sick cows were also mentioned, such as decreased milk production, decreased appetite, and dehydration. The guidelines are vague on diagnostic methods; they only mention that for reproductive organ infections in general, one needs to differentiate between persistent infection and the normal contamination of the uterus with bacteria at parturition. Maybe this is due to there not being many things that one needs to do in order to confirm the diagnosis, if one considers the anamnesis and the clinical symptoms. However, it would evidently be helpful - especially to new professionals - to have a "checklist" for determining the diagnosis (for any disease, really), as the suggestions for diagnostic methods given by the students were somewhat widespread and uncertain for this scenario. Specifically, there was uncertainty about whether the veterinarian normally take samples for bacterial culture in this scenario, and if so, how to collect this sample.
<b>Treatment decision</b>	Cases of acute metritis should be treated systemically with antibiotics and, if needed, supported by fluid therapy and NSAID. In spite of the mixed flora that is generally cultured the drug of choice under Swedish conditions is benzyl-penicillin. An alternative may be an antibiotic with a broader spectrum, such as tetracycline, <b>if experiences from earlier cases and cultures support such a choice.</b> Treatment is recommended to last 5–7 days.	All four students who were asked to go into greater detail on this scenario (as well as a couple more of the students) said that they would opt for antibiotic treatment, and that penicillin most likely would be the first choice. Two students specified that the treatment would be intramuscular, but even for those who did not, it was implied that they meant systemic antibiotics. The students were not specifically asked for a duration of the treatment, but one participant said that they would prescribe an antibiotic treatment for just short of one week, which aligns with the guidelines (5-7 days). No one mentioned treatment with a broader spectrum antibiotic, which may be seen as a good thing, that the students did not go straight

<b>Points of interest</b>	<b>Antibiotic treatment guidelines</b> ( <i>Swedish Veterinary Society, Section for Production Animals 2017</i> )	<b>Summary of student answers and comparison to the guidelines</b>
		<p>for the broader options. Additional treatment was also discussed, mainly NSAIDs and fluid therapy, which are also mentioned in the guidelines. A few suggestions were given for hormonal drugs, to empty the uterus of contents. A few people also brought up the possibility to euthanize the animal, or to mainly stabilize it until it can go to slaughter. The students who had not passed the reproduction course made extrapolations from how one would treat this in horses, and tried to apply those methods to the cow. Many brought up the question of whether or not flushing the uterus with saline is standard practice, as this is commonly seen in horses. The students were not asked about prophylactic measures; only how they would handle an existing case, hence no one discussed how to prevent new cases.</p>
<b>Outcome</b>	<p>The course of the disease generally is quite rapid, which means that continuous evaluation of the effects of treatment and a readiness to change treatment are warranted (ex. prolonging the treatment, changing the medication).</p>	<p>Only the participants who were specifically asked about follow-up discussed this. The two students who said that they would perform a bacterial culture, also said that they would call the farmer once they had the results from the culture (in 1-2 days). Another said that they would call the farmer in 2 days, and maybe again after that. One student said that they would call the farmer before the end of the antibiotic treatment, so that they could prolong it if needed. Only the people who performed the bacterial culture mentioned changing the treatment, probably because, with this course of action, it becomes evident whether or not your chosen antibiotic should be effective or not. One takeaway from this could be that the students do not know how soon the treatment should have an effect, hence they do not know when to follow up, and that they trust that the farmer will call them if the cow gets worse or does not improve. If they did not hear from the farmer, most of them would assume that all is well, and possibly follow up before the end of the prescribed treatment. However, it could also be the case that even without the bacterial culture, they would still follow up after 1-2 days. The guidelines call for quite tight intervals between follow-ups since the course of the disease is rapid, therefore, one needs to be able to adjust the treatment if necessary.</p>



### C) Pyoderma (Dog)

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022)	Summary of student answers and comparison to the guidelines
<b>Etiology</b>	<p>Pyodermi bör alltid betraktas som sekundär till andra faktorer som förändrat hudens skyddsbarriär, såsom allergisk inflammation, traumatisk skada, ektoparasitangrepp, seborroiska, hormonella, nutritionella och immunmedierade sjukdomstillstånd. Infektioner drabbar som regel inte normal hud på hos en frisk individ. Vid hantering av pyodermi är målet att eliminera orsakande bakteriellt agens samt att identifiera och behandla bakomliggande orsaker till infektionen. <i>Staphylococcus pseudintermedius</i> är den i särklass vanligaste bakterien associerad med pyodermi hos hund och tillhör normalfloran. Pyodermier delas in baserat på hur djup infektionen är vilket också har betydelse för behandlingen:</p> <ul style="list-style-type: none"> <li>• <b>Ytpyodermi</b> är en inflammation med bakteriekolonisation av epidermis (överhudens) yttersta del.</li> <li>• <b>Ytlig pyodermi</b> är en bakteriell infektion i epidermis och hårsäckarnas övre delar.</li> <li>• <b>Djup pyodermi</b> är en bakteriell infektion som når djupare än epidermis och hårfolliklar och involverar dermis och ibland subkutis.</li> </ul>	<p>Almost all participants mentioned that there are different levels to how deep the infection extends into the skin; several students correctly said that there were three levels, with a few of them providing the correct names (ytpyodermi, ytlig pyodermi, djup pyodermi). Only a couple of students touched on exactly which layers in the skin that each of these levels correspond to, however, this specific definition was not asked of them. All but three students mentioned that the infection does not happen spontaneously, but that the dog needs to have an impaired skin barrier in some way; examples of causes were mainly allergies, wounds, dense/warm/moist fur, parasites or immune deficiency. The specific bacteria that is commonly found in these infections was not asked for, therefore there was little discussion on this, but a few participants specified that it is the normal flora of the skin. A few students said that the inflammation needs to produce pus, because of the word 'pyo' in the name.</p>
<b>Problem observation</b>	<p>- Nothing - (The assumption in the text is that the dog is already in the clinic)</p>	<p>There is nothing in the guidelines about how the case first presents itself to the vet. Four students discussed this, all but one agreeing that it the owner would normally come in for a scheduled appointment, however, one of them pointed out that it would usually be one that was booked a couple of days ago, not weeks. One student suggested that the owner could also come in through the ER depending on the apparent severity of the case. The common perception was that the owners would book an appointment because the dog had been itching or had visible skin issues, but it was also suggested that this might be something that the owner had not even</p>

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022)	Summary of student answers and comparison to the guidelines
		noticed; that instead, they would come in for a different reason, and the pyoderma would be discovered by the vet as a side issue.
<b>Diagnosis process</b>	<p>Det är mycket viktigt med en utförlig anamnes och noggrann klinisk undersökning av patienter med pyodermi för att om möjligt kunna identifiera bakomliggande orsak. Värdefulla diagnostiska hjälpmedel vid pyodermi är direktmikroskopiering, cytologisk undersökning (av direktutstryk, tejpprov eller nålpunktat) samt bakteriologisk undersökning. Odling tas helst från intakt pustel men även biopsier kan användas.</p> <ul style="list-style-type: none"> <li>• <b>Ytpyodermi:</b> Ex. hudveckspyodermi (intertrigo), fukteksem (hot spot, pyotraumatisk pyodermi utan satellitförändringar), bacterial overgrowth (BOG). Diagnos - Kliniskt bild med rodnad med varierande grad av hyperpigmentering, ibland belagd med smetigt gråvitt sekret (BOG, intertrigo) eller kraftig fokal, smärtande inflammation med purulent sekret utan satellitförändringar samt cytologisk undersökning med påvisande av bakterier extra- och ofta intracellulärt i neutrofiler.</li> <li>• <b>Ytlig pyodermi:</b> Ex. Bakteriell follikulit, impetigo, mukokutan pyodermi och ytlig spridande pyodermi med kliniska tecken i form av varierande förekomst av papler, pustler, krustor på erytematös bas, kollaretter och multifokal alopeci. Diagnos - Kliniskt utseende och påvisande av bakterier extra och intracellulärt i neutrofiler på cytologiprov.</li> <li>• <b>Djup pyodermi:</b> Ex. Cellulit, flegmon, furunkler, dränerande fistlar, hot spots/pyotraumatisk dermatit med nodulära satellitlesioner. Diagnos - Kliniskt utseende och cytologiskt påvisade bakterier (ofta få och intracellulära) och degenererade neutrofila leukocyter samt ofta även makrofager, plasmaceller och eosinofiler.</li> </ul>	<p>The guidelines give examples of different appearances/symptoms for each level of pyoderma: for example, hot spots being a form of surface pyoderma (ytpyodermi). These examples correspond to many that were suggested in the interviews, but the interviewer did not ask the students to specify exactly in what case one would see pustules, for example. The common examples that came up were: itching, hair loss, red/irritated skin, rash/breakout, pus/goo, crusts, pustules/papules, hotspots, furunculosis. For setting a diagnosis, the guidelines emphasize the importance of a thorough anamnesis and clinical examination, in order to already from the start begin to identify underlying causes. Diagnostic tools that the guidelines bring up are direct microscopy, cytology, and bacterial culture, three things that most students mentioned they would do. The most common techniques for sampling that were suggested were scraping, taping, direct impression, needle aspiration, and pulling out hairs. There was some confusion about how one should sample, depending on what one is looking for. The question of cost/benefit for bacterial culture and sensitivity testing was brought up by a few students, and it seems that most are not certain about when they should take a sample and culture it.</p>

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022)	Summary of student answers and comparison to the guidelines
Treatment decision	<p>Vid hantering av pyodermi är målet att eliminera orsakande bakteriellt agens samt att identifiera och behandla bakomliggande orsaker till infektionen. Försök alltid <b>ta reda på bakomliggande orsak</b> till pyodermin så att denna kan adresseras och recidiv därmed förebyggas. Utvärtes behandling med antibakteriella schampon, mousser och/eller antibakteriella sprayer är till god hjälp. Klorhexidin 2-4%, benzoylperoxid, alkohol baserad återfuktande gel och hypoklorsyra för utvärtes bruk är exempel på antibakteriella substanser som finns för topikalt bruk. <b>Schamponering kan ske 2ggr per vecka eller oftare</b> och kompletteras med produkter (mousser/lösningar) som kan lämnas kvar på huden. <b>Djurägaren behöver instrueras noggrant hur shamponeringen ska utföras för bästa chans till effekt.</b> Schampot skall anbringas där infektionen är, masseras in och bör ha en kontakttid på 10 minuter före ursköljning. Det är en fördel om långhåriga hundar klipps där infektionen är. Undvik att traumatisera huden vid shamponeringen och klippning då det kan fördjupa och/eller sprida infektionen. <b>Antibiotika ska endast användas vid uteblivet svar på utvärtes behandling, vid djup pyodermi eller om pyodermin förvärras.</b> Om antibiotikabehandling anses nödvändigt skall följande beaktas: <b>Det antibiotikapreparat som väljs skall helst, och alltid vid recidiverande eller djupa pyodermier, vara baserat på resistensbestämning.</b> Det skall även vara säkert för patienten samt distribueras väl i hud. Orala preparat är att föredra, eftersom djuret som regel inte behöver stationärvård, utan skall skötas i hemmet. Väljer man ett preparat som skall doseras 3-4 ggr dagligen är det viktigt att ta reda på att djurägaren har praktisk möjlighet att genomföra detta, annars bör annat preparat väljas. S. pseudintermedius är ofta betalaktamasproducerande och därmed oftast penicillinresistent. <b>Lämpliga antibiotika är därför klindamycin</b></p>	<p>In general, the guidelines emphasize that one needs to both eliminate the bacterial infection, and find the underlying causes so that one can treat those. This appeared to also be the running theme in the interviews, although the students were not specifically asked how they would investigate underlying causes. Due to limited time (and not wanting to tire the participants) the focus was placed on handling the acute situation, not the long term issue. The guidelines are very detailed on how to treat each level of pyoderma, but state that surface treatment with shampoos, mousses etc. is useful for all cases, which most of the students also indicated. Almost everyone brought up chlorhexidine as a substance; no one talked about the other examples in the guidelines, such as benzoyl peroxide, alcohol gel, or hypochloric acid. This is most likely because chlorhexidine is used for many things, and is the one substance talked most about during clinical training in relation to these treatments. Many students also specified - correctly - that it is essential to instruct the owners carefully about how to perform this treatment. When it comes to antibiotics, the guidelines state that they should only be used in cases not responding to or worsening during topical treatment, or in cases of deep pyodermas. This was echoed well in the interviews; some students only discussed antibiotics in the case of deep pyodermas or failed treatments, but everyone who talked about treatment agreed that they would not prescribe antibiotics at the first visit to a more superficial case. Regarding first-choice antibiotic types when the treatment cannot wait, a few people suggested Klindamycin, and one person guessed Amoxicillin (both are brought up as alternatives in the guidelines, with Klindamycin having the more narrow spectrum). Most of the students said that they would wait for bacterial culture results to initiate antibiotic treatment, alternatively that they would initiate treatment with a first-choice antibiotic and adjust the treatment once the results were in. Something that came up in a couple of the interviews was the idea to give</p>

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022)	Summary of student answers and comparison to the guidelines
	<p>eller cefalosporiner. Amoxicillin med klavulansyra har, liksom cefalosporiner god effekt in vitro mot betalaktamasproducerande stafylokocker. <b>Empiriskt kan klindamycin väljas vid förstagångspyodermier.</b> Substansen har ett snävare spektrum än cefalosporin och amoxicillin med klavulansyra och bör därför dessutom väljas i första hand om resistensbestämningen så medger. Behandlingstidens längd beror på hur djupt ner i hudens lager infektionen sträcker sig.</p>	<p>topical antibiotics, but most of the students agreed on systemic treatment, which corresponds to the guidelines. Most of the participants had not seen any cases of pyoderma, which probably explains why the students were not sure exactly how to treat it, on top of the sheer complexity of the case, with pyodermas having a very wide spectrum of presentations and causes.</p>
<b>Outcome</b>	<ul style="list-style-type: none"> <li>• <b>Ytpyodermi:</b> (Inget specificerat)</li> <li>• <b>Ytlig pyodermi:</b> Kontrollera hunden efter 2 veckor. Om hunden inte svarat på behandlingen kan systemisk antibiotika vara indicerat. Behandling skall pågå tills infektionen är kliniskt utläkt. Fortsatt topikal behandling rekommenderas då denna bidrar till kortare systemisk behandlingstid.</li> <li>• <b>Djup pyodermi:</b> Behandla tills infektionen är utläkt, vilket ofta tar minst tre veckor. Behandlingen skall följas upp med regelbunden kontroll.</li> </ul>	<p>The guidelines do not specify anything on follow-up for surface pyodermas. For superficial ones, the recommendation is a follow-up visit after 2 weeks, and for deep ones, they call for "regular check-ups". The students who answered this said that they wanted to have follow-ups in person; there was one suggestion of doing it over the phone if the case were very mild, but overall, without specifying the exact case, the general perception was that a booked appointment would be best. Additionally, continuing to investigate underlying causes could require in-person appointments.</p>

## D) Pyometra (Dog)

Points of interest	Antibiotic treatment guidelines ( <i>Swedish Veterinary Association &amp; Swedish Veterinary Society, Section for Small Animals 2022</i> )	Summary of student answers and comparison to the guidelines
<b>Etiology</b>	Livmoderinflammation hos intakta tikar uppstår vid en interaktion mellan det progesteronpåverkade endometriet och bakterier från normalfloran. Hos både hund och katt är <i>E. coli</i> dominerande men även andra agens kan förekomma. Sjukdomen är vanligare hos hund än hos katt, och ses oftare hos äldre än yngre individer.	All participants were clearly aware of what a pyometra is, as shown throughout the discussions, even though not all of them said the words 'inflammation of the uterus'. Most students also mentioned either that it appears after heat, that it is more common in older bitches, or both. Two students mentioned correctly that it is commonly <i>E. coli</i> bacteria that invade the uterus, due to increased progesterone levels.
<b>Problem observation</b>	- <i>Nothing</i> - ( <i>The assumption in the text is that the dog is already in the clinic</i> )	There is nothing in the guidelines about how the case first presents itself to the vet. Four students talked about this, and agreed that the owners often come in to the ER. A few others also said that the nature of the disease is serious/life-threatening, and needs to be dealt with urgently. The most common reasons that the dog would come in to the clinic were thought to be: a poor general condition or appearance of tiredness/pain, strange smell, and/or discharge from vulva. One student mentioned that many owners who have an intact female know the risks, and that many already suspect pyometra as they come in to the clinic.
<b>Diagnosis process</b>	- <i>Nothing</i> -	There is nothing in the guidelines on how to diagnose a pyometra, or what symptoms to look for. A few students mentioned that a pyometra often can appear with strange/non-typical symptoms, but as long as the dog is an intact female, one should suspect pyometra until proven otherwise. Almost everyone mentioned poor general condition/tiredness, but other symptoms commonly mentioned were: fever, vaginal discharge (or none, if the uterus is closed), lost appetite, and polyuria/polydipsia. Regarding diagnostic methods, the answers were all very aligned with each other. All participants who discussed this included some of the following: Considering the anamnesis, clinical examination, stomach palpation, blood samples, and ultrasound/X-ray. In

Points of interest	Antibiotic treatment guidelines (Swedish Veterinary Association & Swedish Veterinary Society, Section for Small Animals 2022)	Summary of student answers and comparison to the guidelines
		<p>general, it appears that the students have similar ideas of how a pyometra case would look and how they would handle it.</p>
<p><b>Treatment decision</b></p>	<p>Ovariehysterektomi bör alltid rekommenderas i första hand. <b>Antibiotikabehandling i samband med ovariehysterektomi rekommenderas inte vid opåverkat till måttligt påverkat allmäntillstånd. Vid måttligt till kraftigt påverkat allmäntillstånd rekommenderas antibiotikabehandling perioperativt.</b> Lämplig substans för behandling av bakteriemin inför operation är ampicillin 20-40mg/kg i.v. var 4-6:e timme. Vid svår sepsis eller septisk chock rekommenderas bensylpenicillin 12mg/kg var 4:e timme eller ampicillin 20-40mg/kg IV var 4-6:e timme i kombination med enrofloxacin 5mg/kg en gång om dagen. Behovet av fortsatt antibiotikabehandling bedöms individuellt utifrån djurets allmäntillstånd och eventuella tecken på sepsis postoperativt. <b>Medicinsk behandling av pyometra är endast aktuell i undantagsfall</b> (och aldrig vid sepsis) och baseras på preparat som motverkar progesteronets effekter (t.ex. aglepriston, ev. i kombination med prostaglandiner). <b>Den medicinska behandlingen är förknippad med risker och det föreligger risk för recidiv. Det saknas evidens för att behandling med antibiotika i tillägg till hormonbehandling har någon positiv effekt.</b> De behandlingar som rekommenderas i litteraturen ger sannolikt otillräckliga koncentrationer på infektionsplatsen och på teoretisk grund kan därför nyttan med denna behandling ifrågasättas.</p>	<p>All participants who talked about treatment said that their first choice would be surgery (ovariohysterectomy) for any diagnosed case of pyometra. A couple of them specified that they would not combine the surgery with antibiotics, while a couple of others were not sure; but in general, the impression was that most of the students did not see the need for antibiotics, provided that the uterus is removed and therefore also the infection. The guidelines equally do not recommend perioperative antibiotics for cases of zero to moderately affected general condition, however, in case of moderate to severely affected general condition, antibiotics are recommended. The interviews did not go into great detail exploring mild vs. severe cases, which may explain the lack of perioperative antibiotic use among responses, but this does pose the question of whether or not the students had read the guidelines or had the contents taught in class. Regarding medicinal treatment, the guidelines state that it should only occur as an exception, and never in case of sepsis. This was echoed in the responses; many of the students expressed that medicinal treatment is not as efficient as surgery, and/or comes with a high risk for relapse, hence they would still recommend the surgical treatment. Some said that they might make an exception if the owner is very intent on not castrating the dog, while the disease is mild. When asked what the medicinal treatment consists of, some said antibiotics, while others said it is mainly a treatment to empty the uterus of contents (there were a couple suggestions of Aglepristone, which is recommended in the guidelines); but these students were not sure whether or not they should also add antibiotics. The guidelines do not recommend antibiotics alongside the hormonal treatment, as there is no evidence of a positive effect, but it seems that this treatment is not</p>

<b>Points of interest</b>	<b>Antibiotic treatment guidelines</b> ( <i>Swedish Veterinary Association &amp; Swedish Veterinary Society, Section for Small Animals 2022</i> )	<b>Summary of student answers and comparison to the guidelines</b>
		discussed much in the teaching as the focus is on the surgical treatment, hence the students are not aware of this. On a sidenote, one person had heard that if one treats pyometra medicinally, the owners then have to breed the dog at her next heat to avoid relapse (something that is not in the guidelines).
<b>Outcome</b>	Då <b>medicinsk behandling</b> är förknippad med risker och det föreligger risk för recidiv, måste patienter som genomgår medicinsk behandling stå under noggrann kontroll och uppföljning.	After an uncomplicated surgery, the students either said that they wanted a follow-up visit to check the wound/remove stitches, or alternatively, they would follow up by phone or simply ask the owner to call them if anything occurs. The guidelines only specify that the medicinal treatment has risks and there may be relapses, therefore the follow-up has to be thorough and continuous. However, there is nothing written about the surgical treatment. Most of the students who discussed it said that for the medicinal treatment they wanted a follow-up visit in about a few days to one week. In general, follow-up practices appeared to be understood by the students as a very individual thing for each veterinarian; "you do what works for you".

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