

Guidelines for the use of antibiotics in production animals

Cattle, pigs, sheep and goats



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Swedish Veterinary Society, Section for Production
Animals, April 2013. Translated to English 2016
by Torkel Ekman

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Form: Jan Petersson, Contentera AB

Printed by: Arkitektkopia, Eskilstuna, 2017



Introduction

In 1998 the Swedish Veterinary Association decided to adopt a general policy for the use of antibiotics in animals. Since then specific policies for the use of antibiotics in dogs and cats have been adopted and in 2011 Guidelines for the use of Antibiotics in Production animals – Cattle and Pigs, were accepted. By decision of the board of the Swedish Veterinary Society (SVS) these guidelines have been updated.

The over-arching goal of SVS is to achieve a low and controlled use of antibiotics in Swedish animal production so that the first-hand choices of treatment remain efficient and that the spread of antimicrobial resistance – among animals and herds as well as in the food chain – is kept at a minimum. Keeping antimicrobial resistance in animals low is important also for human health, since we are all part of the same ecosystem. The authors of these guidelines hope that they may be useful for veterinarians in clinical practice when deciding on treatments for common diseases and ailments caused by bacteria. Sometimes the decision may even be to refrain from use of antibiotics and chose other ways of improving herd health.

Preventing disease outbreaks, *i.e.* keeping animals healthy, is the most effective way of reducing clinical as well as subclinical disease. It is therefore our firm belief that an increasingly more important future task for Swedish veterinarians is to, through structured and evidence based advice to farmers, contribute to keeping animals healthy. When an animal is hurt or shows symptoms of being ill, it shall, however, be treated adequately and promptly, keeping in mind that euthanasia may be the treatment of choice.

High treatment rates in herds or unorthodox use of antibiotics should always be investigated to discover the underlying reasons and/or predisposing factors and such factors corrected by means of preventive measures whenever possible. A structured, evidence based program to improve animal health, and subsequently also farm profitability, should be worked out in close collaboration with the farmer/owner.

In order to ensure sustainable use of antimicrobials more clinical research is needed to optimize preventive measures and treatment regimes. This is expected to be increasingly important as herds grow larger and may become more vulnerable to infectious diseases.

Apart from the authors of subsequent chapters many others have contributed to the completion of these guidelines. The work has been ongoing for a long time and in some cases started already in the 1990-ies. SVS' Section of Production Animals offers its sincere and warm Thank You to all these dedicated and hardworking persons.

For SVS' Section for Production Animals

Håkan Landin, Chairman

Over-arching principles for use of antimicrobials:

- Antibiotics should only be used to treat diseases with bacterial etiology or when such etiology is strongly indicated or suspected.
- Diagnosis of bacterial infections accompanied by sensitivity testing should precede treatment with antibiotics whenever possible.
- When treating bacterially induced diseases in production animals the ambition should always be to use pharmaceuticals with a narrow antibiotic spectrum.
- When treating groups of animals an etiological diagnosis should be obtained and a treatment plan established.
- When high treatment rates or unorthodox use of antibiotics are discovered the underlying reasons and/or predisposing factors should be investigated and corrected by means of preventive measures whenever possible.



Considerations prior to initiating antimicrobial treatment

Ylva Persson, DVM, PhD

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General considerations

The main difference between antibiotics and other pharmaceuticals is that antibiotics stimulate antimicrobial resistance. In order to effectively treat bacterial infections in humans and animals in the future it is important to use antimicrobials restrictively and responsibly. Use of antibiotics is only indicated when treating diagnosed bacterial infections (or when bacterial infections are strongly suspected) and when the conclusion is that the patient's immune system cannot combat the infection on its own. Furthermore a positive effect and outcome of treatment should be expected. A correct diagnosis, preferably including an estimation of bacterial sensitivity, is fundamental when deciding to treat an animal with antibiotics. Animal welfare aspects should also be considered. In some instances the correct clinical decision may be to not treat the animal with antibiotics; expected prognosis, general level of infection and potential spread of resistance genes in the herd may make it more prudent to euthanize the animal. On the other hand it may sometimes be indicated to treat groups of animals. Antibiotics should, however, never be used routinely or for preventive purposes. In Sweden this is regulated by laws or regulations, please see SJVFS 2015:32 (D9) and SJVFS 2015:31 (D8). In the latter it is stated that third/fourth generation cephalosporins and quinolones could be used only when an investigation concerning antimicrobial resistance has shown that it is absolutely necessary since these antibiotics should preferably be reserved for use in humans.

Sensitivity of the infectious agent

The antibiotic sensitivity of the infectious agent is of great importance when selecting an antibiotic substance for treatment. Some bacteria have a natural, inherent resistance to certain antibiotics, while others have acquired such resistance. The clinical diagnose should therefore be supported with a bacteriological diagnosis, and analysis should preferably also include a sensitivity test. The result of the bacteriological tests should be critically evaluated before selecting a drug for treatment.

The place of infection

That the infectious agent is sensitive to a certain drug *in vitro* is no guarantee,

however, that it will have clinical effect – the drug must also reach the infection site with a relevant concentration. The pharmaco-kinetic properties of the selected drug are therefore as important as the bacteriological diagnosis and the sensitivity test. Unfortunately, the pharmaco-kinetic properties of older substances are insufficiently documented.

Side effects

An antibiotic generally is only intended to have effects on the pathogen for which is selected. Other possible effects on the treated animal or its microbiota are regarded as side effects. The risk for such unwanted effects must be put in relation to expected benefits of the treatment.

Risk of development of antimicrobial resistance

Treatment strategy (individual versus group, dosage, duration of treatment, etc) as well as choice of antibiotic, affects the risk of development of antimicrobial resistance and antimicrobial drugs differ in their abilities to stimulate resistance. Consequences of resistance also differ. Fluoroquinolones, cephalosporins and macrolides, for instance, are critically important within human medicine according to WHO, and the use of these in veterinary medicine should therefore be limited to a minimum and only used when no other alternatives are present.

It is of great importance that not only the effects on the target bacteria are considered, but also effects on the normal flora of the gut, skin etc, of the treated animal. Since antibiotics with broad spectrums affect selection for resistance in more bacterial species than antibiotics with narrow spectrums the latter should be preferred. In Sweden many pathogens in production animals are sensitive to penicillin and thus this is the drug of choice for many bacterial infections. The current national pattern of antimicrobial resistance in Sweden is described in annual SVARM-reports, which can be found on the homepage of the National Veterinary Institute (SVA) at www.sva.se, but the situation in the herd at hand should always be considered.

Risk of antibiotic residues in food

Antibiotic residues in food products may be harmful to consumers for example because of allergic or toxic effects and possible induction of resistance. In order to reduce these risks for humans EU has determined MRL-values (maximum residue levels) for various substances in foods. Agencies within the EU have also decided on withdrawal times for drugs to ensure that MRLs are not exceeded. Recommended withdrawal times are only valid if drugs are used according to prescription.

Effects on the environment

Many antibiotics and their metabolites are effective even after they have been excreted from the treated animal/-s and therefore may affect the environment both in the barn or other farm buildings and out in the fields where manure is spread. This further motivates restrictive use of antibiotics in animals.

Economics

Apart from the above mentioned therapeutic considerations when selecting an antimicrobial drug also economic factors such as costs of medicines, treatment length, withdrawal period, loss of production, increased labor costs, etc should be considered. On the other hand economic factors, such as short withdrawal time or “easy-to-use” factors must never be allowed to outweigh therapeutic considerations.

Follow-up of treatment results

In order to optimize future treatments with antibiotics results on individual, group and/or herd levels should be followed up by the responsible veterinary practitioner. One prerequisite for this is functional and careful record keeping.

Conclusions

Take home messages are to first make sure that the animal or group of animals have a disease that really needs to be treated with antibiotics. Secondly prudent use of antibiotics should always be aimed at and therefore routine use should be avoided. Narrow spectrum antibiotics should be preferred as drugs of choice and administered at the correct dose and correct duration of treatment.

References

The recommendations of dose, intervals between doses, duration of treatment and choice of antimicrobial etc. in this document are in line with statements made in an expert paper prepared under the leadership of the Swedish Medical Products Agency, please see: Dosering av antibiotika till nötkreatur and får – ny rekommendation. Information från Läkemedelsverket 2013;24(supplement 1):4–14.

www.lakemedelsverket.se/malgrupp/Halso---sjukvard/Treatments--rekommendationer/Veterinara-lakemedel/Dosering-av-antibiotika-till-notkreatur-and-far/

Antibiotics in feed

Per Wallgren, DVM, PhD, Dipl. ECPHM

Introduction

Medication on group or herd level can be an efficient, albeit often short term, way to compensate for a high level of infection and thereby bring down disease and mortality rates in a herd. Even if long term elimination of bacterial agents rarely is achieved with treatment alone, group therapy with antibiotics may be part of an eradication program. In concert with necessary corrections of environmental and/or management insufficiencies temporary group treatment with antibiotics can sometimes be necessary to break a vicious circle and bring a herd to health.

In order to reach desired effects when mixing antibiotics into feed it is essential that the preparation in question is dosed correctly and reaches all animals in the treated group. Group treatment therefore needs to be followed up with clinical examinations. In situations when individual animals vary in their degree of anorexia adding medications in the water may be preferred. It should be observed that acutely ill animals that do not eat also may have reduced water consumption and it is therefore important to treat those animals individually by some other route.

It is often easiest to add the antibiotic as a premix to ready-to-eat feeds or concentrates on the farm. On those farms where wet-feeds are used the antibiotic is added to the tank where the feed is prepared. It should be noted that it may be a bit tricky to calculate exactly which and how many animals that should be fed the mixture that contains antibiotics and it is therefore extremely important to make sure that no animals that are going to slaughter are accidentally medicated.

To do before group-prescriptions

Before prescribing antibiotics to groups of animals an analysis of the problem should be performed. The analysis should comprise a definition of the problem at hand, a retrospective analysis of past herd health issues, an investigation of predisposing factors in the herd and preferably also an *etiologic* diagnosis based on representative bacterial samples, autopsy results etc.

The suggested “check list” below will aid the clinician to document the clinical situation and hopefully localize predisposing factors before treatment is started (the list is based on experiences from investigations in pig herds but may also be useful for cattle and other herds of production animals).

1. Documentation of the clinical situation.
2. Have enough diagnostic measures been performed?
3. Study rearing and production plans, including movements of animals in the herd.
4. Time for weaning needs to be related to management skills and physical limitations of farm buildings.
5. Are piglets from different litters mixed and if so when and where?
6. Check routines for movements of animals.
7. Check environment in cubicles/pens and need for additional heat, especially wintertime.
8. Check hygiene and routines for cleaning pens and units. Also control the manure system.
9. Check ventilation and possible draughts.
10. Check feed and feeding routines.
11. Control the water system with respect to hygiene and functionality.

After a thorough check-up of the health of the herd, using the list above, a decision about the potential need for group medication can be made. Significant malfunctions or insufficiencies in the environment or management need to be corrected before such prescription and proper preventative measures undertaken during the treatment period. The control program and the identified demands on improvements shall be concluded in a written document. During the investigation described above it may be discovered that the magnitude of the problem requires a herd health specialist or other specialists on for instance ventilation etc.

If the identified deficiencies in environment and/or management are not corrected during the course of treatment the prescription should be revoked and treatment stopped.

Rules and regulations

Feed containing antibiotics may, in Sweden, be sold or used only after a prescription by a veterinarian on a case-by-case basis (SFS 2006:805). Use of antibiotics to induce better growth in animals is not allowed (SFS 2006:805). When prescribing antibiotics in feed the veterinarian is responsible that it is done correctly and that careful and complete instructions are given to the owner and/or caretaker, including information about withdrawal periods.

Prescription

All prescription of antibiotics intended to be mixed into feeds should be done through a licensed pharmacy. Prescriptions shall include an instruction on how to

mix the medication into the feed, at a feed mill or on the farm, using equipment that is intended and suitable for the purpose. When prescribing antibiotics intended for use in feeds the prescription should be marked with the word “OBS!”.

When prescribing antibiotics for feeds an estimation of the amount of feed should be done. As a rule of thumb a piglet that eats dry feed can be expected to consume a total of 7 kg until about two weeks past weaning, which is generally done at 5 weeks of age, and about 30 kg until it is sold or moved to a farm that produces pigs for further rearing.

Medication via water (or milk-replacer) demands either individual treatment or knowledge about the consumption of liquids. When treating calves via milk-replacer or water it is therefore recommended to be done individually with the use of buckets. Pigs that are fed dry-feed generally consume about 2.5 liters of water per kg feed. Pigs that are fed in wet-feed systems get most of their water through the feed, which makes it less suitable to use water as a vehicle for medication.

The following should be noted when prescribing antibiotics via feed:

- The amount and type of feed to be used should be stated.
- Information on feed mill delivering to the farm in question is not necessary according to Swedish regulations but should be included for practical purposes.
- The concentration of the active substance should be stated in grams of active substance per 100 grams of feed stuff (percent).
- Within the feed industry it is common to use the unit ppm (parts per million). For practical reasons it is therefore useful to also state the concentration of antibiotic in the ready-to-use feed in ppm.



Diseases in cattle

Udder infections and teat injuries

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Etiology

Mastitis is a multi-factorial disease. Cow factors as well as management and environmental factors may markedly increase the risk for the udder infections with micro-organisms (usually bacteria), and development of mastitis. Surveys in Sweden have shown that bacteria sensitive to penicillin dominate as etiological agents. In most cases of acute clinical and subclinical mastitis Gram-positive bacteria are isolated (most commonly staphylococci and streptococci), while Gram-negative bacteria are less common.



Diagnostics

Diagnosis of mastitis is based on a thorough anamnesis, clinical examination of the udder and the cow, and a 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. In cases of clinical mastitis it is common practice that bacteriological culturing of milk samples is performed by the field veterinarian. 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.

When evaluating culture plates a preliminary diagnosis is done after 16–24 hours of incubation at 37° C while the final evaluation is done after 36–48 hours incubations. When growths of staphylococci is detected a test detecting production of beta-lactamase is performed at the first evaluation. In cases of low or no effect of therapy a sample can be sent to a laboratory for bacteriological examination and evaluation of antimicrobial resistance.

Treatment

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.

Acute clinical mastitis

Acute clinical mastitis 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.

Choice of antibiotics

If the spectrum of infective agents is not known in the herd, or if infections with Gram-positive penicillin sensitive bacteria dominate, the first hand choice of treatment is benzyl-penicillin. When the herd history is well known with well documented problems of Gram-negative bacteria during a six months period preceding the case the principle of using benzyl-penicillin as the first hand choice can be abandoned.

Gram-positive micro-organisms (not producing beta-lactamas)

Drug of choice: Benzyl-penicillin*

Gram-positive micro-organisms (producing beta-lactamas)

Drug of choice: Only supportive therapy (no antibiotics)**

Gram-negative micro-organisms (*Escherichia coli*)

Drug of choice: Only supportive therapy (no antibiotics)***

Gram-negative micro-organisms (*Klebsiella* spp.)

Drug of choice: Fluoroquinolone*

* Supportive therapy may be added. Parenteral treatment with antibiotics is recommended in most cases.

** As an exception, antibiotics can be used in severe and life threatening cases. In such cases, tetracycline is recommended.

*** As an exception, 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.

Choice of treatment should always be evaluated and, if needed, corrected when the result of the bacteriological culture is present.



Preliminary evaluation after 16–24 hours:

| | |
|-------------------|--|
| No growth | Continue treatment if benzyl-penicillin has been used; if antibiotics aimed at Gram-negative agents are used such treatment is discontinued. |
| Expected growth | Continue treatment. |
| Unexpected growth | Change or discontinue treatment according to agent and clinical symptoms. |

Final evaluation after 36–48 hours:

| | |
|-------------------|---|
| No growth | Discontinue treatment. |
| Expected growth | Continue treatment. |
| Unexpected growth | Change or discontinue treatment according to agent and clinical symptoms. |

Duration of antibiotic treatment:

| | |
|------------------------------|---|
| <i>Staphylococcus aureus</i> | 5 days (may be prolonged 1–2 days if clinical signs are improved but not completely satisfying).* |
| <i>Streptococcus uberis</i> | 5 days. |
| Other Gram-positive agents | 3–5 days, depending on clinical signs and herd.** |
| Gram-negative agents | 3 days. |

* Parenteral treatment may be complemented with intramammary treatment with short-acting intramammaries containing benzyl-penicillin.

** *Streptococcus agalactiae*-infection treatment only with intramammaries containing short-acting benzyl-penicillin may be considered.

If the cow does not respond 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 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.

Exacerbative and chronic clinical mastitis

Cows with exacerbative or chronic clinical mastitis generally have a poor prognosis with low response to antibiotics. Animals that are so sick that treatment with antibiotics is considered for animal welfare reasons to eliminate conditions with severe general symptoms and severe pain should, however, promptly be treated with available drugs. In most of these cases, however, supportive treatments other than antibiotics are usually enough to alleviate the symptoms. Culling should be considered at the earliest possible convenience.

Subclinical mastitis

Cows with chronic subclinical mastitis should be culled if possible. This is especially important when an animal is positive on culture for *S. aureus* and *Str. agalactiae*. While on the culling list cows with chronic subclinical mastitis should be separated from the healthy cows. Antimicrobial treatment of subclinical mastitis is recommended at drying off (see below).

Treating injuries at the teat end (“trampled teat”)

A traumatized teat end should be allowed to rest. If milking is kept up there is a high probability that the cow will contract mastitis within a matter of days. The injured teat should be allowed to rest 8–12 days, before an attempt is made to milk it again. If the teat is not milked for longer than 12 days the udder quarter often dries off, and it is then recommended that the teat is not milked for the rest of the lactation.

When examining an injured teat a milk sample for culture and CMT should be obtained. It may be suitable that the milk sample is collected directly from the teat or udder cistern using a needle for a correct evaluation of the degree of bacterial infection in the udder. Treatment depends on the extent of injury; extensive teat damage may warrant treatment with antibiotics regardless of CMT and bacterial culture.

The following guidelines based on CMT and culture results may be useful when deciding on therapy:

CMT 1–2 without growth of bacteria: The teat is allowed to rest for 8–12 days **without** local or systemic treatment with antibiotics.

CMT 1–2 with growth of bacteria or CMT 3 with or without growth of bacteria: The teat is allowed to rest for 8–12 days with local or systemic antibiotics.

CMT 4–5 with or without growth of bacteria and/or clinical mastitis: The teat is milked during the healing phase and the need for treatment with antibiotics is determined on a case-by-case basis.

Abundant growth of bacteria regardless of CMT:

The teat cannot be allowed to rest but needs to be milked out at least during the healing phase. Treatment with antibiotics is determined on a case-by-case basis.

Dry cow therapy

Dry cow therapy with intra-mammary antibiotics should be administered directly after the last milking before the dry period after thorough cleaning of the teat end. If calving is due more than six weeks later a long-acting preparation can be used. All four quarters should be treated. It is important to group cows according to udder health status also during the dry period. The effect of dry cow treatment should be followed up and evaluated at parturition and early lactation.

The following guidelines form the base of decision when deciding on a suitable dry cow therapy:

- Cows with low probability, (UHC*0-2), of subclinical udder infection should not receive antibiotics during the dry period.
- Cows with medium probability (UHC 3-5), of subclinical udder infection should receive antibiotics regarding cell count history, CMT and culture results.
- Cows with high probability (UHC 6-8) of subclinical udder infection should receive antibiotics during the dry period regardless of cell count and culture results.
- Cows with incurable chronic subclinical mastitis (UHC 9) should not receive antibiotics because of poor prognosis and elevated risk for antibiotic resistance.

*UHC = Udder Health Class; Classification of Swedish cows on SCC history in the DHI system.

Drug of choice: Long-acting dry cow preparation containing benzyl penicillin.

High or deviating consumption of antibiotics

An annual incidence of antibiotic treatment of clinical mastitis of more than 15 % on herd level is considered high. If the proportion of antibiotic treatments with benzyl penicillin at cases of mastitis is less than 75 %, and there is no documentation to support other choices of drugs, the choice of antibiotics is considered deviating from the recommendations. When such conditions are identified the herd veterinarian should perform a herd investigation of udder health and, in dialogue with the farmer/owner, suggest measures to keep disease and treatment levels low and the use of drugs in compliance with the guidelines in this publication.



Infections of the reproductive organs

Hans Gustafsson, DVM, PhD

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. Common bacteria are *Fusobacterium necrophorum*, *Trueperella pyogenes* (earlier *Arcanobacterium pyogenes*), *Escherichia coli* and *Streptococcus* spp. If infections persist outside of this period the effect of treatment generally is poor, which makes prophylactic measures all the more important. 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.

Diagnostics

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.

Acute metritis

Acute metritis is a serious infection that involves endometrium, sub-mucosa, muscularis and serosa, *i.e.* also the deeper layers of the uterus. 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.

Treatment

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 BPP. An alternative to BPP may be an antibiotic with a broader spectrum, such as tetracycline (TET), if experiences from earlier cases and cultures support such a choice. Treatment is recommended to last 5–7 days, but 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.

Endometritis and pyometra

Endometritis is a superficial infection of the endometrium that is characterized by a catarrhal-purulent-mucopurulent discharge that does not cease within the normal time (about 4 weeks) after calving. On palpation the uterus feels normal (grade 1) or may be flaccid and/or enlarged with a thickened wall (grade 2). The animal has an unaffected general condition and generally cycles normally or sometimes with irregular heats.

Endometritis grade 3 (pyometra) is characterized by a uterus filled with pus, often accompanied by a closed cervix and absence of heats with a persistent *corpus luteum*. Cows with pyometra generally have unaffected general condition.

Treatment

Antibiotics generally have little effect on endometritis in cattle why such treatment should be avoided, due to the risk of inducing antimicrobial resistance. The healing mechanisms of the cows should instead be stimulated by good care, balanced feed, good hygiene and ditto management. Commencement of heats propagates the normal healing processes in the uterus and hormonally induced heats, with for example prostaglandins, are therefore often advantageous. If the cow shows symptoms of endometritis more than 4 weeks after calving she should be treated with prostaglandin. Treatment may be repeated after 10–14 days.

In chronic cases of pyometra, with a persistent *corpus luteum*, treatment with prostaglandin is recommended to initiate cyclicity and subsequent emptying of the uterus.

Retained placenta

A cow is defined as having a retained placenta (RP) if the fetal membranes are not expelled from the uterus within 12 hours. Cows that contract RP are at increased risk of getting metritis or endometritis. The etiology for RP is multifactorial and may be due to metabolic as well as hygienic factors. The majority of published studies indicate that RP does not greatly affect fertility.



There are, however, indications that attempts to manually remove the RP may impair fertility.

Treatment

The most common way to deal with RP in Sweden today (2016) is to use conservative treatment, *i.e.* to let the normal involution of the uterus take its course and dissolve and expel the membranes. The farmer/owner is advised to check appetite, body temperature and general condition daily. If temperature rises above 39.5° C and the general condition of the cow is affected, treatment with BPP (or TET) for 3–5 days is recommended. Local antibiotics have a limited effect on bacteria and may have adverse effects on the mucosal membranes of the uterus. Manual removal of RP is not recommended and may even be contra-indicated since about 50% of the RP are too firmly attached to the uterine wall to be removed.

High or unorthodox consumption of antibiotics

An annual treatment incidence rate of 4 % or higher of uterine infections with antibiotics is considered high in Sweden (2016) and is therefore regarded as an alarm level in the national advisory systems. Cephalosporins shall not be used (see other chapter in these guidelines) and if TET is used in more than 50 % of the cases that is also regarded as being outside of recommendations. If such conditions are detected on a farm it is recommended that an investigation of reproductive health and use of antibiotics is done in cooperation with a herd health specialist.



Infections of the locomotor system

Christer Bergsten, DVM, PhD

Interdigital phlegmon

Interdigital phlegmon (also called Foot rot, Foul in the foot, Interdigital necrobacillosis) causes acute lameness that is usually located to only one leg. The symptoms are local swelling of the affected foot, fever and decreased general condition. In the interdigital space traditional signs of inflammation are found, *i.e.* swelling and reddening of the skin. Later in the course of the disease fissures, necrotic tissue and foul-smelling, pussy discharges can be found. The disease is often sporadic, but can be endemic in herds or groups of cattle, often due to predisposing factors in that environment. Introduction of bacteria, generally by introducing new animals, to a herd is an important risk factor as well as a soiled environment and trauma to the interdigital space.



The primary bacterial agent is *Fusobacterium necrophorum*, an ubiquitous opportunistic pathogen; several different spp of bacteria are often found simultaneously. Sampling for bacteria may be relevant when a herd suffers an acute outbreak of what is perceived as a new disease, in order to establish bio-type and sensitivity of *F. necrophorum*. At outbreaks of interdigital phlegmon a thorough check of the herd should be done and predisposing factors corrected. In order to prevent further spread of the disease the affected animals should be isolated. Animals that recover generally develop immunity, which is why a low incidence in a herd may help to keep animals healthy. In dairy herds it may be advantageous to let the young stock be exposed to the contagion in older animals and thus become immunized.

Treatment

Benzyl-penicillin procaine (BPP) given systemically for three days is the recommended therapy under Swedish conditions. In order to follow the course of the disease, minimize spread of infection and to make work easier for the farmer/handler, affected animals should be separated from the rest of the herd. If animals that are difficult to handle contract the disease it may be indicated to use a long-acting preparation, for example long-acting penicillin. If an animal is only mildly affected or the diagnosis is made early, local treatment to clean and disinfect the affected skin and surrounding area may be enough. If only local treatment is used the animal should be followed closely and systemic therapy be administered immediately if the lameness does not improve. Inadequate therapy or measures that are administered too late may result in involvement of the joints in the lower leg and may be fatal. More drastic treatment alternatives may be to surgically drain the inflamed area through a radical resection or to amputate the affected claw, provided that the other is unaffected and sound.

Infection of the hock

The skin on the hock of cattle is often damaged due sub-optimal conditions in the resting areas, such as hard and/or dirty surfaces and narrow cubicles. These hock-wounds often become infected and swollen and may, in serious cases, involve the joint. The latter will lead to a decreased general condition and fever. Common bacteria are *Trueperella pyogenes* and *Staphylococcus* spp.

Treatment

Infections in the lower limbs that lead to fever and lameness, with or without cellulitis, should be treated systemically with antibiotics – BPP is the drug of choice. A sequestered inflammation, which may not be affected by local or systemic antibiotics, needs to be drained surgically. The prognosis for return to full health is poor if resting places are not improved and quality and amount of bedding increased. In the summer access to a well-drained pasture is advantageous.

Secondary infections of lesions of the claw capsule

Injuries to the claw horn capsule such as ulceration of the sole, white line and/or toe are not primarily caused by infectious processes. These injuries heal spontaneously, without antibiotics, if they are detected and treated in time. Treatments include surgical drains and attaching a block to the other claw to take weight off the injured one. If, however, these injuries, and the associated lameness, are neglected they might lead to more complicated, necrotic and secondarily infected

processes that may involve deeper structures of the foot, such as the deep flexor tendon, navicular bone/- bursa and/or the distal phalangeal joint. It may also result in a severe cellulitis in the lower limb.

Treatment

Complicated, secondarily infected injuries to the wall of the claw heal slowly and the prognosis is poor. Apart from the above mentioned primary treatments the prognosis is only marginally improved with antibiotics. If treatment with antibiotics is indicated, as in cases with an elevated body temperature, BPP is the drug of choice. If the navicular bursa and/or the distal phalangeal joint are inflamed they can be drained through radical resections. A more common approach would be to amputate the affected claw provided that the other one is healthy.

Digital dermatitis

Digital dermatitis (DD) is an ulcerous, bleeding eczema at the rear of the claw. The condition is painful to the touch and may induce lameness. It differs from interdigital phlegmon (described above) in that it usually does not cause fever or local swelling. DD is often found on more than one claw and more commonly affect the hind feet. The eczematous processes are most often seen at the back of the feet where the skin meets the horn of the sole, but are also seen inter-digitally and around the coronary band, on the bulbs and in rare cases around the dew claws. The disease is contagious and will be a herd health problem. Spirochetes of the genus *Treponema* plays a central role in the etiology. Soiled floors with poor hygiene appear to be a pre-requisite for the infection and secondarily the condition may cause warts, heel horn erosion and interdigital hyperplasia ("Fibroma"). The disease may heal spontaneously if floor hygiene is radically improved, but it may be difficult for the herd to return to full health once the infection has been introduced.



Treatment

Spirochetes that have been isolated from cases of DD are sensitive to all common antibiotics. A common clinical practice is to spray oxy- or chlortetracycline on the affected areas which are then bandaged for one day. An alternative therapy may be to apply a powder containing salicylic-acid which is then protected with

a bandage for 4–5 days. Treatment is important for animal welfare reasons and to reduce bacterial numbers since immunity does not develop. Local treatment with antibiotics of the whole herd, or an entire group of animals, should only be done if the whole herd or a section of a herd is sanitized concomitantly with measures to radically improve hygiene in the herd, and with the long term aim to eradicate the infection.

High and/or unorthodox use of antibiotics

An annual treatment incidence rate of more than 5 % on a herd level with systemic antibiotics for infections of the locomotor apparatus is currently (2016) considered high and can serve as an alarm level. Swedish investigations have not demonstrated resistance against penicillin in micro-organisms causing infections of limbs and feet of adult cattle. There are therefore no indications for use of broad-spectrum antibiotics when treating these diseases.

Calves and recruitment animals

Anita Jonasson, DVM

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Infection of the navel

Infections of the navel and umbilical area can be seen in young calves. Important predisposing factors are high infective pressure in calving pens and where young calves are kept and deficiencies in routines for handling and feeding colostrum. Symptoms vary from local inflammation to septicemia, especially in new-born calves, more on septicemia below. Common infectious agents are opportunistic pathogens like *Staphylococcus* spp. and *Streptococcus* spp., sometimes as mixed infections. If navel infections become a herd health problem calves should be autopsied and bacterial samples taken, including sensitivity testing, to establish etiology.

Treatment

Navel infections are often caused by bacteria that are sensitive to penicillin and the drug of choice is benzyl penicillin procaine (BPP). Recommended time of treatment is five days. Antibiotics should be complemented with supportive treatment including extra milk, fluid therapy and climate control.

Septicemia

Septicemia is most common in new-born or very young calves where umbilical infections or pneumonia very rapidly can develop into life-threatening septic conditions. The bacteremia may induce secondary infections of other organs such as lungs and joints. Common agents are opportunistic bacteria like *E. coli*, *Staphylococcus* spp. or *Trueperella pyogenes*, sometimes in mixed infections. If calf mortality becomes a herd health problem calves should be autopsied and bacterial samples taken, including a sensitivity test, to establish etiology.

Treatment

In cases of septicemia rapid onset of therapy is important. Since progression of the disease is often per-acute and several potential pathogens, Gram-positive as well as -negative are involved, systemic treatment with a broad-spectrum antibiotic, such as T/S is indicated. Recommended treatment time is not less than five days. Antibiotic therapy should be supported with NSAIDs and fluid therapy, additional heat, bedding, milk replacer etc.

Infections of the gastro-intestinal tract/Enteritis

Enteritis in calves is a multi-factorial disease and the most common causes of infection in Sweden are rotavirus and cryptosporidiosis. Bacterial infections, such as *E. coli* F5 are less common. Coccidia can cause diarrhea in some herds, both in stall and on pasture.

In herds with high morbidity/mortality attempts should be made to establish the plausible cause by investigating pre-disposing factors in the environment and management - for instance feeding routines and hygiene, and, through sampling and/or autopsies, possibly identify an etiological agent.

Prophylactic measures in herds with diarrhea include correct and adequate administration of colostrum and improvements in the environment to increase calf comfort and reduce spread of infections.

In Sweden positive experiences from vaccination programs are limited. Salmonella is an important cause of diarrhea in calves in many countries and also occurs in Sweden. When salmonella is suspected a veterinarian must be called to the herd in accordance with the law on handling of zoonoses (SFS 1999:658) and take actions to diagnose and eradicate the disease.

Treatment

Antibiotics are not indicated in animals with uncomplicated diarrhea and unaffected general condition. Systemic therapy with antibiotics is indicated in cases where the general condition of the animal is affected and a bacterial infection is suspected. T/S is recommended as the drug of choice. Other antibiotics may be used if supported by a bacteriological diagnosis, preferably accompanied by a test of sensitivity. Duration of treatment should be 3 days. Sick and dehydrated calves should be isolated and given extra fluids orally and/or IV. Milk replacer should be administered to keep up with energy demands. NSAIDs may be given to alleviate symptoms.

Infections of the respiratory tract

Pneumonia is most often caused by infections, primarily viral. In Sweden para-influenza-3 virus, bovine respiratory syncytial virus (BRSV) and bovine corona



virus are most common. With the exception of BRSV most viral respiratory diseases generally cause only minor symptoms or are subclinical. Viral infections may, however, lead to infections with bacteria such as *Pasteurella multocida*, *Mannheimia haemolytica*, *Histophilus somni* and *Mycoplasma bovis*. In Swedish investigations *Pasteurella* spp. are the dominating agents. Lungworm in animals on pasture sometimes leads to infections with opportunistic bacteria that may cause serious, acute pneumonia. An etiological diagnosis can be obtained via autopsies and samples for bacteriology and is of great value when investigating herd outbreaks. A test for antimicrobial sensitivity is especially valuable when cases of non-responders to therapy appear. Swedish experiences of vaccination programs against respiratory infections are limited.

Treatment

Affected animals should, if possible, be isolated and given supportive therapy, such as fluid therapy, extra heat, extra heat and/or insulating blankets or NSAID as needed. Rapid onset of treatment improves prognosis. Recommended duration of treatment is 5 days. Recommended duration of treatment is 5 days and the drug of choice is BPP. If infection with *Mycoplasma bovis* is diagnosed tetracycline is the drug of choice.

Group therapy

If many severe respiratory cases appear in a short time in a herd, for instance at outbreaks of BRSV, this can be an indication for group therapy where an entire herd, or group of animals within a herd, is treated at the same time. In these cases it is recommended to use a narrow spectrum systemic antibiotic such as BPP. Preventive measures to avoid future problems of a similar nature should be discussed with the farmer/manager on these occasions.

Polyarthrititis

Polyarthrititis in young calves generally is secondary to umbilical infections or septicemia and is often caused by *T. pyogenes*, staphylococci or streptococci. *E. coli* usually dominates when the arthritis is secondary to septicemia.

Treatment

Early initiation of antimicrobial therapy is important when treating cases of polyarthrititis. Under Swedish conditions the drug of choice is BPP administered systemically for 14 days to get a therapeutic response. Often treatment results are fairly poor, likely because onset of therapy might be delayed. When infections with Gram-negative bacteria are indicated T/S can be used. Supportive treatment

with NSAID to ease clinical symptoms and to reduce inflammatory reactions in the joint/s is indicated. If only a single joint is involved local treatment to rinse out inflammatory products and bacteria may be considered.



Diseases in pigs

Maria Lindberg, DVM, Spec. pig diseases

Infections of the gastro-intestinal tract

In the first week of life diarrheas in the pig are often caused by a single infective agent and may therefore be prevented by vaccinating the sows. From the second to third week the situation becomes more complex as more infectious agents and factors in the environment become involved. Diarrhea at the time of weaning is one such syndrome even though the agent most often found is *E. coli*. Diarrhea is often diagnosed also in growing pigs and is then often associated with *Brachyspira* spp. or *Lawsonia intracellularis*. Dysentery, caused by *Brachyspira hyodysenteriae*, and diarrheas caused by enteric parasites, as well as diarrheas with a multifactorial etiology are also found in commercial pig farms. Salmonella is uncommon in Sweden, but should not be ruled out.

Subclinical gastro-enteritis causes growth depression and uneven litters. The prevalence of wasting pigs increases post-weaning and sometimes secondary effects may manifest themselves as respiratory diseases. When disturbances in herd health are investigated the microbiological etiology should be established via laboratory analyses.

Diarrhea in new-born piglets

Diagnosis

Diarrhea in new-born piglets generally appears during the first 24 hours of life. The dominating agent is *E. coli*. Piglets show signs of weight loss and depressed general condition. The dorsal protrusions of the spine become prominent and if pressure is put on the abdomen loose stool/diarrhea oozes out of the anus. In unvaccinated herds the major part of the litter is affected and mortality can be high. It is recommended to obtain a bacteriological diagnosis with a test for sensitivity.



Treatment

Rapid onset of therapy is crucial. Piglets should be offered an electrolyte solution to avoid dehydration. A ***trimethoprim/sulfa*** preparation injected systemically is the drug of choice. When antimicrobial therapy does not have expected clinical effect choice of another antimicrobial should be based on bacteriological culture and sensitivity test. If there are indications that the diarrhea may be caused by clostridia ***benzyl penicillin procaine (BPP)*** is an adequate choice. When treatment rate exceeds 10 % of litters a herd health investigation should be made, not forgetting to check the health of the sows. If sows do not produce enough milk, including colostrum, it will negatively affect the piglets' consumption of colostrum which in turn leads to poor health.

Prevention

The piglets are protected against diarrhea by vaccinating the sow before farrowing and it is therefore important that the sow produces enough good quality colostrum and that she presents her clean udder to the piglets so that they can get access to the teats.



The farrowing barn should be thoroughly cleaned and disinfected and kept empty sufficiently long between batches to allow the floors to dry to reduce bacteria. The piglets need a warm and dry environment, free of draughts and with a hiding place where they can rest and not loose energy unnecessarily.

“Three-week” diarrhea and post-weaning diarrhea

Diagnosis

“***Three-week***” ***diarrhea*** is associated with bacteria - mainly *E. coli*, parasites – mainly *Iso spora suis* or viruses – such as rotavirus, but also other infectious agents have been found. *Iso spora suis* and rotavirus are also found in animals without clinical symptoms.

Post-weaning diarrhea is generally found 5 to 14 days after weaning and is often associated with *E. coli*. Symptoms vary from subclinical infections to per-acute disease with fatal outcome. Oedema disease is a per-acute disease during this period and is caused by vero-toxin producing *E. coli*. Oedema disease is often fatal and piglets sometimes die without displaying any symptoms due to the rapid progression of the disease.

In order to get an etiological diagnosis of diarrheas in this time period the clinician in charge is recommended to perform autopsies, if possible, and to obtain a bacteriological diagnosis, including a test for sensitivity. If oedema disease is suspected it should be stated on the referral form.

Treatment

“Three-week” diarrhoea – for treatment of *E. coli*-related diarrheas, please see piglet diarrhoea above. There are no effective therapies for viral diarrheas except feeding electrolyte solutions. Herd health problems caused by *I. suis* should be treated by initiating preventive measures, see above.

Post-weaning diarrhoea – if diarrhoea is found in a litter of newly weaned pigs the first action is to withdraw or drastically reduce the feed for the next 24 hours. The amount of feed should then gradually be restored to the desired amount. Electrolytes should be served to reduce the risk of dehydration and to compensate for the loss of feed. It is recommended to add peat to the bedding in order to normalize gut peristalsis and to improve hygiene. If the diarrhoea cannot be cured through these initial measures individual pigs may be treated with *T/S* parenterally. Another antibiotic may be chosen if supported by bacterial diagnosis and a sensitivity test.

If more than 10 % of litters are treated annually with antibiotics a herd health investigation should be initiated. In severe cases, and when a large proportion of the herd is affected, group therapy may be indicated, see Strategies for group treatment.

Prevention

The process of weaning is stressful for the young pig. Age and weight at weaning is of great importance. A prolonged period for suckling is indicated for those litters that are born late in the farrowing batch. Other positive factors are good hygiene, proper heating and good quality feed of correct composition. The principle of “all-in-all-out” to reduce bacteria load and enable cleaning, disinfection and drying of floors should result in good, clean conditions in the cubicles. If the herd suffers repeatedly from post-weaning diarrhoea Zink oxide may be mixed into the feed, see Strategies for group treatment.



General preventive measures, including composition of feed, are of particular importance to prevent oedema disease. The course of the disease may be so rapid that the pigs die before therapy can be administered and the prognosis may be unfavorable even with treatment. Vaccinating against oedema disease has been tried in Sweden but with limited success.

Diarrhea in the growing and fattening pig

Diagnosis

In Sweden the time post-weaning until slaughter is often divided into two stages (apart from the immediate post-weaning period) where the pigs first have a growth period, often in one facility, and then before slaughter, a fattening period. Diarrhea in the later part of the growing – and during the fattening period can have different etiologies. Samples for bacteriological culture should therefore be taken from pigs with diarrhea, with the exception of wasting pigs. Pigs that exhibit blood stained or bloody diarrheas should always be sampled because of the possibility of dysentery. *Brachyspira* spp. and *Lawsonia intracellularis* may each cause clinical problems but are often found in mixed cultures. To arrive at the correct diagnosis and treatment the clinical symptoms should be supported by autopsy results and bacteriological culture or PCR. A sensitivity test should be included in the diagnostic package. Rapid changes in the feed type or composition may lead to diarrhea, often caused by *E. coli*. Parasites with predilection sites in the large bowels may also cause diarrheas in these stages of the pig's life.

Treatment

In all cases of diarrhea the animals shall be offered fluids, preferably with electrolytes. Infections of the large bowels are often caused by *Brachyspira* spp. and the only effective antimicrobials are pleuromutilins and possibly **tylosin**. If *B. hyodysenteriae* is identified the aim should be to sanitize the herd. In the case of *Lawsonia intracellularis*-infections the drug of choice is **tylosin**. **Chlortetracycline** is an alternative but should not be used unless supported by a bacteriological culture result. *Lawsonia intracellularis* is generally sensitive to tiamulin, but use of this antibiotic should be reserved for treatment of *Brachyspira* spp. Infections caused by *L. intracellularis* may be treated with pleuromutilins only when there are no other alternatives as uncritical use increases risk of development of antimicrobial resistance.

Trimethoprim/sulfa (T/S) is the drug of choice for cases of diarrhea caused by *E. coli*. In case of non-responders to T/S use of some other antibiotic should be supported by bacterial culture and results of a sensitivity test.

Prevention

Good hygiene, a warm environment and high quality feed are important when moving pigs to new facilities. Rearing pigs in batches with cleaning and disinfection of the stalls and sufficient time to let the floors etc dry, reduces the bacterial load and leads to a favorable climate in the cubicles. With increasing age the pigs are less dependent on added heat. In the summer excess heat may lead to decreased hygiene in cubicles as the pigs search for cooler resting places.

If *Brachyspira hyodysenteriae* is found in a herd a sanitation program should be started. Sanitation comprises emptying, cleaning, disinfecting and drying out barns. All parent animals should be treated with tiamulin before returning to the cleaned and dried barns. Animals destined for slaughter or sale should not be allowed to return to the barns. The sanitation needs to be thorough and should preferably be done in the summertime. It is advantageous to, at the same time, intensify elimination of rodents.

Sanitation aimed at eradicating *Lawsonia intracellularis* and *Brachyspira pilosicoli* may be contemplated, but is costly and difficult to do. The risk of reinfection is high because of incomplete sanitation or reintroduction of the infections through purchase of new animals. A live vaccine against *Lawsonia* is available on the market.

Post-weaning multi-systemic wasting syndrome, PMWS

PMWS is associated with porcine circo-virus typ 2 (PCV2). The infection can be prevented by vaccinating the sows and/or the young pig. Antibiotic therapy is not indicated.



Infections of the respiratory tract

Infections of the airways of pigs are often caused by bacteria but these infections are often secondary to or complicated by viral infections. The most common primary infectious agents are *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae*. Infections of the respiratory tract occur most frequently in the fattening period but may also affect younger pigs. Secondary infections are common, where *Pasteurella multocida* is a frequently identified micro-organism. Toxin producing *P. multocida* is part of the etiology of atrophic rhinitis.

Diagnosis

Diagnostics of bacterial respiratory infections are best based on autopsies and/or serological testing of different age groups of animals. Culture of *M. hyopneumoniae* is difficult and time consuming. Isolation of *A. pleuropneumoniae* can only be done from acutely affected lung tissue. Since *P. multocida* is a common cause of secondary infections, concurrent with other diseases, serology is unsuitable as a diagnostic tool. *P. multocida* should be cultured, preferably with a test for antimicrobial sensitivity. In order to diagnose atrophic rhinitis a toxin producing strain of *P. multocida* must be identified.



Treatment

Choosing a suitable and effective antibiotic is not an easy task. Sampling for bacteriological culturing, complemented with a sensitivity test needs to be done whenever possible. Combating respiratory infections in pig herds demands constant follow ups and evaluations. If wide spread and severe outbreaks occur in a herd group treatment may be indicated; see Strategies for group therapy.

Mycoplasma hyopneumoniae

Infections with *M. hyopneumoniae* often progress with a weak cough in batches of fattening pigs. Other clinical symptoms are less common even if naive animals may suffer from acute pneumonia that may resemble an acute *A. pleuropneumoniae*-infection. Infections caused by *M. hyopneumoniae* generally are chronic and should only be treated if animal welfare is at stake. The infection generally spreads slowly in a herd and often reaches its peak at the time of slaughter. General condition is often unaffected and signs of disease only show up at slaughter.

Pigs that become infected with *M. hyopneumoniae* in the growing period may develop a dry cough. If general condition is affected, or the infection is widely spread, treatment should be contemplated. The drug of choice under Swedish conditions is tetracycline (TET) but *M. hyopneumoniae* is also sensitive to pleuromutilins, tiamulin for example. Tiamulin should, however, be reserved for treatment of *Brachyspira hyodysenteriae*-infections, but may be used strategically, for instance in eradication programs or sanitation of a herd. A third option might be enrofloxacin that often is effective against *M. hyopneumoniae*, but this antimicrobial ought not to be used without a prior bacteriological diagnosis and a test of sensitivity.

Actinobacillus pleuropneumoniae

Clinical symptoms at infections caused by *A. pleuropneumoniae* vary from no symptoms where pathological changes – commonly pleuritis, are found at slaughter to severe, acute symptoms with high fever ($>40^{\circ}\text{C}$), anorexia and high mortality. A common find at slaughter are deposits of fibrin on heart and lungs. In mild outbreaks one finds only a few animals with cough, elevated body temperature and depressed appetite. Recommended treatment of these pigs is individual injections of systemic BPP for 5–7 days. The Swedish Medical Products Agency recommends a higher daily dose than stated by the manufacturers at 25–30 mg/kg and day (instead of 20 mg/kg SID³). Antibiotic treatment may be comple-

³SID = Semel in diem = once a day, BID = Bis in diem = Twice a day etc.

mented with NSAID. In more severe cases, when the infection is widely spread in a herd, group therapy with TET may be indicated and in cases with high mortality and low effect of above mentioned antimicrobials enrofloxacin may be tried, but only if supported by results from bacteriological cultures and tests of sensitivity have been received from an accredited laboratory.

Pasteurella multocida

Since *Pasteurella multocida* is a common pathogen associated with secondary infections therapy should also be aimed at this pathogen. Under Swedish conditions *P. multocida* is often sensitive to BPP, which is the drug of choice.

Even though the above mentioned micro-organisms are the most frequently found in cases of infections of the respiratory tracts of pigs also others can be found. If the clinician experiences weak or no effect of therapy, samples for bacterial culture and tests of sensitivity should always be obtained, in order to direct therapy properly and prudently.

Prevention

In order to prevent respiratory tract infections in pigs a strict practice of rearing in batches in accordance with the all-in-all-out principle should be upheld. Larger herds should divide the animals in age groups. Older “left over”-pigs, that have not been able to keep up with their ordinary group, shall never be allowed to move in with a new group of pigs. Environmental factors such as adequate temperature and quality of air must be optimal for both the newly weaned pig and the pig that is ready for slaughter, and since they have different demands on their environment, this is another reason for strict sectioning according to age. Temperature in the barn for newly weaned pigs should not be below 22° C. When the pigs are half grown the temperature should be gradually lowered to 15° C. The aim should be to change the air, through proper ventilation, to keep a good quality of air. Thorough cleaning of barns, alleys and cubicles, proper disinfection and a long enough time for dry-up and leaving the stalls empty (at least 3–7 days depending on indoor temperature) between batches are necessary management practices to keep the pigs healthy and to achieve an economically sustainable level of income.

Mastitis in sows

There are three main types of mastitis in sows: 1, acute agalactia, which often involves the udder, in the early post-partum period, see more below, 2, acute clinical mastitis during lactation usually affects separate udders and 3, in the dry period a chronic mastitis, often manifested as abscesses, appear. All three are caused by bacteria but therapy differs.

Diagnosis

The older term *agalactia in sows* refers to a syndrome in the early post-partum period where the more modern “postpartum dysgalactia syndrome” (PPDS), or “mastitis, metritis and agalactia” (MMA) are used today. Early symptoms are anorexia in the sow and hunger in the piglets. The sow often gets an elevated temperature, >40°C, and affected general condition. On palpation of the udder one or more swollen and warm udder glands are often identified. A discharge from the vulva is often present as metritis is part of the disease complex.

In cases of mastitis the etiology is often *E. coli*. Bacteria in the environment are believed to enter the udder through the teat canals and cause an acute inflammatory response. Streptococci and staphylococci have also been isolated from the udder.

Mastitis later in lactation and at drying off usually affects single udder glands without systemic symptoms. Streptococci and staphylococci are often present, but also other bacteria, aerobic as well as anaerobic, have been found.

The chronic case of mastitis often manifests itself as an abscessed udder. Actinosis or actinomycosis as well as streptococci and staphylococci are part of the etiology. Diagnosis is made by palpating the udder. The abscess may involve all of one udder gland or it may appear as a sub-cutaneous bunch of grapes.

Treatment

Early diagnosis and ditto therapy are important when handling cases of PPDS. The first measure should be to inject the sow with oxytocin to stimulate milk let-down so that the piglets can suckle. Systemic administration of NSAID may ease the sows pain and discomfort.

Treatment with antibiotics generally is not necessary in mild cases of PPDS. If, however, general condition is affected and rectal temperature elevated therapy with antibiotics and/or NSAID are indicated. T/S is the drug of choice. If T/S fails BPP would be the logical alternative, but other drugs may be used on indication from bacterial cultures and tests of sensitivity.

Mastitis in the latter part of lactation and after drying-off generally does not affect temperature or general condition of the sow. BPP is the drug of choice since the bacteria involved generally are sensitive to penicillin.

Sows with udder abscesses should not be treated with antibiotics as the bacteria are sequestered and cannot be reached. Sows with udder abscesses should be sent to slaughter. If this for some reason is not possible they must be isolated until farrowing and during the next lactation.

Prevention

The incidence of PPDS in Swedish pig herds is normally around 10 % of farrowings. Hygiene in the farrowing box as well as good feed and water hygiene are important to keep incidence low. Amount and composition of feed also play a role. An elevated incidence of diarrheas in piglets may indicate problems with subclinical PPDS.

If incidence rises above 10 % the herd veterinarian should initiate a herd health analysis to identify underlying causes and, in dialogue with the farmer/owner, arrive at measures to improve the situation.

Mastitis later in lactation and at drying-off is prevented by treating sows with damaged teats and udders promptly before lesions develop into chronic forms. Poor milk production may be second to subclinical mastitis, which in turn makes the piglets hungry and more violent as they try to suckle. It is also important that the sows, and especially the young sows, do not lose too much weight during lactation and that they are kept in good condition.

Good hygiene and intra-herd prevention of infections are of major importance to reduce incidence of **abscessed udders**. Post-weaning the sows are sensitive for infections as un milked udders may be infected via the teat canals. Since the sows often are mixed at weaning a palpation of all sows udders should be done to identify which animals that should not be mixed with the healthy ones. Udder palpations should be repeated at insemination and heat checks when the dried-up udder is softer and abscesses easier to feel. Affected sows should be sent to slaughter if at all possible or at least kept separate from other animals.

Infections of the locomotor system – arthritis

Lameness is the most common cause for treatment with antibiotics in suckling pigs as about 10 % are treated for lameness under Swedish conditions. Etiological agents are mainly streptococci, staphylococci or *E. coli*, but *Trueperella pyogenes* may also cause problems. Prevention should aim at reducing trauma to legs and feet. Several studies have shown that piglets treated for arthritis grow slower than their untreated litter mates. Arthritis and lameness in fattening pigs are often associated with Gram-positive bacteria, but *Mycoplasma hyosynoviae* may also cause herd health problems. Infections with *Erysipelothrix rhusiopathiae*, can cause problems in outdoor herds and the owners of such herds should consider vaccinations.

Diagnosis

Seventy-five percent of all pigs treated for lameness were, under Swedish conditions, treated in the first three weeks of life (2013). Symptoms, outside of lameness – include swollen and painful joints and sometimes an elevated rectal temperature. In serious cases, when septicemia has complicated the disease, depressed general condition may be seen. Early detection and therapy is important to avoid chronic changes. Lameness can also be caused by traumatic injuries and abrasive floors. A thorough clinical examination is necessary in order to arrive at a correct diagnosis.

Treatment

Suckling pigs

Streptococcus dysgalactiae subsp. *equisimilis* is the most common pathogen that is isolated from septic arthritis in Sweden. BBP is therefore the drug of choice. When more than 10 % of piglets are treated for arthritis/lameness a herd health investigation is warranted. *Staphylococcus hyicus* may also cause arthritis and strains often produce beta-lactamas. An alternative to BPP is *T/S*, which generally is effective against arthritis caused by *E. coli*. Use of T/S should be supported by a sensitivity test. *Streptococcus suis*, that also may cause meningitis and severe arthritis, have been found in higher numbers than expected in Sweden. *Sr. suis* is sensitive to penicillin.

Fattening pigs

The drug of choice when treating fattening pigs with arthritis is BPP. If BPP fails beta-lactamas producing staphylococci may be the causative agent in which case T/S is an alternative. When *Mycoplasma hyosynoviae* is identified as the cause TET is indicated.

The herd health veterinarian and farmer/owner should always be prepared to support therapeutic choices with autopsies and samples for bacteriology, including sensitivity testing, of diseased pigs in order to arrive at an etiologic diagnosis.

Prevention

All forms of ulcers, lacerations, traumatic lesions of skin and mucosa increase the risks of infections that may lead to arthritis. Lacerations on the faces and abrasions on the carpi of piglets fighting for access to teats may lead to arthritis and lameness. Good care of the sow and enough bedding and floors of good quality are necessary to prevent diseases in both piglets and sows.

Strategies for group therapy

In herds that experience severe and wide spread outbreaks of diseases caused by bacterial infections group therapy may be indicated. Group therapy should never be practiced routinely or replace preventive measures. Etiological diagnostics, including autopsies and bacteriological sampling with sensitivity tests, should always be performed before resorting to group therapy. The antimicrobial can be administered via the feed or water systems. Animals that have a depressed general condition cannot be expected to eat or drink normal amounts and therefore need to be treated individually and systemically.

Infection of the gastro-intestinal tract

Disorders of the gastro-intestinal tract are not uncommon at weaning and are a fairly common indication for group therapy in pigs. Before such therapy is started a thorough herd health investigation should be made in order to initiate proper prevention.

If post-weaning diarrhea occurs repeatedly in spite of preventive measures Zinc oxide (ZnO) may be mixed into the feed already at the start of the weaning period. Feed containing ZnO at a concentration of 2500 ppm can be fed to the pigs for not more than 14 days. Feeding for a longer period may lead to intoxication.

Infections of the respiratory tract

In herds that experience severe and wide spread outbreaks of respiratory diseases group therapy may be contemplated when preventive measures have been tried and the etiologic agent is known. Drug of choice in cases of *M. hyopneumoniae* and *A. pleuropneumoniae* is **tetracyclin**. A sensitivity test may indicate alternative antimicrobials.

Diseases in sheep

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Mastitis

Mastitis is a common and important disease in Swedish meat and/or milk producing sheep herds. The most frequently found bacterium is *Staphylococcus (S.) aureus*.

Diagnosics

Clinical symptoms such as fever, anorexia, clots in the milk, swollen udder and pain that often shows up as lameness in the ewe. Regardless of type of mastitis samples should be taken for bacteriological culture. Subclinical cases can be identified via use of California Mastitis Test (CMT). Milk from udder halves with a CMT-reaction >2 are sampled for bacteriological culture. The milk sample should be sent in a suitable medium to an accredited laboratory (lab).

Treatment

Acute clinical mastitis often has poor prognosis, especially if initiation of therapy is delayed. If the ewe develops gangrene (“blue bag”) she should be euthanized for animal welfare reasons. The ewe should be separated from others during the treatment period, but have her lambs with her if she is lactating. If the ewe is being treated for acute clinical mastitis caused by *S. aureus* or if the mastitis becomes chronic she should be culled when her lambs are weaned.

The drug of choice is benzyl penicillin procaine (BPP), 20 mg/kg im SID⁴ for 5 days. Mastitis caused by beta-lactamas producing staphylococci or *E. coli* should not be treated with antibiotics and neither should chronic cases. There are at least two reasons for this: 1, the response to treatment is generally poor and 2, removing ewes with penicillin resistant *S. aureus* also removes those resistance genes from the herd, which reduces the risk of buildup of antimicrobial resistance in the herd/population.

⁴ A hypodermic needle gauge 18 (US), corresponding to 1.2 mm outer diameter, usually allows good flow of milk.

There is limited experience in Sweden of treatment of mastitis in sheep with intramammaries only. If intramammaries intended for dairy cows are to be used in sheep, in accordance with the cascade principle, the dose should be adjusted and a syringe with a narrower tip used. The lambs should be prevented from suckling the dam for 1–2 hours after administration of the intramammary tube.

Antibiotic therapy may be complemented with supportive treatments with NSAID and frequent milkings, which may be preceded by injections of oxytocin.

Metritis

Metritis is generally caused by opportunistic environmental bacteria, Gram-positive as well as Gram-negative, and common underlying causes are high-weight lambs, mal-presentations, assisted lammings, dead fetuses, uterine prolapse and retained fetal membranes (RP). Cases of metritis are generally sporadic in sheep herds.

Diagnostics

Ewes with metritis often have an affected general condition and other clinical symptoms such as fever, anorexia, foul discharge from the vulva and generally stand with an arched back.

Treatment

The ewe with metritis and affected general condition should be isolated together with her lambs. Drug of choice is BPP given systemically, 20 mg/kg im, SID for 5–7 days. An alternative antimicrobial may be TET, if supported by bacterial culture results and sensitivity testing. Recommended dose is 10 mg/kg im SID, or 20 mg/kg im every 48 hours.

Antibiotic therapy can be supported with NSAID and IV fluids.

Prognosis is considered favorable and fertility is generally not affected given a good response to therapy.

Ewes with RP and/or endometritis with unaffected general condition should be treated conservatively as the large majority heals on their own without complications.

Septicemia and “watery mouth”

Septicemia, which is a rare disease in sheep in Sweden, is often caused by *E. coli* and affects neonatal lambs with a decreased immune defense, generally due to not receiving enough maternal antibodies via colostrum. The disease is sometimes

seen in lambs younger than 4 weeks. In Great Britain the syndrome “watery mouth” in lambs younger than 3 days, is associated with *E coli*-infections and bacteremia. Cases have also been reported in Sweden in recent years (2013). When herd health problems with “watery mouth” are suspected preventive measures directed at securing routines regarding handling and feeding good quality colostrum should be initiated rapidly.

Diagnostics

Septicemia is diagnosed at autopsy, including bacteriological culture. “Watery mouth” should be suspected when young lambs – 1–3 days old show symptoms of severely affected general condition, profuse salivation, distended abdomen and cold extremities. Affected lambs seldom have elevated body temperature.

Treatment of septicemia

The drug of choice in cases of septicemia is trimethoprim/sulfa (T/S), 15–22.5 mg/kg, injected systemically BID, 3–5 days. The prognosis is generally very poor and antimicrobial therapy should be supported with IV-fluids, NSAID, extra feed (milk or –replacer), additional heat and insulation, etc., as needed.

Enteritis

Enteritis in lambs is a multifactorial disease that is strongly dependent on management and environmental factors. Common pathogens are *Eimeria* spp. (coccidia) and *E. coli*.

Diagnostics

When investigating a group of lambs for suspected coccidiosis the clinician needs to look at the clinical picture as well as lab results – from fecal samples and/or autopsies.

Treatment

The drug of choice against coccidiosis is some coccidiostatic drug, such as toltrazuril (T). T is administered as an oral solution to all lambs in the group where coccidiosis is present. The best results of therapy are seen at metaphylaxis: treatment of groups of animals that are infected but have not yet displayed clinical symptoms.

When treating single or only a few animals it is recommended to use a sulfonamide preparation in the form of a paste (50 %), dosed 0.4 g/kg body weight SID orally for three days. An alternative may be systemic therapy with T/S im, at 15–22.5 mg/kg SID for three days.

Arthritis

Arthritis or polyarthritis in lambs is often seen secondary to anaplasmosis, umbilical infections or sometimes septicemia. For treatment of septicemia see paragraph above. Staphylococci, streptococci, *E. coli* and less commonly *Erysipelothrix rhusiopathiae* have been shown to cause arthritis in sheep in Sweden. If arthritis becomes a herd health problem predisposing factors such as hygiene at lambing, surface of floors and amount of bedding, as well as problems with ticks should be investigated.

Diagnostics

Clinical symptoms of arthritis are decreased general condition and lameness, fever, swollen joints etc. Swelling of joints varies and may be hard to diagnose, especially at infections with *E. rhusiopathiae*. If several cases are seen in a herd it is recommended to do one or more autopsies on infected lambs and also include bacterial culture and sensitivity testing in the diagnostic package.

Treatment

The drug of choice is BPP, dosed 20 mg/kg im, BID (SIC!) for 10–14 days. Alternatively the dose is increased to 40 mg/kg im SID. NSAID may support antimicrobial therapy. Lambs should not be injected in the neck as the local reaction may be painful and may make it impossible for the lambs to suckle.



Sole abscess

Abscesses in the sole occurs sporadically in all age groups. Punch wounds from sharp objects in the bedding or on pasture are more frequent in lambs since they have thinner soles than adult animals. An abscess in the sole that is left untreated generally opens spontaneously at the coronary band or less often in the interdigital space. The inflammatory process sometimes involves the distal phalangeal joint which leads to a poor prognosis.

Diagnostics

Typical clinical symptoms are severe swelling above the coronary band and lameness, commonly located to one leg.

Treatment

BPP is the drug of choice administered im, at 20 mg/kg SID for 5–7 days. NSAID may be given to ease pain and discomfort.

Foot rot

Foot rot is often preceded by bacteria, commonly *Fusobacterium necrophorum*, infecting the skin in the interdigital space creating an eczema-like condition. The traumatized, infected skin is then secondarily infected by *Dichelobacter nodosus*, which has the ability to dissolve the horn of the claw and cause foot rot.

Diagnostics

Foot rot is diagnosed by identifying the typical clinical symptoms of a necrotizing inflammation in the interdigital space, which involves the soft medial horn on the claws. The symptoms generally involve several animals in the herd. In severe cases the inflammatory process also involves the horn of the sole. In the interdigital space a foul smelling exudate is seen and animals are lame to variable degrees on one or more legs.

Treatment

Systemic treatment of affected animals with a prolonged effect tetracycline generally works well under Swedish conditions.

When eradication of foot rot is attempted the clinician needs to combine the measures:

1. culling of chronically affected animals
2. repeated foot baths with Zink sulfate and
3. injections of TET simultaneous with, at least, the first foot bath.

Pneumonia

Infections of the respiratory tract are relatively common in Swedish sheep herds but knowledge of etiological agents – bacteria, virus and parasites, is limited. *Mycoplasma ovipneumoniae*, *Pasteurella multocida* and *Mannheimia haemolytica* are often diagnosed in herds with respiratory diseases. In a small study done in 2008 *M. ovipneumoniae* was a fairly common find, while viral-, parasitic- and other bacterial infections were uncommon. When a herd experiences problems with respiratory disease a herd health investigation of potential predisposing factors should be performed.

Diagnostics

M. ovipneumoniae often causes coughing without affecting general condition of the animals, while *P. multocida* and *M. hemolytica* often induce clinical symptoms of varying severity; per-acute cases with sudden deaths without signs of respiratory disease may occur.

Clinical symptoms such as cough, dyspnea, fever and/or affected general condition can be seen. Bacteria, including mycoplasma, can be found at autopsy and microbiological examination (culture/PCR), or when sampling at slaughter. Nasal swabs are of limited value according to Swedish experiences.

In order to investigate viral or parasitological etiologies sampling for serology and/or analyses of feces may be done.

Treatment

The drug of choice when treating cases of respiratory disease is BPP, 20 mg/kg im, administered BID (SIC!) for five days. An alternative therapy may be injecting 40 mg/kg im, SID for five days. A third option is using long term BPP dosed at 30 mg/kg im, SID for five days.

When *M. ovipneumoniae* is verified or suspected the drug of choice under Swedish conditions is tetracycline (TET), dosed at 10 mg/kg, im, SID for 5–7 days or 20 mg/kg 2–3 times injected im every 48 hours. Long-term TET may be administered at 20 mg/kg 2–3 times with a 60 hour interval.

Listeriosis

Encephalitis is the most common manifestation of listeriosis in Sweden, where sporadic cases are seen in the wintertime. Silage contaminated by earth and with a pH >5 is considered an important risk factor. Confirmed cases must, according to the law on zoonoses, be reported to governmental agencies by the lab that

makes the diagnosis. Since the turn of the millennium 30–35 cases are reported annually.

Diagnostics

Cases of encephalitis have affected general condition, sometimes fever, often display facial paresis of one half of the face, salivation and CNS disturbances like going around in circles or laying recumbent with the head and neck forcibly bent to one side. The diagnosis is made at autopsy.

Treatment

In accordance with the cascade principle benzyl penicillin sodium (BPS) dosed at 12 mg/kg im or iv – preferably the latter if the animal has pronounced clinical symptoms, BID for 7 days can be used. If the animal is less severely affected BPP may be administered with a start-up dose of 60 mg/kg (SIC!) im, followed by 40 mg/kg SID for at least 6 days. A third option may be to give BPS dosed at 12 mg/kg BID until symptoms subside and then switch to BPP SID at 40mg/kg.

Prognosis is rather poor and early and vigorous therapy is necessary for a successful outcome. Antimicrobial therapy should be supported with NSAID and other medication as needed. Cases of abortions should not be treated with antibiotics.

Infections of the eye

Infections of the eyes occur sporadically in sheep but sometimes affect herd health.

Etiology is largely unknown in Sweden, but culture results from herd outbreaks show that bacteria such as *Mycoplasma conjunctivitis*, *Listeria monocytogenes* and *Moraxella* spp. dominate. Sheep of the breeds Leicester and Texel relatively often develop hereditary entropion that may cause secondary traumatic corneal ulcers, especially in young lambs.

Diagnostics

Clinical symptoms often seen are tearful (runny) and/or shut eyes indicating pain, hyperemic conjunctiva and/or opaque cornea. The etiologic agent may be identified through bacteriological sampling and culture.

Treatment

Best effect of treatment is seen if therapy is initiated early in the inflammatory process. Local treatment is recommended only in those cases where symptoms are present in the superficial structures of the eye. Local treatment should always be

applied to both eyes even if only one appears to be affected. Antibiotics for local treatment of eye infections in sheep can be obtained via prescription through a license or by “off-label use” of suitable bovine intramammary preparations when registered products are not available.

Entropion should be corrected through planned breeding by selecting animals with favorable conformation. A single animal that suffers can be corrected surgically.

If infection with mycoplasma is verified or suspected, local daily treatment for 3–5 days with an oculentum containing chlortetracycline is recommended. An alternative is systemic therapy with oxytetracycline, dosed at 10 mg/kg im, SID for 3–5 days or 20 mg/kg im, repeated after 48 hours.

If infections with *Moraxella* spp., *Listeria* spp. or some other bacterium sensitive to penicillin are suspected, local treatment with an oculentum containing cloxacillin can be used twice with 48 hours interval. An alternative may be local treatment with a suitable bovine intramammary preparation (“off-label use”) containing benzyl penicillin or an oculentum containing chlortetracycline administered once a day for three days. Systemic injections of oxytetracycline may be contemplated.

Diseases in goats

Ylva Persson, DVM, PhD

Introduction

In Sweden only one antimicrobial is registered for use in goats – benzyl penicillin procaine (BPP) (Penovet®, Boehringer Ingelheim Vetmedica, FASS VET. Sweden 2015). All other drugs for therapy need to conform to the EU cascade principle. Since goats might react with strong pain to injections with tetracycline other antimicrobials should be preferred if BPP cannot be expected to be effective.

Mastitis

Mastitis is the most important production disease in goat milk herds. Good udder health is important for animal welfare as well as from food safety aspects. The most frequently isolated udder pathogens in dairy goats in Sweden are *Staphylococcus (S.) aureus* and coagulase negative staphylococci (CNS). Subclinical mastitis is seen more often than clinical.

Diagnostics

Milk samples for bacteriological culture should be taken from the udder half with symptoms of clinical mastitis – swollen gland and changed milk. California Mastitis Test (CMT) can be used to diagnose subclinical mastitis. Samples are taken from udder halves with a CMT reaction >2. Milk samples from cases of subclinical mastitis should be sent to an accredited laboratory in a suitable medium – chilled if possible.

Treatment

The therapy of choice for cases of acute, clinical mastitis in goats is systemic injections of BPP dosed at 20 mg/kg, im SID for five days. If *S. aureus* has been identified as the etiological agent the parenteral treatment may be combined with short-acting intramammaries containing penicillin, infused in the affected udder half SID for five days. Intramammaries should be infused after milking and the kids should not be allowed to suckle the doe until two hours have passed. Antimicrobial therapy can be supported by extra milkings, injections of oxytocin to stimulate milk let-down and NSAID depending on symptoms.

Animals with chronic clinical or exacerbated mastitis or mastitis caused by *E. coli* or beta-lactamas producing staphylococci should not be treated with antibiotics

for reasons stated above (poor prognosis, non-prudent use of antibiotics and risk of propagating antimicrobial resistance in herds). Subclinical mastitis could be treated with long-acting intramammaries containing penicillin in both udder parts at drying off. Aseptic principles must be used when administering intramammary tubes and care must be taken not to damage the teat canals.

Metritis

Metritis can cause high fever, abdominal pain and pussy, sometimes foul smelling, vaginal discharge. Normal puerperal discharge is red-pink, may contain lumps but not pus. The normal involution of the uterus takes about two, sometimes three, weeks.

Diagnostics

Clinical symptoms are identified through clinical examination.

Treatment

The drug of choice when treating cases of metritis with elevated body temperature and/or depressed general condition is BPP, 20 mg/kg, im, SID for 5 days.

Septicemia

E. coli is the most likely etiological agent under Swedish conditions to cause septicemia that may affect neonatal kids with deficient immune systems. Kids are, as all other young ruminants, dependent on ingesting enough good quality colostrum to acquire protection against pathogens.

Diagnostics

A clinical examination may be complemented with autopsies and sampling for bacteriological culture and sensitivity testing.

Treatment

The drug of choice under Swedish conditions is T/S dosed 15–22.5 mg/kg administered im or iv BID 3–5 days. The first injection should be given iv in order to quickly reach high concentrations.

The prognosis is generally poor. Antimicrobial therapy should always be supported with other measures and treatments when treating septicemia.

Enteritis

Diarrhea is most frequently found in kids. The most likely pathogenic bacteria that would require antimicrobial therapy under Swedish conditions are *Eimeria* spp., *i.e.* coccidia, and pathogenic *Escherichia coli* (ETEC). There is limited experience of treating ETEC in goats in Sweden.

Diagnostics

Clinical symptoms identified through clinical examination and supported with analyses of feces and or autopsies.

Treatment

The drug of choice against coccidiosis is some coccidiostatic drug, such as toltrazuril (T), in an oral solution, which is administered to all lambs in the group where coccidiosis is present. The best results of therapy are seen with metaphylaxis, which is treatment of groups of animals that are infected but have not yet displayed clinical symptoms.

When treating single or only a few animals it is recommended to use a sulfonamide preparation in the form of a paste (50 %), dosed 0.4 g/kg body weight SID po for three days. An alternative may be systemic therapy with T/S im, at 15–22.5 mg/kg SID for three days.

ETEC may be treated with T/S dosed at 15–22.5 mg/kg depending on product and administered im or iv, BID, 2–3 days. The first injections should be iv to rapidly get high concentrations.



Arthritis

Arthritis in adult goats may be caused by CAE-virus, mycoplasma and several spp of bacteria. Knowledge of the etiology of arthritis in kids in Sweden is limited but *E. coli* has been known to cause polyarthritis. Norwegian studies indicate streptococci as the most common cause of polyarthritis.

Diagnostics

Clinical symptoms identified through clinical examination and supported by bacteriological analysis and/or PCR, serology or other diagnostic test and/or autopsies.

Treatment

If a bacterium sensitive to penicillin is suspected BPP is the drug of choice, administered at 20 mg/kg, BID, 10–14 days or at 40 mg/kg, SID. Early initiation of treatment is crucial for success. Prognosis is poor.

If *E. coli* is diagnosed or suspected T/S may be used, view paragraph on septicemia.

Arthritis caused by mycoplasma has a very poor prognosis but TET administered systemically can be tried, taking animal welfare into consideration.

Arthritis caused by CAE is impossible to treat with antibiotics but supportive therapy may be used on a case-by-case basis.

Diseases of feet and claws

Foot rot may affect goats as it sheep. *Dichelobacter nodosus* is the etiological agent. Goats are also affected by interdigital dermatitis caused by *Fusobacterium necrophorum*.

Diagnostics

Identification of clinical symptoms, for foot rot see paragraph on sheep.

Treatment

Foot rot is primarily treated with Zink sulfate in a foot bath. In more severe cases long-acting tetracycline can be used dosed at 20 mg/kg, injected once, simultaneous with the first foot bath. For eradication see text on sheep.

Interdigital dermatitis is primarily treated by cleaning and disinfecting the locally inflamed area. Severely affected cases with elevated body temperature and or

lameness should be treated with BPP dosed at 20 mg/kg im, SID for 3 days. Alternatively long-actin penicillin can be used, injected im once at 30 mg/kg.

Pneumonia

Pneumonia in goats is a multifactorial disease. Environmental factors such as poor ventilation and dirty stalls combined with high animal density and stress favor pathogens like bacteria, viruses and parasites. *Mycoplasma*, *Pasteurella multocida* and *Mannheimia haemolytica* are seen in Swedish goat herds.

Diagnostics

Outside of clinical symptoms an autopsy may provide an etiological diagnosis. Nasal swabs are of limited value mainly due to the mixed flora in the upper respiratory tract.

Treatment

BPP is the drug of choice at infections with *Pasteurella multocida* and *Mannheimia haemolytica* and is dosed 20 mg/kg im BID or 40 mg/kg SID. Therapy should be kept up for at least 5 days.

Mycoplasma is not sensitive to penicillin and the effect of other drugs is generally poor, but tetracycline may be tried., taking animal welfare into consideration. The recommended dose is 10 mg/kg im SID for 5 days or 20 mg/kg twice with 48 hours interval. If a slow-release product is used it should be dosed 20 mg/kg im, twice with a three day interval. Supportive therapy with NSAID and other drugs or measures is done on a case-by-case basis according to symptoms.

Listeriosis

Listeriosis is caused by the bacterium *Listeria monocytogenes*. Goats may exhibit symptoms from the central nervous system and, less commonly, septicemia that may induce abortions. Listeriosis is a zoonosis and must be reported by the laboratory that makes the diagnosis. Contaminated silage of poor quality is considered a risk factor.

Diagnostics

Clinical symptoms and results from autopsy.

Treatment

L. monocytogenes is sensitive to penicillin and the drug of choice is benzyl penicillin sodium and, in accordance with the cascade principle, benzyl penicillin

sodium (BPS) dosed at 12 mg/kg im or iv – preferably the latter if the animal has pronounced clinical symptoms, BID for 7 days may be used. If the animal is less severely affected BPP may be administered with a start-up dose of 60 mg/kg (SIC!) im, followed by 40 mg/kg SID for at least 6 days. A third option may be to give BPS dosed at 12 mg/kg BID until symptoms subside and then switch to BPP SID at 40mg/kg.

Prognosis is rather poor and early and vigorous therapy is necessary for a successful outcome. Antimicrobial therapy should be supported with NSAID and other medication as needed. Cases of abortions should not be treated with antibiotics.

Infections of the eye

In Norway *Moraxella* spp. and *Mycoplasma conjunctivae* are reported as the most frequent etiology of eye infections of goats.

Diagnostics

Clinical symptom found at examination. The etiological agent can be identified via bacteriological culture.

Treatment

If infections with *Moraxella* spp. or some other bacterium sensitive to penicillin is suspected, local treatment with a suitable bovine intramammary preparation containing benzyl penicillin infused once daily for three days or an oculentum containing cloxacillin infused twice, with 48 hours interval, can be used. An alternative may be local treatment with an oculentum containing chlortetracycline SID for three days. Systemic injections of oxytetracycline dosed at 10 mg/kg im SID, 3–5 days or 20 mg/kg im repeated after 48 hours may be contemplated, but should be avoided for reasons of animal welfare.

Mycoplasma infections may be treated with tetracycline as described above with the necessary consideration of animal welfare. Duration of treatment may need to be prolonged.



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