



NZVA
New Zealand Veterinary Association

Antibiotic judicious use guidelines for the New Zealand veterinary profession

Dairy





Published in September 2018 by
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Foreword

Good anti-microbial usage and prescribing practices at farm level are essential tools to ensure that both the needs of the food industry and the expectations of consumers are met.

In many cases, antimicrobial agents are life-saving medicines both within human and veterinary medicine. One of the largest threats against public and animal health is, however, the increase in antimicrobial resistance. Antimicrobial-resistant bacteria can be transferred between animals and humans and thus, in the case of the veterinary use of antimicrobials, the benefits must be weighed-up against the possible effects on public health.

Resistance development can be counteracted by the responsible use of antimicrobials, good hygiene and active disease control. Active advice to animal owners on, for example, hygiene and vaccination also plays an important part.

In July 2015 the New Zealand Veterinary Association produced an aspirational statement, "By the year 2030 New Zealand Inc. will not need antibiotics for the maintenance of animal health and wellness." This is an aspirational statement that means the veterinary profession is taking leadership on the issue of antimicrobial stewardship.

Clearly antimicrobial therapy will still be relevant and animal welfare is the overriding factor. However, by taking this position the profession is removing itself from dependency on, and possible misuse of, antimicrobials in the effort to ensure that these drugs remain valuable weapons in the therapeutic armoury, not only of veterinarians themselves, but also the human medical profession.

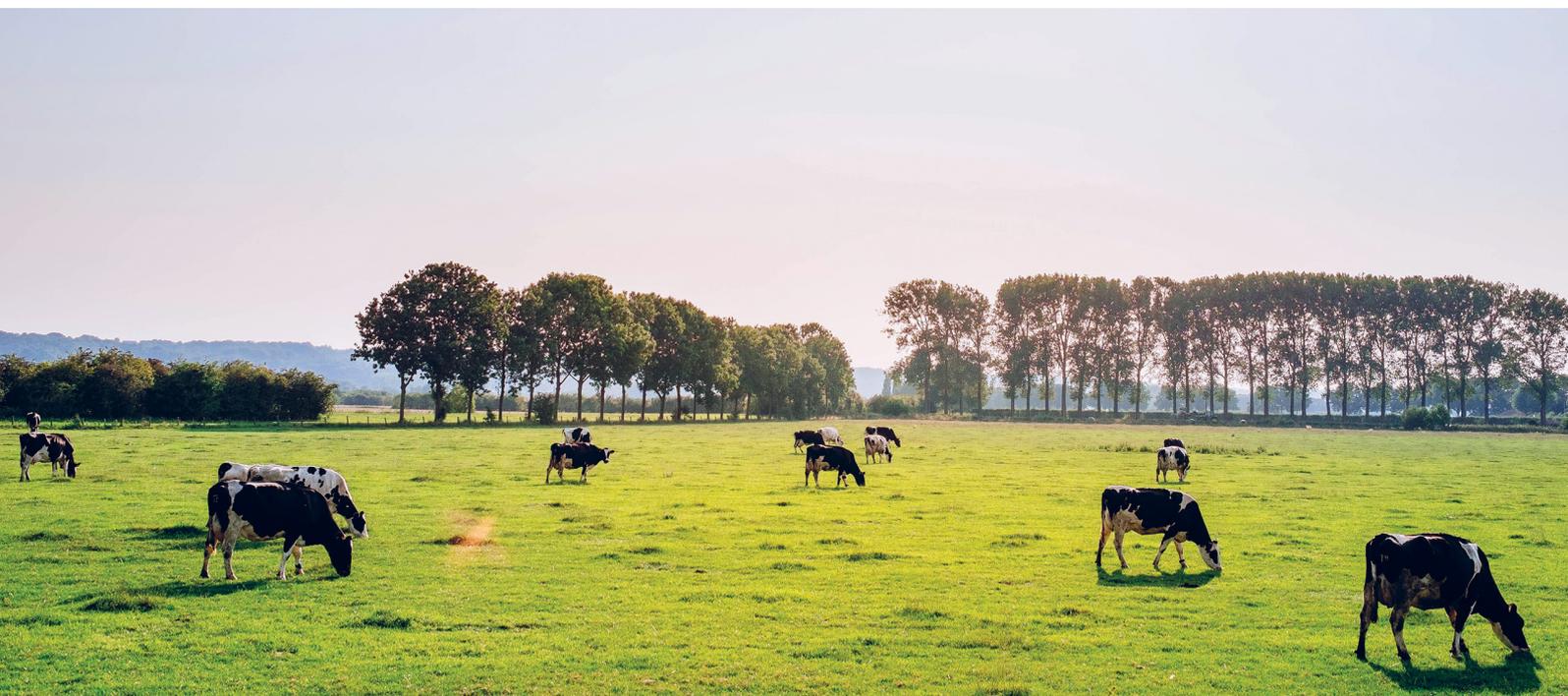
The objective of this document has been to produce a guide that can be used when deciding upon a course of treatment and it is written for current New Zealand conditions and practices.

Antimicrobial treatment is normally only indicated if both of the criteria described below are fulfilled:

- There is a bacterial infection (or when there is sufficient cause to suspect that an actual bacterial infection is present)
- If the infection, in all likelihood, will not resolve without the support of antimicrobial therapy.

If there are equivalent methods of treatment by which antimicrobial agents are not used, these should be the chosen courses of therapy. It is of fundamental importance that antimicrobial agents should only be used when absolutely necessary and that the occurrence of infections should be counteracted, whenever possible, by means of preventative measures.

Prophylactic antimicrobial treatment can in few specific situations be motivated in connection with specific surgical procedures, where the risk for bacterial infection is high or where an infection can drastically worsen the prognosis. The prophylactic use of antimicrobial agents should never be implemented to compensate for poor hygiene.



When possible, the actual infectious agent should be demonstrated by means of laboratory examination. This is especially important in cases of therapy failure, relapse and on other occasions when antimicrobial resistance can be suspected. Samples should always be taken from infections that arise postoperatively.

The risk of antimicrobial resistance should always be taken into consideration when choosing an antimicrobial agent. This means that the antimicrobial agent and the route of administration should be chosen so that the animal's normal flora is affected as little as possible (so-called narrow-spectrum antimicrobials). With this in mind, local treatment when correctly implemented can, in fact, be preferable provided that its effect is thought to be sufficient. Any effect on the normal flora can also be minimised if the course of treatment is kept as short as possible and is then discontinued if the indication is no longer thought to be applicable.

These guidelines have been adapted from the International Dairy Federation Guide to Prudent Use of Antimicrobial Agents in Dairy Production 2013, ISBN 978-92-9098-041-4 the Purata Farm Antibiotic Stewardship Plan and the 2015 RUMA (Responsible Use of Medicines in Agriculture) Guidelines.

The aim is to provide a framework to support the responsible use of antimicrobial agents on dairy farms. The IDF guidelines stress the importance and need for a whole supply chain approach to ensure food safety therefore apply not only to farmers and veterinarians but also milk processing companies, pharmaceutical companies and regulators.

On the other hand the NZVA guidelines are to assist New Zealand veterinarians with their own practice principles and to assist the practices in providing advice and education for their clients. Therefore only the sectors pertaining to farmers and veterinarians have been adapted from the IDF Guidelines.

As antibiotic usage and resistance profiles may differ between regions such guidelines are naturally broad, encompassing principles, and individual practices are encouraged to develop their own prescribing habits based upon these principles.

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The farming section from the IDF guidelines has been modified for New Zealand and included at the end as a means of assisting practitioners in their discussions with farmers.

Therefore the guide highlights the role of:

- Dairy farmers in managing animal health and husbandry practices to minimize the occurrence and spread of disease
- Veterinarians providing expert advice focusing on prevention and control and to ensure that the most appropriate treatments are used correctly

As disease patterns, microbial sensitivities and resistance profiles may differ between regions, practices are encouraged to use these documents as background to develop their own practice antimicrobial protocols.

The term "antimicrobial agent" is used rather than "antibiotic" in this Guide. The term antimicrobial agent is as defined by the World Organisation for Animal Health (OIE) and means a naturally occurring, semi-synthetic or synthetic substance that exhibits antimicrobial activity (kills or inhibits growth of microorganisms) at concentrations attainable in vivo.

Anthelmintics and substances classed as disinfectants or antiseptics are excluded from this definition. Antimicrobial agents are inclusive of anti-bacterials, anti-virals, anti-fungals and anti-protozoals.

The guiding objective is that milk and meat should be produced from healthy animals under generally accepted agricultural conditions, with minimal and controlled use of antimicrobial agents.

Dairy farmers should apply Good Agricultural Practices (GAP) when using antimicrobial agents in the following areas:

- Animal health
- Milking techniques and hygiene
- Nutrition
- Animal welfare
- Environment

Veterinarians (or appropriate authorized technical advisors) should assist dairy farmers to apply GAP by providing a veterinary health plan. This Veterinary Health Plan should be drawn up in conjunction with the farm's veterinary surgeon and reviewed on a regular basis. The plan allows diseases known or thought to be present on the farm to be recorded along with outline preventative measures and the treatments prescribed by the veterinary surgeon. Key measures of performance can be tabulated. Cleaning programmes can be noted and staff training requirements identified.

There should be written instructions on each farm outlining the farmer's obligations in law concerning his use of medicine including antimicrobials. It should cover:

- Storage
- Administration techniques
- Recording
- Withdrawal periods
- Disposal.

Part of the instructions should be specific to the farm including:

- The correct dosage and duration of medication
- The correct circumstances of use
- The correct procedures for observing withdrawal periods.

All of which is to ensure the accuracy of medication of animals at the anticipated site of infection.

These written instructions should be in conjunction and co-ordination with a written Preventative Medicine Programme as part of the Veterinary Health Plan tailored to meet the needs of the farm and emphasising those areas of management that are likely to reduce the requirement to use medication.

All available veterinary practice information should be consolidated into one form or database, such that this centralised information should:

- Allow monitoring of the level of medication used
- Contain a list of those medicines permitted for use on each farm
- Contain a list of medicine withdrawal and a system for allowing information to be updated
- A record of antibacterial sensitivities
- Any comments concerning the response of medication under these circumstances.

Acknowledgments

These guidelines have been formulated by the Antimicrobial Working Group appointed by NZVA.

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Core Principles

1. All dairy farmers and their vets must be totally committed to producing safe food.
2. Dairy farms should be managed to reduce the risk of disease challenge and, therefore, the need to use antibiotics and other medicines.
3. Dairy farmers and their vets should draw up, implement and regularly review an appropriate herd health plan that outlines routine preventive treatments (e.g. biosecurity, vaccination programmes etc.) and disease control policy.
4. Antibiotics should only be prescribed by a vet when there is evidence of a susceptible bacterial infection, treatment is necessary to maintain animal health and welfare and no other treatment such as drainage or antiseptics is likely to be effective. Treatment should be restricted to individual animals where possible.
5. Choice of antibiotic should be based on knowledge of common pathogens and local laboratory data.
6. Antibiotics and dose regimes should be chosen to minimise the development of clinically significant resistance in people or animals.
7. An appropriate withholding time must be applied before the slaughter of treated animals or inclusion of milk from treated cows to the bulk milk tank.
8. Accurate information recording the identity of the treated cattle, the nature of the condition being treated, drugs used and withholding period must be kept.

Antimicrobial Classification

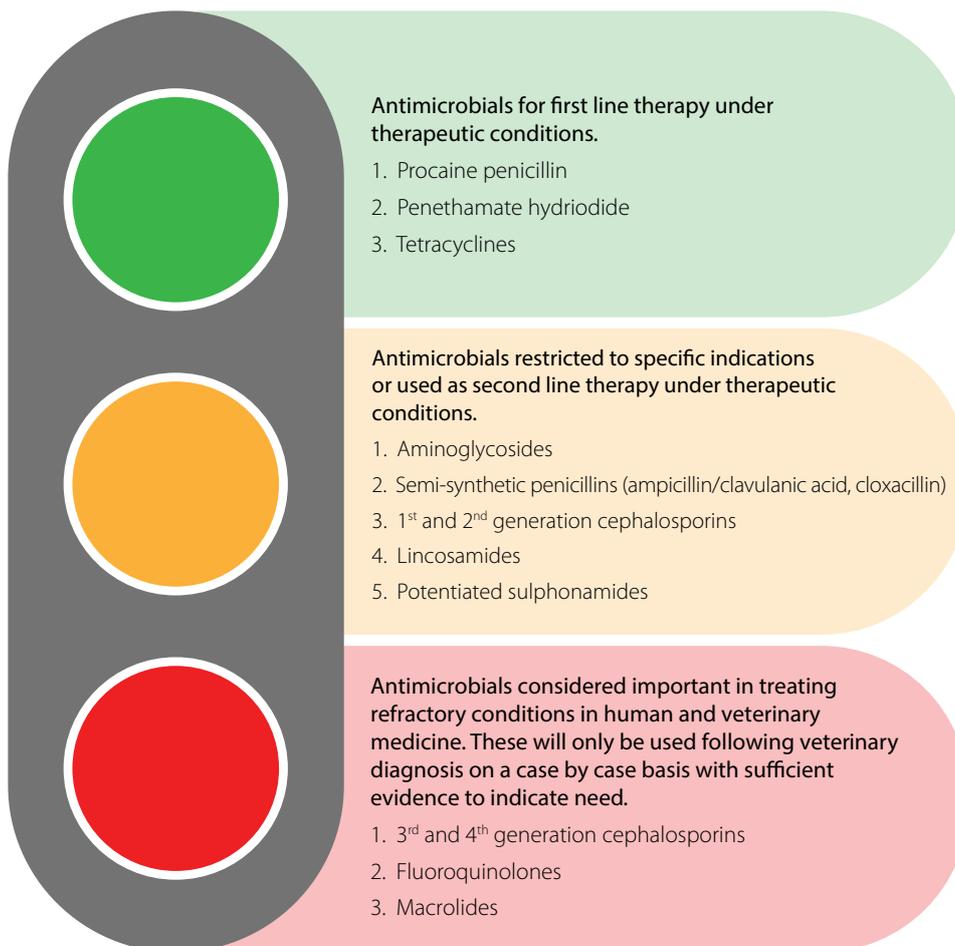
General guidelines classifying antimicrobials according to a three tier (traffic light) system is an example of a type of system that might be employed.

This classification is based on, but differs, from the WHO classification, being less restrictive and intended to suit practical guidelines for veterinary practice in New Zealand conditions.

Consideration should always be given to PK/PD properties to ensure enough of the appropriate antibiotic is available at the biophase.

Culture and susceptibility should be utilised, when clinically relevant, to aid in the selection of antimicrobials.

Narrow-spectrum antimicrobials should be used in preference to broad-spectrum antimicrobials whenever appropriate.



The 5 R's

The 5 R's refer to an acronym popularised in Europe for responsible antimicrobial stewardship and refer to reduction, refinement and replacement (where possible) of antimicrobials and also responsibility (taking ownership of the issue) and review (constantly monitoring progress).

Reduction

Reduction is achieved by:

1. Preventative measures
 - a. Husbandry
 - b. Vaccination
 - c. Monitoring
 - d. Training
2. Elimination of use of antimicrobials where they are of limited or no use, (for example, in uncomplicated viral infection or in a lame cow where trimming only is needed) this requires:
 - a. Accurate diagnosis
 - b. Training
 - c. Treatment guidelines detailing when not to use antimicrobials
3. Use of topical / local antimicrobials in preference to systemic delivery

Refinement

Continuously evaluate prescribing practices and therapeutic plans, based on:

- a. Response to treatment with reference to the desired treatment outcomes
- b. Repeat cases
- c. Clinical studies
- d. In-house and local resistance data
- e. Industry use guidelines

Replacement

Selection pressure can be reduced with adoption of an alternative, non-antimicrobial, approach. For example:

1. Use of internal teat sealants without an accompanying antimicrobial
2. Use of prostaglandin F2 alpha treatment in CL+ cows with evidence of endometritis

The decision to use an alternative must be evidence based on, and take into consideration, the health and welfare outcomes for the animal. Replacement will only be instigated where there is peer reviewed evidence that this will be equally or more effective than antimicrobial treatment.

Responsibility

Without engagement, understanding and personal responsibility of people at all levels involved in the prescription, treatment and management of stock stewardship plans cannot hope to achieve the desired outcomes.

Engagement will be achieved through:

1. Positioning of a program and clear description of the 'Why' to all involved
 - a. What's in it for me?
 - b. What's in it for the animals?
 - c. What's in it for the business?
 - d. What's in it for the industry and community?
2. Ensuring understanding of the core principles not just the operational procedures.
3. Encouragement of 'upward leadership' – empowerment of team members to contribute to success of the plan, bring new ideas and innovation and refine the processes.

Review

A stewardship plan is a 'living document' and will be subject to periodic (at least annually) review to ensure objectives are met.

1. Animal health and welfare outcomes remain top priority and monitored to ensure they are achieved
2. Protocols should be reviewed for compliance and relevance by the practice on a yearly basis.
3. There should be awareness of any susceptibility data available to ensure appropriate selection of antimicrobials, maximise efficacy and monitor resistance in target pathogens.
4. Investigation of strategies that can be employed to improve stewardship of antimicrobials within a veterinary practice should occur on an on-going basis.

Good practices

1. Veterinarians

Veterinarians provide an important role in ensuring the prudent supply of antimicrobial agents for dairy farms. They are responsible for promoting animal health and welfare, as well as identifying, preventing and treating animal diseases. The promotion of sound animal husbandry practices, hygienic procedures, biosecurity and vaccination strategies, where relevant, can help to minimise the need for antimicrobial use in food-producing animals. The

prescribing veterinarian should be familiar with the health status of the livestock being treated to ensure that the antimicrobial agents used are appropriate. The veterinarian must also ensure that clear directions are given to the people administering the treatments and managing the livestock, with particular reference to the required dose rate, route of administration and withholding periods.

Good practices to ensure the prudent use of antimicrobial agents on dairy farms	Examples of suggested measures to support dairy farmers in the prudent use of antimicrobial agents	Objective of measures
1.1 Assess the requirements for antimicrobial treatment	1.1.1 Be knowledgeable in the health status of the animals being treated 1.1.2 Diagnose the condition requiring antimicrobial treatment by considering the animal's history, signs and results of a clinical examination and/or by carrying out further diagnostic tests 1.1.3 Consider preventive and other measures that may help with accurate diagnoses and that may eliminate or reduce the need to use antimicrobial agents	Only supply antimicrobial agents when and where necessary Ensure the antimicrobial agents prescribed will be effective for the condition being treated
1.2 Select an appropriate antimicrobial product for the circumstances	1.2.1 Select antimicrobial products that have good efficacy for the disease being treated whilst minimizing risks to the animal, product and user 1.2.2 Use reliable, accurate diagnostic tests to inform antimicrobial selection, especially for complicated or non-responsive diseases 1.2.3 Only use combinations of antimicrobial agents that are complementary and possibly synergistic, and approved by ACVMG for use together 1.2.4 Prescribing or using antimicrobial agents off-label must only be undertaken if the risks can be adequately managed 1.2.5 Prescribing or using unregistered antimicrobial agents must only be undertaken if the risks can be adequately managed	Most effective treatment is used, while considering the prudent use guidelines mentioned above, and spread of infection minimised Antimicrobial agent use is minimised Antimicrobial resistance is reduced
1.3 Give clear advice on the appropriate use of the antimicrobial agent	1.3.1 Products should be used on label unless there is clear evidence that off label description is required 1.3.2 Give clear instructions to persons that are responsible for administering antimicrobial agents about dose rates, method of administration and withholding periods 1.3.3 Label all medicines supplied according to ACVMG legislation 1.3.4 Record details of treatments administered and antimicrobial agents supplied	Antimicrobial agents are used appropriately with minimal risks to people, livestock or food safety
1.4 Review treatments	1.4.1 Periodically review the health status of livestock being treated and the appropriateness of antimicrobial agent therapies 1.4.2 Report unexpected outcomes of antimicrobial use to ACVMG	Problems with antimicrobial use are identified and investigated

2. Dairy farmers

While veterinarians have a role in education and support, ultimately, dairy farmers are responsible for the health and welfare of their livestock. Applying Good Agricultural Practice (GAP) on dairy farms can greatly reduce the need to use antimicrobial agents. Veterinarians need to understand GAP in order to facilitate their role in education and support.

Good dairy farming practices have been described in the FAO and IDF Guide to Good Dairy Farming Practice and the

key practices that support the prudent use of antimicrobial agents on farms are collated in the table below.

Section 2.11 refers to recommendations for the care of housed animals. In New Zealand's extensive farming system there are very few housed animals and this section applies to that small sector.

Good dairy farming practices to ensure prudent use of antimicrobial agents	Examples of suggested measures that underpin the prudent use of antimicrobial agents on dairy farms	Objective of measures
2.1 Establish the herd with resistance to disease	2.1.1 Choose breeds and animals well suited to the local environment and farming system 2.1.2 Determine herd size and stocking rate based on management skills, local conditions and the availability of land, infrastructure, feed and other inputs 2.1.3 Vaccinate all animals as recommended by your veterinarian	Enhance herd disease resistance and reduce stress
2.2 Prevent entry of disease onto the farm	2.2.1 Only buy animals of known health status (both herd and individual animals) and control their introduction to the farm, using quarantine if indicated 2.2.2 Ensure that animal transportation on and off the farm does not introduce disease 2.2.3 Monitor risks from adjoining land and neighbours and have secure boundaries 2.2.4 Where possible, limit access of people and wildlife to the farm 2.2.5 Have a vermin or pest control program in place 2.2.6 Only use clean equipment from a known source	Maintain farm biosecurity Keep animals healthy
2.3 Have an effective herd health management program in place	2.3.1 In NZ it is mandatory to use an identification system that allows all animals to be identified individually from birth to death 2.3.2 Develop an effective farm herd health management program focused on prevention that meets farm needs as well as regional and national requirements 2.3.3 Regularly check animals for signs of disease 2.3.4 Establish diagnosis and recommended treatment (consult veterinarian if necessary) 2.3.5 Sick animals be attended to quickly and in an appropriate way 2.3.6 Keep sick animals isolated 2.3.7 Separate milk from sick animals and animals under treatment and dispose of the milk appropriately 2.3.8 In NZ it is mandatory to keep written records of all treatments and identify treated animals appropriately 2.3.9 Manage animal diseases that can affect human health (zoonoses) such as leptospirosis, salmonella, cryptosporidiosis	Detect animal diseases early Prevent spread of disease among animals Ensure food safety Ensure traceability

[Table continued on next page...]

Good dairy farming practices to ensure prudent use of antimicrobial agents	Examples of suggested measures that underpin the prudent use of antimicrobial agents on dairy farms	Objective of measures
2.4 Use all antimicrobial agents and veterinary medicines as directed	<p>2.4.1 Only use antimicrobial agents and veterinary medicines approved for supply and use under relevant legislation</p> <p>2.4.2 Only use veterinary medicines as prescribed by veterinarians</p> <p>2.4.3 Store antimicrobial agents and veterinary medicines securely and properly. Vaccines must be refrigerated at 2C – 8C., Dispose of antimicrobial agents responsibly – do not use out of date products.</p> <p>2.4.4 Maintain records of all treatments with veterinary medicines – do not use out of date products</p>	<p>Most effective treatment of animal disease</p> <p>Prevent occurrence of antimicrobial residues in milk and meat</p>
2.5 Ensure milking routines do not injure the animals or introduce contaminants into milk	<p>2.5.1 Identify individual animals that require special milking management</p> <p>2.5.2 Segregate milk harvested from sick or treated animals for appropriate disposal</p> <p>2.5.3 Ensure regular maintenance of milking machines.</p>	<p>Prepare animals for hygienic milking</p> <p>Avoid contaminants in milk</p>
2.6 Ensure animal feed and water are of suitable quantity and quality	<p>2.6.1 Ensure the nutritional needs of animals are met</p>	<p>Keep animals healthy with good quality feed</p>
2.7 Ensure animals are free from discomfort	<p>2.7.1 Design and construct buildings and handling facilities to be free of obstructions and hazards</p>	<p>Protection of animals against adverse climatic conditions and risk of disease</p> <p>Provide a safe environment</p>
2.8 Ensure animals are free from pain, injury and disease	<p>2.8.1 Follow appropriate birthing and weaning practices</p> <p>2.8.2 Protect against lameness. Use healthy hoof programmes</p> <p>2.8.3 Milk lactating animals regularly</p> <p>2.8.4 Avoid poor milking practices as they may injure dairy animals</p>	<p>Prevention of pain, injury and disease</p> <p>Prompt treatment of pain, injury and disease</p>
2.9 Ensure farm tasks are carried out safely and competently	<p>2.9.1 Have appropriate procedures and equipment in place for undertaking dairy farming tasks</p> <p>2.9.2 Induct and train/educate staff appropriately for their work</p> <p>2.9.3 Ensure staff carry out their tasks competently</p> <p>2.9.4 Choose competent people for training, advice and interventions</p>	<p>Limit risks to staff, livestock and infrastructure</p>

Good dairy farming practices to ensure prudent use of antimicrobial agents	Examples of suggested measures that underpin the prudent use of antimicrobial agents on dairy farms	Objective of measures
2.10 Ensure dairy farming practices do not have the potential to increase the frequency of antimicrobial resistance in animals and the environment	<p>2.10.1 Contain dairy run off on the farm</p> <p>2.10.2 Use veterinary treatments appropriately to avoid contamination of the local environment</p> <p>2.10.2 Undergo yearly restricted veterinary medicine (RVM) review.</p>	<p>Limit the impact of dairy farming practices on the environment and the pool of antimicrobial resistant microorganisms</p>
2.11 Recommendations for the care of housed animals	<p>2.11.1 Design and construct buildings and handling facilities to be free of obstructions and hazards</p> <p>2.11.2 Provide adequate space allowances and clean bedding</p> <p>2.11.4 Provide housed animals with adequate ventilation</p> <p>2.11.5 Provide suitable flooring and footing in housing and animal traffic areas</p>	<p>Provide a safe environment</p> <p>Keep animals healthy</p>



Antibiotic recommendations

Condition	Treatment	Alternative	Notes
Respiratory System			
Calves			
Calf diphtheria/ Necrotic stomatitis	Procaine penicillin im 25 mg/kg SID	Trimethoprim + sulpha im 16–20 mg/kg SID	Poor prognosis in laryngeal infection due to poor blood supply to affected tissue and scarring of the larynx
Enzootic pneumonia of calves	Amoxicillin im 7–15 mg/kg SID/EOD	Oxytetracycline im 4–20 mg/kg SID/EOD Trimethoprim + sulpha po 24–35 mg/kg SID Trimethoprim + sulpha im 16–20 mg/kg SID	Oxytetracycline is indicated as second choice because of possible tissue irritation in case of long term use
Young Stock			
Pathogen unknown	Amoxicillin im 7–15 mg/kg SID/EOD	Trimethoprim + sulpha po 24–35 mg/kg SID Trimethoprim + sulpha im 16–20 mg/kg SID Oxytetracycline im 4–20 mg/kg SID/EOD Tulathromycin Sc 2.5 mg/kg SID	If the animals are not yet eating fibre then the preference is to give oral antibiotics especially for formulations that can cause tissue irritation. Oxytetracycline is indicated as second choice because of possible tissue irritation in case of long term use Do not use Tulathromycin in female dairy cattle 20 months of age or older
Pasteurella multocida, Pasteurella haemolytica, Salmonella dublin	Amoxicillin im 7–15 mg/kg SID/EOD	Oxytetracycline im 4–20 mg/kg SID/EOD Ceftiofur hydrochloride im/sc 2.2 mg/kg SID Tylosin im 10 mg/kg SID Tilmicosin 10 mg/kg once	
Histophilus somni	Oxytetracycline im 4–20 mg/kg SID	Ceftiofur hydrochloride im/sc 2.2 mg/kg SID	
Adult			
Pathogen unknown	Trimethoprim + sulpha im 16–20 mg/kg SID Amoxicillin im 7–15 mg/kg SID	Oxytetracycline im 4–20 mg/kg SID Ceftiofur hydrochloride im/sc 2.2 mg/kg SID Tylosin im 10 mg/kg SID	Oxytetracycline is indicated as second choice because of possible tissue irritation in case of long term use
Pasteurella multocida, Pasteurella haemolytica, Salmonella dublin	Amoxicillin im 7–15 mg/kg SID Trimethoprim + sulpha im 16–20 mg/kg SID	Oxytetracycline im 4–20 mg/kg SID Marbofloxacin sc/iv/im 10 mg/kg Once Enrofloxacin sc 5 mg/kg SID Ceftiofur hydrochloride im/sc 2.2 mg/kg SID Tilmicosin 10 mg/kg once	
Aspiration pneumonia Mixed infection often with obligate anaerobes	Procaine penicillin im 25 mg/kg SID	Oxytetracycline im 4–20 mg/kg SID	Prognosis poor – consider euthanasia
Alimentary system			
Woody Tongue/ Actinobacillosis	Streptomycin im 15–25 mg/kg SID	Oxytetracycline im 4–20 mg/kg SID/EOD	Consider treatment with iodide e.g. sodium iodide at 1g/12kg live weight in 10% solution, repeat 10–14days
Lumpy Jaw/Actinomycosis	Streptomycin im 15–25 mg/kg SID	Oxytetracycline im 4–20 mg/kg SID/EOD	<ol style="list-style-type: none"> Poor prognosis, long treatment course required. Only likely to halt progression and not resolve the lesion. Consider treatment with iodide e.g. sodium iodide at 1g/12kg live weight in 10% solution IV, repeat 10–14days. Avoid peri-vascular administration. Surgical debridement and packing the wound with iodine may also be of use.
Necrotic stomatitis/Calf diphtheria	Procaine penicillin im 25 mg/kg SID	Trimethoprim + sulpha Im 16 mg/kg SID	Poor prognosis in laryngeal infection due to poor blood supply to affected tissue and scarring of the larynx.

Rumenitis – Pre ruminant calves	<p>Sulpha po 200 mg/kg start; 70–100 mg/kg maintenance SID/BID</p> <p>Trimethoprim + sulpha po 24–35 mg/kg SID</p> <p>Trimethoprim + sulpha im 16–20 mg/kg SID</p>	<p>Amoxicillin/clavulanic acid Im 7–15 mg/kg mg/kg SID/EOD</p>	<p>Immediately initiate symptomatic treatment to maintain hydration with electrolytes and water.</p> <p>Consider NSAIDs.</p> <p>Check that the diet (nature and amount) is correct.</p> <p>Orally administered drugs are preferable when treating pre-ruminant calves except for Salmonella for which parenteral treatment is preferred.</p> <p>Every effort should be made to establish the identity of the pathogen before antibiotic treatment is implemented.</p>
Salmonellosis Calf	<p>Trimethoprim + sulpha im 16–20 mg/kg SID</p>		
Colibacillosis (Escherichia coli)	<p>Oxytetracycline im/po/iv 4–20 mg/kg SID</p> <p>Trimethoprim + sulpha po 24–35 mg/kg SID</p> <p>Trimethoprim + sulpha im 16–20 mg/kg SID</p>		
Enterotoxaemia (Clostridium perfringens)	<p>Procaine penicillin im 25 mg/kg SID</p>		Prognosis poor
Adult (Ruminant) enteritis Pathogen unknown	<p>Trimethoprim + sulpha Im 16 mg/kg SID</p> <p>Oxytetracycline im 4–20 mg/kg SID/EOD</p>	<p>Marbofloxacin sc/iv/im 2 mg/kg SID</p> <p>Enrofloxacin sc 5 mg/kg SID</p>	<p>Immediately initiate symptomatic treatment to maintain hydration with electrolytes and water.</p> <p>Consider NSAIDs.</p> <p>Check that the diet (nature and amount) is correct.</p> <p><u>Antimicrobials may not be required at all.</u></p>
Adult (Ruminant) enteritis Salmonella	<p>Oxytetracycline im/sc 4–20 mg/kg SID/EOD</p> <p>Trimethoprim + sulpha Im 16 mg/kg SID</p>	<p>Marbofloxacin sc/iv/im 2 mg/kg SID</p> <p>Enrofloxacin sc 5 mg/kg SID</p>	
Yersiniosis	<p>Oxytetracycline im 4–20 mg/kg SID/EOD</p>	<p>Trimethoprim + sulpha im 16–20 mg/kg SID</p>	
Peritonitis Mixed infection including anaerobes	<p>Procaine penicillin im 25 mg/kg SID</p>	<p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	
Renal system			
Pyelonephritis Pathogen unknown	<p>Procaine penicillin im 25 mg/kg SID</p> <p>Trimethoprim + sulpha im 16–20 mg/kg SID</p>	<p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	
Contagious bovine pyelonephritis (Corynebacterium renale)	<p>Procaine penicillin im 25 mg/kg SID</p> <p>Amoxicillin im 7–15 mg/kg SID</p>	<p>Amoxicillin/clavulanic acid Im 8.75 mg/kg SID</p>	
Leptospirosis (Leptospira interrogans ser. hardjo, pomona, tarassovi, interrogans)	<p>Streptomycin im 15–25 mg/kg SID</p> <p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	<p>Procaine penicillin im 25 mg/kg SID</p>	
Cystitis Pathogen unknown	<p>Trimethoprim + sulpha im 16–20 mg/kg SID</p>	<p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	
Reproductive tract			
Retained foetal membranes Mixed infection including anaerobes	<p>Procaine penicillin im 25 mg/kg SID</p>	<p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	Antibiotics are only required if the cow is systemically ill.
Acute metritis (affected systemically)	<p>Procaine penicillin im 25 mg/kg SID</p> <p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	<p>Oxytetracycline im/sc 4–20 mg/kg SID/EOD</p> <p>Ceftiofur hydrochloride im/sc 2.2 mg/kg SID</p>	
Endometritis (not affected systemically) Mixed infection including anaerobes	<p>Cephapirin* iu 500 mg Once</p>		<p>Cephapirin cannot be used within 14 days after calving.</p> <p>Cows with luteal tissue may respond to prostaglandin injection.</p>
Vaginitis/Peri-vaginal Reactions Mixed infection including anaerobes	<p>Procaine penicillin im 25 mg/k Once SID</p> <p>Amoxicillin im 7–15 mg/kg SID/EOD</p>	<p>Oxytetracycline im 4–20 mg/kg SID/EOD</p>	

Vibriosis	Streptomycin im 15–25 mg/kg SID	Oxytetracycline im 4–20 mg/kg SID/EOD Procaine penicillin im 25 mg/kg SID	
Trichomoniasis	No treatment available		
Cardiovascular system			
Endocarditis and Pericarditis	Procaine penicillin im 25 mg/kg SID Amoxicillin im 7–15 mg/kg SID/EOD		
Navel ill (omphalophlebitis)	Procaine penicillin im 25 mg/kg SID	Amoxicillin/clavulanic acid Im 7–15 mg/kg mg/kg SID/EOD	Extended therapy often required, surgical resection may be necessary to assist healing and antibiotic penetration.
Central nervous system			
Spinal cord abscess	Procaine penicillin im 25 mg/kg SID		Prognosis poor – consider euthanasia
Listeriosis	Procaine penicillin im 25 mg/kg SID Trimethoprim + sulphamethoxazole im 16–20 mg/kg SID	Oxytetracycline 4–20 mg/kg SID 7-15 mg/kg	If cow is recumbent, consider euthanasia
Tetanus	Procaine penicillin im 25 mg/kg SID		<ol style="list-style-type: none"> Also administer tetanus antitoxin If a wound is detectable then debridement and flushing the wound should be undertaken
Meningo-encephalitis/ Encephalitis			
Pathogen unknown	Procaine penicillin im 25 mg/kg SID Trimethoprim + sulphamethoxazole im 16–20 mg/kg SID Amoxicillin im 7–15 mg/kg SID/EOD	Ceftiofur hydrochloride im/sc 2.2 mg/kg SID Marbofloxacin sc/iv/im 2 mg/kg SID Enrofloxacin sc 5 mg/kg SID	
B-haemolytic streptococci	Procaine penicillin im 25 mg/kg SID Amoxicillin im 7–15 mg/kg SID/EOD	Ceftiofur hydrochloride im/sc 2.2 mg/kg SID	
Histophilus somni	Procaine penicillin im 25 mg/kg SID Amoxicillin im 7–15 mg/kg SID/EOD	Ceftiofur hydrochloride im/sc 2.2 mg/kg SID Marbofloxacin sc/iv/im 2 mg/kg SID Enrofloxacin sc 5 mg/kg SID	
Musculoskeletal disease			
Footrot	Procaine penicillin im 25 mg/kg SID		
Toe abscess	No antibiotics indicated		Effect good drainage and apply hoof block to take weight off the affected digit
Joint ill-Arthritis-Osteomyelitis-Peri-arthritis	Procaine penicillin im 25 mg/kg SID Amoxicillin/clavulanic acid im 8.75 mg/kg SID/EOD	Oxytetracycline im 4–20 mg/kg SID/EOD	
Blackleg	Procaine penicillin im 25 mg/kg SID		
Cellulitis	Procaine penicillin im 25 mg/kg SID Amoxicillin im 7–15 mg/kg SID/EOD	Trimethoprim + sulphamethoxazole im 16–20 mg/kg SID	If lesion is around the head use a penicillin based product
Mastitis			
Streptococcal Mastitis	Procaine penicillin i/mam 1g BID × 3 Penethamate hydriodide im/sc 5g SID × 3 Amoxicillin 200mg/50mg	1st gen cephalosporin Imam	<ol style="list-style-type: none"> Where multiple quarters are affected, or with heifers for which it may be difficult to administer intramammary products, consider systemic treatment with penethamate Consider using NSAIDs
Staphylococcal/CNS Mastitis	Procaine penicillin imam 1g BID × 3 Cloxacillin i/mam 0.2g SID/EOD	Penicillin/cloxacillin i/mam 1g/0.2g SID Lincomycin/Neomycin 0.33g/0.1g BID or SID Oxytetracycline + Oleandomycin + Neomycin i/mam 0.2g/0.1g/0.1g SID	Where multiple quarters are infected, or with heifers where intramammary administration may be difficult consider systemic therapy. Consider culling.

Staphylococcal/CNS Mastitis Systemic Therapy	Penethamate hydriodide* im 5g SID	Tylosin im 10 mg/kg SID	*For Staphylococcal isolates that are known to be sensitive to penicillin. Approximately 30% of bovine S. aureus isolates are penicillin resistant in New Zealand. However there is variation amongst herds as to whether resistant S. aureus are present, so sensitivity should be checked before prescribing.
Nocardia Mastitis	These infections are usually refractory to treatment and should be culled.		
Coliform Mastitis	Marbofloxacin sc/iv/im 10 mg/kg Once Enrofloxacin sc 5 mg/kg SID Cefquinome im1 mg/kg SID	Ceftiofur hydrochloride im/sc 2.2 mg/kg SID	In acute, endotoxic coliform mastitis 1st priority goes to supportive therapy to ensure survival – fluids and NSAIDs. Note: systemically ill cattle associated with E. coli mastitis are rare in New Zealand. Parenteral antimicrobial therapy is only indicated if there is systemic involvement. Intramammary therapy with antimicrobials is not indicated.
Other Gram –ve Mastitis	Treatment of infections with Gram negative species other than coliforms should be based on culture and sensitivity. Some pathogens e.g. Klebsiella and Serratia, have poor prognosis and culling should be considered. Mastitis caused by Pseudomonas spp. are often fatal despite treatment. There are limited options for antibiotic treatment. Supportive therapy (fluids and NSAIDs) and frequent milk out may be helpful.		
Dry cow therapy			
Short acting: Coverage over period of involution, up to 4 weeks	Cloxacillin (500mg)	Cloxacillin (500mg) / Ampicillin (250mg)	New Zealand Veterinary association recognizes that the use of DCT in non-infected cows is no longer appropriate in an era of effective alternatives such as internal teat sealants (ITS) and improved management practices and proposes that by 2020, DCT will only be used in the treatment of existing intramammary infections.
Medium acting: 5–8 weeks		Cephapirin (300 mg) Cloxacillin (600mg)	
Long acting: 9+ weeks	Internal teat sealant	Cloxacillin plus internal teat sealant Cephalonium Cloxacillin (600 mg) / Ampicillin (300 mg)	
Teat and udder lesions			
Black spot			1. Topical treatment preferred, antibiotics including sulpha drugs 2. Milking once a day will aid healing
Udder abscess	No antibiotics indicated – lance the abscess to effect good drainage		
Skin conditions			
Dermatophilus	Procaine penicillin im 25 mg/kg SID		Topical treatment with iodine or chlorhexidine compounds in mild cases
Ringworm Trichophyton spp			Topical treatment with iodine or chlorhexidine compounds in mild cases
Eyes			
Pink Eye Moraxella bovis	Topical Oxytetracycline powder for mild cases Topical cloxacillin Procaine oenicillin subconjunctivally	Oxytetracycline im 4–20 mg/kg SID for severe cases	Normally self-limiting disease but can be debilitating and permanent eye damage can result.
Surgery			
	Procaine penicillin im 25 mg/kg SID	Amoxicillin im 7–15 mg/kg SID/EOD	Possibly indicated with surgeries of the gastrointestinal tract, umbilical hernias, teat surgery, hoof surgery and caesarian section. Preferably give pre-operatively.



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