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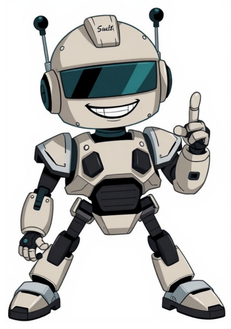

Written by: Dr. Jacquie Jacob, University of KentuckyNOTE: Drugs maynot be used in organic poultry production. However, organic producers may not withhold medical treatment from a sick animal in an effort to preserve its organic status. All appropriate medications must be used to restore an animal to health when methods acceptable to organic production fail. Livestock treated with a prohibited substance must be clearly identified and shall not be sold, labeled, or represented as organically produced.ANTIBIOTICSAn antibioticis a drug that kills or slows the growth of bacteria. (Drugs that kill bacteria are referred to as bacteriocidal; those that slow the growth of bacteria are referred to as bacteriostatic.) Antibiotics are chemicals produced by microorganisms such as bacteria and fungi.Concerns over the development of antibiotic resistance in human medicine have led to the development of new regulations controlling the use of antibiotics in animal feed. Veterinary Feed Directive (VFD) drugs are medically important antibiotics whose use is regulated. New guidelines for these drugs become effective on January 1, 2017. Some of these drugs have been used in poultry medicine.How will these changes affect small-scale poultry producers? After the end of 2016, a veterinarian prescription will be required to get medicated feed as well as purchase what were over-the-counter drugs. Over-the-counter drugs that were previously available online or in feed stores will no longer be available without a VFD. The VFD must be issued by a licensed veterinarian and there must be a veterinarian-client relationship. Small-scale poultry producers need to develop a relationship with a veterinarian so if their birds get sick they can obtain the needed drugs.Webinar: Poultry medications rule changes affecting small and backyard poultry flocksThere are many different kinds of antibiotics, and they destroy bacteria in different ways. The antibiotics within a class generally have similar effectiveness and mechanisms of action and resistance and they tend to attack the same types of bacteria. Some antibiotics, referred to as broad-spectrum antibiotics, treat a wide range of infections. Others, called narrow-spectrum antibiotics, are effective againstonlyafew types of bacteria. Although antibiotics are sometimes used in conventional animal feeds, some of the antibiotics discussed below can be used only under the supervision of a veterinarian.Major classes of antibiotics include the following:Aminoglycosides (e.g., gentamycin, neomycin, spectinomycin, and streptomycin)Bambermycins (e.g., bambermycin, flavophospholipol)Beta-LactamsPenicillins (e.g., penicillin and amoxicillin)Cephalosporins (e.g., cefotaxime)Glycopeptides (e.g., vancomycinnot approved for animal use)Ionophores (e.g., monensin)Lincosamides (e.g., lincomycin)Macrolides (e.g., erythromycin, tylosin)Polypeptides (e.g., bacitracin)Quinolones (e.g., fluoroquinolones)Streptogramins (e.g., virginiamycin)Sulfonamides (e.g., sulfa drugs)Tetracyclines (e.g., chlortetracycline and oxytetracycline)AminoglycosidesAminoglycosides are derived from various species of Streptomyces bacteria. These antibiotics act by blocking the synthesis of proteins vital to bacterial growth. The aminoglycosides remain in the digestive tract so are effective in the treatment of enteric infections. Examples include gentamycin, neomycin, spectinomycin, and streptomycin.Brand names:Biosol(neomycin)OTOMAX (gentamycin)Agri-Mycin17 (streptomycin; The Organic Materials Review Institute [OMRI]lists this drug as allowed with restrictions for crop production.)BambermycinsBambermycins are derived from Streptomyces bambergiensis. These antibiotics act by inhibiting the synthesis of the bacterial cell wall. Examples include bambermycin and flavophospholipol, which are effective against gram-positive pathogenic bacteria and do not affectLactobacillus, Bifidobacterium, and other protective bacteria.Brand names: Beta-LactamsPenicillins and cephalosporins are the two major types of beta-lactams.PenicillinsPenicillins, the first antibiotics to be discovered, are produced by the mold Penicillium notatum. Penicillins are bacteriocidal, and they kill bacteria by inhibiting the formation of the bacterial cell wall. The wall breaks down, releasing the contents of the cell. Amoxicillin and ampicillin are examples of penicillins. Penicillins are effective in the treatment of sinusitis and chronic respiratory disease in poultry.Brand names: CephalosporinsStructurally, cephalosporins are closely related to penicillins. This class of antibiotics is further divided into the first, second, and third generations. Each generation has a broader spectrum of activity than the one before. Like penicillin, cephalosporins interfere with the formation of bacterial cell walls. The Food and Drug Administration (FDA) issued an order on January 4, 2012, that prohibits certain extra-label uses of the cephalosporin class of antimicrobial drugs in cattle, swine, chickens, and turkeys. The order became effective on April 5, 2012. (The term extra-label refers to the use of a drug in a way that is not listed as an approved use on the label.)In its order, the FDA prohibited extra-label or unapproved uses of cephalosporins, specifically includingthe use of cephalosporin drugs at unapproved dosage levels, frequencies, or durationsor via unapproved methods of administration;the administration of cephalosporin drugs to species for which the drugs have not been approvedfor example, administering cephalosporin drugsintended for people or companion animals to cattle, swine, chickens, or turkeys; andthe use ofcephalosporin drugs for disease prevention.GlycopeptidesGlycopeptides act by interfering with cell-wall formation as well as the production of proteins. The only glycopeptide antibiotic available in the United States is the human product vancomycin (Vancocin). Vancomycin is often the treatment of last resort for methicillin-resistant Staphylococcus aureus (MRSA) infections in humans. The FDA Center for Veterinary Medicine (FDA-CVM) issued an orderin 1997prohibiting the extra-label use of all glycopeptides in food animals.IonophoresIonophores are feed additives used in the control of coccidiosis, primarily when raising broilers, broiler breeders, and replacement pullets. Coccidiosis is a disease in poultry worldwide and is caused by a protozoan parasite (Eimeria) that invades the cells of poultry intestines. Ionophores are used primarily as an anti-microbial but can control some bacteria so is often grouped with antibiotics. Ionophores are not used in human medicine.LincosamidesLincosamides are structurally different from macrolides, but they have the same antimicrobial effect. Lincosamides are produced by Streptomyces lincolnensis. Lincomycin is a lincosamide that penetrates most tissues well, including bone. Lincomycin is effective against bone and joint infections, as well as necrotic enteritis caused by Clostridium perfringens.Brand names: MacrolidesMacrolides, which are derived from the Streptomyces bacteria, are bacteriostatic and act by interfering in protein production. An example is a tylosin, which is produced by Streptomyces fradiae. Tilmicosin is a semisynthetic macrolide. Macrolides are effective against Mycoplasmaand Orhnithobacterium rhinotracheale and canbe used to treatnecrotic enteritis.Brand names: PolypeptidesPolypeptides have bactericidal activity against bacilli. Examples of polypeptides include bacitracin, whichis effective againstClostridiumbacteria,and polymyxin E, which is effective against E. coli, Salmonella, Pasteurella, and Pseudomonas aeruginosa.Brand names:BMDPennitracin MDAlbacBacifermQuinolonesFluoroquinolones are synthetic antibiotics not derived from bacteria or fungi. They are broad-spectrum bacteriocidal drugs. Fluoroquinolones prevent bacteria from making DNA, thus preventing the bacteria from multiplying. Examples include enrofloxacin, danofloxacin, flumequine, norfloxacin, and difloxacin. Fluoroquinolones are effective against salmonellosis, colibacillosis, fowl cholera, and Pseudomonas aeruginosainfections.Brand names:Baytril (enrofloxacin; This drugis not permitted for animal use in the United States.)StreptograminsStreptogramins are produced by Streptomyces species and consist of two structurally unrelated molecules. One inhibits protein synthesis, and the other, cell-wall formation. Individually the molecules are bacteriostatic, but the combination of the molecules is bacteriocidal. The drug virginiamycin is a streptogramin that is effective against necrotic enteritis.Brand names:StafacLACTROL(virginiamycin and dextrose)Sulfonamides (sulfa drugs)Sulfonamides are produced by chemical synthesis. They have bacteriostatic activity against a broad spectrum of pathogens. They interfere with RNA and DNA, which are necessary for cell growth and replication. Sulfonamides, such as trimethoprim, are effective against Staphylococcus species, Streptococcus species, Pasteurella, Salmonella, and E. coli.Brand names:SulmetSulfa-MaxSulfasure(sulfamethazine)AlbonDurvet SulfadimethoxineDi-Methox(sulfadimethoxine)TetracyclinesTetracyclines are derived from the bacteria Streptomyces. They are broad-spectrum bacteriostatic agents. Tetracyclines prevent bacteria from multiplying while the host animals immune system deals with the original infection. Examples include chlortetracycline (Aureomycin) and oxytetracycline (Terramycin). Doxycycline is a semisynthetic tetracycline. Tetracyclines are effective against Mycoplasma, Chlamydia, Pasteurella, Clostridium, Ornithobacterium rhinotracheale, and some protozoa.Brand names: NOTE: Brand names appearing in this article are examples only. No endorsement is intended, nor is criticism implied of similar products not mentioned.COCCIDIOSTATSCoccidiosis is a common parasitic disease of poultry. It is the result of an infestation of coccidia in the intestines. A number of different drugs, called coccidiostats, are available for use in conventional diets to control coccidiosis in poultry.Coccidiostats that can be used in conventional poultry production include the following:Amprolium (e.g., Amprol, Corid)Bambermycin (e.g., Flavomycin, GAINPRO)Decoquinate (e.g., Deccox)Diclazuril (e.g., Clinacox)Halofuginone hydrobromide (e.g., Stenorol)Lasalocid (e.g., Avatec)Monensin (e.g., Coban)Narasin (e.g., Monteban)Nicarbazin (e.g., Nicarb 25%)Salinomycin (e.g., Bio-Cox, Sacox)Semduramicin (e.g., Aviax)Sulfadimethoxine and ormetoprim 5:3 (e.g., Rofenaid)For more information about coccidiostats, refer to the article Use of Anticoccidial Medications and Vaccines in Poultry Production.MEDICATION FOR CONTROLLING INTESTINAL WORMSThere are several types of parasitic worms that can infect poultry, including roundworm, tapeworm, cecal worms, and capillary worms. There are only a few products that can be added to conventional poultry feed to control internal parasites. No products are approved for use with egg-laying hens.Acceptable products for worm control include the following:Fenbendazolefor turkeys only (e.g., Safe-Guard)Hygromycin Bfor chickens only (e.g., Hygromix-8)For more information about intestinal worms, refer to the article Internal Parasites of Poultry.PRODUCTS FOR CONTROLLING EXTERNAL PARASITESThere are several types ofexternal parasitethat can infest a poultry flock. Typical pesticides used for control of external parasites include: For more information refer to the Insect Control on Poultry fact sheet by the University of Kentucky Cooperative Extension.PRODUCTS FOR CONTROLLING DARKLING BEETLESDarkling beetles are a common problem in poultry facilities. The adults are black with hardened front wings and antennae that start under a ridge near the eyes. The larvae (referred to as mealworms) are worm-like and slightly hardened for burrowing. Both the larvae and beetles eat decaying leaves, sticks, grass, dead insects, feces, and grains.Brand-name products that can be used to control darkling beetles include the following: For more information about darkling beetles, refer to the article Darkling Beetles.PRODUCTS FOR FLY CONTROLCompounds that can be added to conventional feed to aid in fly control in poultry houses include the following:Cyromazine (e.g., Flyzine, Larvadex, and Solitude IGR)NOTE: Brand names appearing in this article are examples only. No endorsement is intended, nor is criticism implied of similar products not mentioned.Current update on drugs for game bird species (FARAD) As a library, NLM provides access to scientific literature. Inclusion in an NLM database does not imply endorsement of, or agreement with, the contents by NLM or the National Institutes of Health. Learn more: PMC Disclaimer | PMC Copyright Notice . 2024 Sep 29;11(3):675685. doi: 10.5455/javar.2024.k817Antimicrobials are employed in the control of contagious illnesses in humans and animals and are also utilized as growth enhancers in livestock and poultry. Improper application of antibiotics results in the development of multi-drug-resistant (MDR) bacteria, such as methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant S. aureus (VRSA), colistin-resistant, extended-spectrum beta-lactamase (ESBL)-producing E. coli, and fluoroquinolone-resistant Salmonella. Transmission of MDR bacteria happens among animals, from human to animal, and vice versa, resulting in treatment failure, increased treatment cost, and high morality. In this article, we analyzed the recent publications of the current antimicrobial application practices in livestock and poultry farms and the development of antimicrobial resistant (AMR) bacteria in livestock and poultry and its adverse effects on human and animal health using PubMed, Google Scholar, and Google. Citations from published articles were also analyzed. Several drug-resistant bacteria, including MRSA, VRSA, colistin-resistant strains, ESBL-producing E. coli, and fluoroquinolone-resistant Salmonella, have emerged due to heavy antibiotic application in cattle and poultry, according to the analysis. Transmission happens between people and animals as well as throughout the production chain, which raises the chance of failure of antibiotic therapy and fatality. To stop the proliferation of drug-resistant bacteria, it is important to ensure the proper use of antibiotics in livestock and poultry. Especially in developing nations, strict control and implementation of antimicrobial rules are necessary. To successfully address antimicrobial resistance and lessen dependency on antibiotics, alternative disease management strategies in livestock and poultry must be developed.Keywords: Antimicrobial usages, antimicrobial resistance (AMR), livestock, health, hazards poultryAntibiotics are chemical substances produced by microorganisms that either kill (bactericidal) or prevent (bacteriostatic) the growth of other microorganisms [1]. Antibiotics produced by bacteria are mostly live in soil [2]. Penicillin, the first antibiotic, was discovered in 1941. There are various ways that antibiotics combat microorganisms. It hinders the production of the cell membrane, cell wall, protein, and vital enzymes [3]. Narrow-spectrum and broad-spectrum antibiotics can be broadly divided into two groups. Medication with a narrow spectrum (such as penicillin, streptomycin, and so on) only inhibits the growth of particular types of bacteria, such as Gram-positive or Gram-negative. Tetracycline, chloramphenicol, and other antibiotics with a broad range of action are effective against both Gram-positive and Gram-negative bacteria [4]. Some types of antibiotics and their mechanisms of action are summarized in Table 1.Class of antibioticsName of antibioticsMechanism of actionReferencesAminoglycosidesGentamicin, streptomycin, neomycin, and paromomycin.Inhibit protein synthesis.[57]CephalosporinCefoxitin, cephalexin, ceftaroline, cefuroxime, cefroxadine and ceftezole.Inhibit cell wall synthesis.[58]TetracyclineTetracycline, oxytetracycline, doxycycline, minocycline and tigecycline.Inhibit protein synthesis.[59]PenicillinMethicillin, oxacillin, flucloxacillin, ampicillin, amoxicillin and benzyl- penicillin.Inhibit cell wall synthesis.[60]SulfonamidesSulfadiazine, sulfafurazole, sulfadoxine and methazolamide.Inhibit folate synthesis.[61]FluoroquinolonesCiprofloxacin, norfloxacin, levofloxacin and moxifloxacin.Inhibit DNA replication.[62]MacrolidesAzithromycin, erythromycin, carbomycin a and nystatin.Inhibit protein synthesis.[63]GlycopeptidesVancomycin, telavancin, corbomycin, bleomycin, lipopeptides and polymyxins.Inhibit cell wall synthesis.[64]LincosamidesClindamycin, lincomycin and pirlimycin.Inhibit protein synthesis.[65]CarbapenemsImipenem, meropenem, doripenem and razupenem.Inhibit cell wall synthesis.[66]The increased demand for meat and milk for human consumption leads to a huge expansion of intensive livestock and poultry farms both in rich and poor countries across the globe. Antibiotics are necessary for the therapeutic management of illness in both people and animals and for the improvement of food safety, animal welfare, and production. The most often used antibiotics in livestock and poultry sectors include tetracycline, colistin, ciprofloxacin, tylosin, neomycin, amoxicillin, trimethoprim, sulfonamides, doxycycline, erythromycin, and tiamulin [5]. These medications are frequently used to treat bacterial and other infectious diseases. Antibiotics can also be used to treat certain fungus, chlamydial, and rickettsial diseases [6]. In developing countries, poor biosecurity practices, less vaccination coverage against bacterial diseases, and a lack of adequate nutritious feed are often associated with disease outbreaks in livestock and poultry farms. Antibiotic usage in animals and poultry as a preventative measure is a standard procedure to halt the spread of infectious diseases [7]. To boost livestock and poultry production, antibiotics are often utilized as growth promoters [8,9]. Animals guts develop antimicrobial resistant (AMR) bacteria as a result of antibiotic use at accurate or low doses in feed and water. The application of antibiotics as growth enhancers is responsible for the rise of AMR bacteria [10].Antibiotics are widely available to farmers without a prescription, which contributes to antibiotic overuse. Because of AMR, which has emerged as a result of antibiotic abuse, some infections can no longer be treated [11]. The extensive use and misuse of antimicrobial drugs in livestock farms led to the development and spread of antimicrobial resistance. There have been reports of farmers abusing antibiotics that were available without a veterinarians prescription [12].Extended-spectrum beta-lactamase (ESBL)-producing E. coli, Methicillin-resistant S. aureus (MRSA), Vancomycin-resistant S. aureus (VRSA), colistin-resistant E. coli, and fluoroquinolones-resistant Salmonella are the most common multidrug resistant (MDR) bacteria in people and animals [13]. Numerous reports demonstrate the spread of MDR pathogens from animal to human and inversely [14]. Consuming foods derived from animals (such as eggs, meat, and milk) that are contaminated with the MDR bacteria as well as coming into direct contact with animals are two ways that humans might become infected with the MDR bacterium [15]. The AMR is a serious public and animal health threat around the world [16]. It is yet unclear how the widespread utilization of antibiotics and the emergence of AMR affect the livestock industry. There are still many gaps in our present knowledge of how AMR develops and spreads in the cattle and poultry industries [17]. This study addresses the present use of antibiotics in livestock and poultry farms, the transmission of AMR bacteria in livestock and poultry, and the health hazards caused by AMR to humans and animals.A search of the review of the literature was conducted in PubMed, Google Scholar, and Google to meet the objectives. The right combination of keywords was employed, such as antimicrobial usages (in cattle and poultry), antimicrobial resistance (AMR and MDR), and health risks (human and animal). We also looked for and reviewed the articles cited in this review.Antimicrobials are used in animal husbandry for several purposes, such as prophylaxis (preventive treatment), metaphylaxis (therapeutic management of the whole herd whenever a disease epidemic occurs), and growth stimulation [18]. Brazil, Russia, India, China, and South Africa (BRICS) are countries that have turned toward vertically integrated, extremely cost-efficient intensive livestock production systems to meet the massive demand for protein for their people [19]. Antimicrobials are necessary in these production systems to ensure the well-being of animals and productivity. The utilization of antimicrobials in cattle has been rapidly increasing in developing countries in South and Southeast Asia, including Bangladesh, India, Nepal, Bhutan, Sri Lanka, Myanmar, Thailand, and Indonesia [20], as well as in the African countries of Ethiopia and Tanzania [18,21] in 2017. The World Health Organization (WHO) instructed its member nations to minimize the application of antibiotics in food animals. The European Union (EU) has prohibited the utilization of antibiotics for growth enhancement since 2006. In the United States, the application of low concentrations of antibiotics through feed and water to increase the ratio of feed conversion and health was declared illegal in 2017. The application of antibiotics in livestock farms is loosely controlled and regulated in many low-middle-income nations [22]. This results in the improper usage of antibiotics. Farm animals consume 73% of all antimicrobials throughout the world, although the amounts of antibiotic consumption are different among countries. For example, animals are treated with small quantities of antibiotics in Northern European countries when compared to humans. A study conducted in 2015 stated that developing BRIC nations are expected to increase the use of agricultural antibiotics by 67% between 2010 and 2030. The two main factors driving the increase in antimicrobial usage in agriculture are the increased livestock output and consumer demand for animal items [19]. Table 2 displays antimicrobial usage practices by nation for farm animals.Country Antimicrobial usage practiceReferencesEthiopiaThe types of antibiotics used in different agro-ecological zones and production systems were reported to be used differently. Antibiotics were most frequently used by pastoralists (86.7%), then anthelmintics (70.8%). Among all the study sites, the most commonly utilized antibiotic classes were trimethoprim-sulfonamides (6.2%), aminoglycosides (31.3%), and tetracyclines (36.4%).[18]TanzaniaPenicillin (36.4%) was the most often used antimicrobial agent in the small-scale dairy farms having records of antimicrobial use. Sulfamethoxazole (22.3%), oxytetracycline (14.3%), and dihydrostreptomycin were the next most commonly used antimicrobial agents (11.5%).[21]BangladeshAntibiotics are mostly used to treat illnesses in livestock. The most commonly prescribed antibiotics were streptomycinpenicillin (31%) followed by sulfadimidine (14%), amoxicillin (11%), gentamicinsulfadiazinetrimethoprim combination (9%), and tylosin (1%).[67]BhutanAll animals with wounds and diarrhea were regularly treated with broad-spectrum antibiotics such as penicillin, tetracyclines, trimethoprim + sulfa, and sulfonamides. Prescriptions for antibiotics fall under the AWaRe access group (45%70%) and watch group (up to 25%).[68]IndiaIn milk-producing animals, antibiotics are frequently used for both therapeutic and preventative objectives.According to estimates, India used 3% of the worlds antibiotics used in food animal production in 2010, ranking fourth in the world.[11,19]MyanmarThe majority of medications are utilized as feed additives for sub-therapeutic prevention, growth promotion, and therapy.-lactams, tetracycline, fluoroquinolones, aminoglycosides, macrolides, and sulphonamides are among the principal antimicrobial classes utilized in Myanmars livestock industry.[25]NepalMore than 70% of veterinary medicine sales were from paraprofessionals or retail establishments. The top seven antibiotics used in Nepal are tetracycline, enrofloxacin, neomycin-doxycycline, levofloxacin, colistin, and tylosin, with ampicillin, amoxicillin, ceftriaxone, and gentamicin being the drugs most frequently administered incorrectly.[69,70]Sri LankaThe most often used antibiotic is tetracycline. Combinations of the antibiotics sulfa trimethoprim, cloxacillin, bacitracin, and neomycin are frequently used to treat mastitis.[71]IndonesiaTetracycline and amoxicillin were the most frequently used antibiotics, being used by 28.7% of the farmers. Benzylpenicillin, gentamicin, ciprofloxacin, oxytetracycline, enrofloxacin, and doxycycline were other antibiotics utilized.[72]In order to prompt growth, prevention, and control of diseases in poultry, antibiotics are frequently used on the entire flock [23]. Countries that produce poultry have the provision for using antibiotics for the prevention of infectious diseases. Intestinal infections such as colibacillosis, necrotic enteritis, and other illnesses are treated with antibiotics [24]. The class and intensity of AU practices vary from country to country depending on the countrys financial status, as well as the degree of development, animal-rearing methods, and animal species [25]. Depending on the stage of production and the danger of disease, different antibiotic dosages and administration techniques are used [26]. Table 3 displays antimicrobial usage patterns for poultry by country.CountryAntimicrobial usage practicesReferencesNigeriaTetracycline was the most preferred antimicrobial medicine among farmers (41.0%), while amoxicillin and a combination of oxytetracycline, amoxicillin, colistin, and streptomycin were the lowest ranked (1.0 %).[73]TanzaniaSeven classes and seventeen different antimicrobial agents were identified in chicken farms.The majority of farms (87.7% of poultry farms) used antibiotics for medical treatment. The drug withdrawal periods were not followed by about 41% of the chickens.The most often used antimicrobials on these farms included beta-lactams, fluoroquinolones, sulphonamides, tetracyclines, and macrolides.[21]BangladeshOf the antimicrobials used in layer farms (17/54), ciprofloxacin (37.0%), amoxicillin (33.3%), and tiamulin (31.5%) were the most commonly utilized.The three drugs with the highest usage rates on broiler farms were colistin (56.6%), doxycycline (50.6%), and neomycin (38.6%).84.7% of farmers used antimicrobials prophylactically, compared to only 15.3% who used them only for therapeutic purposes. Overall, 75.2% of farmers used antibiotics in clinical conditions, while 24.8% of farmers used antibiotics as preventative measures.[10,74]NepalSix farms (22%) used antibiotics for prophylactic, while 21 (78%) utilized them for therapeutic purposes.Quinolones, macrolides, and tylosin were among the seven antibiotics administered, which came from six different classes.Tylosin (47%), colistin (47%), and neomycin and doxycycline dual treatments were the most widely utilized antibiotics (33%).[75]VietnamThe three most common antimicrobials in chicken feed formulations were bacitracin (15.5% feeds), 11.4% chlortetracycline, and 10.8% enramycin.Antimicrobials such as amoxicillin, colistin, tetracyclines, neomycin, lincomycin, and bacitracin that the World Health Organization has determined to be relevant for use in human medicine accounted for 57% of the total quantitative consumption.[76]ChinaThe most prevalent antimicrobials used in the production of poultry are coccidiostats and arsenicals. There are also concerns about antimicrobial resistance and public health due to the use of macrolides, penicillins, and tetracyclines.[77]ColumbiaIn chicken farms, antibiotics are frequently used as feed growth enhancers and as a treatment for the most prevalent infectious diseases, like bronchitis and infected bursal disease.There were numerous reports of the usage of antimycoplasma agents (65.7%). Overall, calcium phosphomycin (44.3%), enrofloxacin (44.3%), ciprofloxacin (31.4%), norfloxacin (12.9%), and trimetho-prim-sulfamethoxazole were the most often reported antimicrobials utilized for treatments (18.6%).[78]Animals can transmit their resistance to humans in several ways, the food-borne route is the most important. Other ways of transmission consist of coming into direct contact with animals, eating contaminated foods, and indirectly through a polluted environment [27,28].In developed nations, the food-borne route is likely the pathway by which the majority of infections with enteric bacterial pathogens, such as Salmonella entererica, Campylobacter coli/jejuni, and Yersinia enterocolitica, occur. Humans can contract MRSA CC398 through direct animal contact, environmental contamination, and handling or consuming contaminated meat [29]. Table 4 shows the transmission pathways of AMR bacteria originating from poultry.CountryLocationAMR transmission (s) pathwaysOperation levelKey findingsReferencesIndiaUrbanIntensive farmingLargeE. coli with a high rate (94%) of ESBL production and multidrug resistance (87%).[79]ZimbabwePeri-urban CountrysideUrbanIntensive farmingSmallLargeThe intensity of farming is correlated with higher AMR levels of Salmonella spp. Public health is at risk from salmonellosis when isolates of S. enteritidis are MDR in 12.1% of cases.[80]KenyaCountrysideIntensive farmingSmallLargeThermophilic Campylobacter species with confirmed antibiotic resistance in small-scale chicken systems.[81]NigeriaUrbanAMR transmission across speciesLargeSamples of chicken and cattle excrement were discovered to have high amounts of AMR and virulent Enterococcus spp., suggesting cross-species transmission.[82]EcuadorCountrysideAMR transmission across breedsTransmission of Zoonotic AMRSmallThe amount of E. coli that produces the beta-lactamase CTX-M in backyard hens increased significantly (66.1%). The sequencing of blaCTX-Mrevealed a high degree of similarity between human, broiler chicken, and backyard chicken samples from the villages, which may point to zoonotic transmission of AMR.[83]IndiaCountrysideTransfer indirectly to backyard chickensSmallMDR and avian pathogenic E. coli related virulence genes were found in high prevalence in the backyard layer chickens and their environment 75.5%. Possibility of AMR contamination in surrounding ponds and/or flocks of commercial broiler chickens due to human feces.[84]EcuadorCountrysideTransfer indirectly to backyard chickensSmallThere have been reports of thermophilic resistant Campylobacter species in untreated backyard hens given unrestricted freedom to roam.[85]`BangladeshUrbanIntensivefarmingZoonoticLargeMediumMDR Escherichia coli isolated from hands of poultry workers, intensive poultry operations, and poultry husbandry environments.[86]Costa RicaCountrysideSpread to wild avian specieSmallNeotropical birds are at risk of contracting resistant E. coli from free-ranging chickens.[87]KenyaCountrysideTransfer indirectly to backyard chickensSmallSalmonella spp. and E. coli that were isolated from backyard chicken feces were found to have class 1 integrons beta-lactamase genes.[88]VietnamCountrysideIntensivefarmingExposure at WorkSmallMediumShowed a connection between farmers and intensively farmed poultry and AMR Salmonella spp.[81]Factors that help develop antibiotic resistance (AMR) include bacterial mutation, spontaneous evolution, and horizontal gene transfer [30]. Through bacterial evolution and mutation, AMR could arise naturally [31]. Furthermore, transposons and insertion sequences allow plasmidssmall circular DNA fragments that are common in bacteriato acquire a wide range of resistance genes [32]. Antibacterial resistance among different species of bacteria can be spread by plasmid [33]. Furthermore, the transmission of AMR is sped up by bacteria harboring resistance genes with one another by horizontal gene transfer [34].Several factors are accelerating the rate of AMR bacteria: (i) Antibiotic prescriptions are the only means of providing patient treatment in many countries without sufficient medical diagnostic skills. This might result in the improper or excessive administration of antibiotics; (ii) self-treatment of antibiotics is often practiced in countries where antibiotics are available without a prescription; (iii) treatment of disease conditions with antibiotics where these are not required; and (iv) administration of antibiotics to healthy animals food and water to promote growth [35]. Table 5 lists the prevalence of MDR bacteria by country in livestock and poultry.CountrySpecimen typesMDR BacteriaPrevalence (%)ReferencesBangladeshPoultryE. coli36.6[89]MilkC. jejuni57.1[90]C. coli33.33PoultryC. jejuni49[91]C. coli42MilkSalmonella spp.100[92]BeefSalmonella spp.66.67Poultry meatSalmonella spp.93.10MilkS. aureus12[92]Poultry meatS. aureus53.85EggS. aureus90.91BhutanPig fecal sampleE. coli2.4[93]IndiaBovineE. coli71.43[94]PoultryE. coli63.2[95]PigletsE. coli80[96]BovineShiga toxin-producing E. coli17[97]PoultrySalmonella spp.100[84]BovineS. aureus2030[98]IndonesiaPoultryE. faecalis84.5[99]MyanmarPoultrySalmonella spp.52.2[100]NepalBuffaloE. coli52.5[101]poultry meatProteus spp.77.7S. aureus40.0Sri-LankaPigs, chickens, and cattleS. aureus65[102]ThailandPoultryESBL-producing S. Typhimurium77.3[103]PigESBL-producing S. Typhimurium40.4PigESBL-producing E. coli77[104]PorkESBL-producing E. coli61PorkA. baumannii and P. aeruginosa40PoultryESBL-producing E. coli40Poultry meatESBL-producing E. coli50Reduced effectiveness of antibioticsThe misuse of antibiotics in public health encourages the growth of bacteria resistant to current drugs and lessens their efficacy [36]. Individuals suffering from chronic medical conditions such as diabetes, asthma, and rheumatoid arthritis are particularly vulnerable to the impact of AMR [30]. Doctors could have to employ antibiotics from the last-resort classes, such as carbapenems and polymyxins. These medications are costly, not always easily accessible in impoverished nations, and have several negative effects. The persistence trends of AMR reduce the effectiveness of antibiotics [30].Treatment failureAMR may result in early treatment failure because it delays the start of effective antibacterial medication and forces doctors to hunt for more toxic and rare antibiotic alternatives. Gram-negative bacteria that are resistant to drugs multidrug resistant-gram negative bacteria (MDR-GNB) have made treating several illnesses, including pneumonia and urinary tract infections, more difficult [37]. Two types of bacteria that are generally resistant to most commercially available antibiotics include vancomycin-resistant enterococci and methicillin-resistant Staphylococcus aureus [38].Increased mortalityInfections resistant to antibiotics are becoming a more serious medical and public health issue in the US. MDR, in particular, is an AMR in bacteria that poses a worldwide health risk to humans and animals [33]. According to estimates from the Centers for Disease Control and Prevention (CDC), infections caused by AMR claim the lives of 23,000 people annually [39]. According to predictions, MDR will cause 10 million more fatalities in humans by 2050 than cancer will [40]. MRSA, is one of the most important antimicrobial resistance (AMR) bacteria, associated with increasing annual death rates globally [41].Increase treatment costsAntibiotic-resistant illnesses place a heavy cost on a nations healthcare system. When first- and second-line antibiotic therapy options are few or nonexistent, healthcare professionals may be forced to use antibiotics that are costlier and damaging to the patient [42]. According to Prestinaci et al. [12] and Shrestha et al. [43], AMR contributes to treatment failures, increased expenses for second-line treatments, lengthier hospital admissions, and catastrophic illnesses. The EU is estimated to lose more than 9 billion euros a year as a result of AMR [12,44]. Drug resistance to typhoid fever, gonorrhea, and tuberculosis is growing annually and significantly contributes to the high costs of healthcare for individuals and systems globally, especially in developing nations [44].Direct transfer of MDR bacteriaIndividuals working in farms and slaughterhouses, veterinarians, and farm laborers themselves are directly exposed to the danger of acquiring resistant bacteria through close contact with animals that are colonized or diseased [45]. Tetracycline- and penicillin-resistant E. coli was discovered to have infected poultry farm workers and family members through direct or indirect contact with poultry [46,47]. Swine farmers were known to be infected with drug-resistant S. aureus, Streptococcus spp., and E. coli [48]. MDR bacteria MRSA ST398 were transferred to Dutch veal farmers from Dutch veal calves [49]. For years, reports indicated that the increased frequency of bacteria resistant to several drugs might be attributed to the misuse of antibiotics in veterinary treatment or as growth promoters in animal feed [50].Salmonellas selection for the plasmid-carried gene aac (3)-IV suggests that using apramycin in production animals causes an increase in the development of resistance to aminoglycosides, such as gentamicin and netilmicin [51]. Enterococcus that is resistant to high-level aminoglycoside resistance, vancomycin-resistant, and MDR Enterococcus pose specific concerns [52]. Spanish chickens that had been slaughtered were the source of the antibiotic-resistant E. coli that hospital patients were confirmed to be afflicted with [53].Transfer of drug-resistant genesThere is speculative evidence that bacteria can transfer resistance genes, like the vanA gene cluster or genes that give new generations of cephalosporins resistance, to both humans and animals [54]. The resistance-specific blaCMY gene was present in all resistant Salmonellaenterica serotype Newport isolates from humans, pigs, cattle, and poultry [44].Antibiotic residuesThe production of food animals, mostly through manure, leaves behind a large number of bacteria and antibiotic residues in the environment that impact both natural bacteria and wild animals. Because of this, reservoirs for food-animal and human consumption may be refilled with resistant bacteria from the environment and wild animals [29]. Public health appears to be less at risk from antimicrobial residues that may be present in items generated from animals than it is from germs that are resistant to them. According to a 2003 report by a WHO expert committee, foodborne pathogens resistant to antibiotics and the accompanying risks are far greater than the risk associated with antimicrobial residues in food under the current regulatory frameworks [55]. Foods originating from animals may contain antimicrobial residues that might lead to serious health problems in humans, including allergic responses, AMR, mutagenesis, and carcinogenesis [56].Regarding human health, AMR is a serious concern. Antimicrobial drugs are indiscriminately used in the production of livestock and poultry around the world for treatment, disease prevention, and growth promotion. Animals gut-developing AMR bacteria are linked to using antimicrobials at sub-therapeutic doses for longer periods. AMR bacteria from animal guts can contaminate food, water, and the environment. These AMR bacteria are spread via contaminated food, water, and soil to both animals and humans. By coming into direct contact with animals, humans can contract the AMR bacteria. Animals given antibiotics keep residues of the drugs in their tissues, and humans can contract them by consuming milk, meat, or eggs. Through horizontal gene transfer methods, drug-resistance genes are transferred from one bacterium to another. Human and animal health risks from the AMR bacteria include treatment failure, an increase in mortality, and an increase in treatment costs. To combat the rise of AMR, prudent antimicrobial agent use in livestock and poultry production is crucial. One way to limit the spread of antibiotic-resistant bacteria in poultry and animals is to offer them probiotics and prebiotics. Other strategies include adapting biosecurity measures in livestock and poultry farms and vaccinating against infectious diseases.This work was supported by the authors.AMR, Antimicrobial Resistant; EU, European Union; ESBL, Extended Spectrum Beta-Lactamase; MDR, Multidrug Resistant; MRSA, Methicillin Resistant Staphylococcus aureus; VRSA, Vancomycin Resistant Staphylococcus aureus; WHO, World Health Organization.No conflict of interest was declared.MAI: conceptualization, review of the relevant literature, data analysis, writing, and editing of the article. PB: researching literature, analyzing data, and drafting manuscripts. MZR: Writing drafts and assessing literature. MM: Data collection, searching literature, and writing manuscripts. PS: Literature searching and drafting the manuscript. TA: Data collection and searching literature. MMK: Data analysis and preparation of manuscript.

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[DOI] [PMC free article] [PubMed] [Google Scholar]Articles from Journal of Advanced Veterinary and Animal Research are provided here courtesy of Network for the Veterinarians of Bangladesh As a library, NLM provides access to scientific literature. Inclusion in an NLM database does not imply endorsement of, or agreement with, the contents by NLM or the National Institutes of Health. Learn more: PMC Disclaimer | PMC Copyright Notice . 2021 Mar 29;99(6):181235. doi: 10.1111/avj.13034Foreword antimicrobial prescribing guidelines for poultryAntimicrobials are essential to modern medicine for treating a range of infections in humans and animals. Importantly, antimicrobial resistance (AMR) is a growing global threat that presents a serious risk to human and animal health. Inappropriate and/or unrestrained use of antimicrobials in humans and animals exerts a strong selection pressure on microbial populations to evolve resistant traits. As a result, antimicrobials have become less effective over time leading to treatment complications and failures, and increased healthcare costs for people and animals. Resistant organisms spread between people, animals and the environment. Globalisation and international travel facilitates this spread between countries.Here in Australia, the veterinary profession and foodproducing animal industries have a long history of addressing AMR. Their previous and ongoing work a result of partnerships across the animal sector has resulted in demonstrated low levels of AMR in our foodproducing animals. Over the past 5years, the veterinary profession has consolidated its partnership with industry and government by helping to successfully implement Australia's First National Antimicrobial Resistance Strategy 201519. With the recent release of Australia's National Antimicrobial Resistance Strategy 2020 and Beyond (2020 AMR Strategy), the veterinary profession will continue to play a critical role in how we minimise AMR.One of the seven key objectives of the 2020 AMR Strategy relates to appropriate antimicrobial usage and antimicrobial stewardship practices. Resistance to antimicrobials occurs naturally in microorganisms, but it is significantly amplified by antimicrobial overuse, growth promotion use, and poor husbandry and management.The antimicrobial prescribing guidelines for poultry directly addresses the fourth objective of the 2020 AMR Strategy, and in particular, Priority Area for Action 4.1, that seeks to ensure that coordinated, evidencebased antimicrobial prescribing guidelines and bestpractice supports are developed and made easily available, and encourage their use by prescribers.These guidelines for Australian poultry veterinarians are sure to be a ready resource. They have been developed specifically for the Australian poultry industry and contain bestpractice prescribing information to help clinical veterinarians in their daytoday use of antimicrobials. The guidelines encourage veterinarians to first pause and consider the need to use antimicrobials in that circumstance: Are there effective nonantimicrobial alternatives? Prevention and control of infections through strict onfarm biosecurity is a recognised approach to minimising disease entry and the need to use antimicrobials. Vaccination may also be available to control several important poultry diseases. If antimicrobial use is indicated, have you considered the five rights: right drug, right time, right dose, right duration and right route? Using a lower rating or narrowspectrum antimicrobial is the preferred approach, and you can also refer to the Australian Antibacterial Importance Ratings to help with these decisions.I commend the work of all involved in the development of these guidelines, and urge every poultry veterinarian to use this advice. In doing so, you will help safeguard the ongoing, longterm efficacy of antimicrobials, deliver the best possible veterinary service to the Australian poultry industry, and play your role in the global response to AMR.Dr Mark SchippAustralian Chief Veterinary OfficerPresident of the OIE World AssemblyDr Peter Gray BVScPeter Gray graduated with a Bachelor of Veterinary Science from Sydney University in 1983. He spent 2years in a pet and aviary birdfocused private practice in western Sydney, and started with Inghams Enterprises in 1986 as a poultry veterinarian. During his ongoing work life at Inghams, Peter has had technical and veterinary roles that have involved him in all aspects of a poultry operation from importation, export, breeding, feed mills, hatching, growing, processing and further processing. His work has covered veterinary work in both chicken and turkey species, as well as welfare and food safety. He has always valued the learnings from many experienced colleagues both from within Inghams and the wider Australian Veterinary Poultry Association community. He has been a representative on industry and government committees, and is a qualified poultry welfare auditor with the Professional Animal Auditor Certification Organization (PAACO). Over the course of his working life, he has seen great change in the Australian industry where genetics, biosecurity, new vaccine strategies and improved management practices have seen an extensive reduction in antibiotic use in the poultry industry. He hopes these guidelines can play a part in continuing that positive trend while maintaining good welfare outcomes for the birds under our care.Dr Rod Jenner BVScRod Jenner is a consultant poultry veterinarian consulting to both the chicken meat and egg industries, and conducting projects on behalf of Agrifutures Australia and Australian Eggs Ltd. He has been in the poultry industry since graduation.Rod has served on a number of industry representative committees over the years, including the RIRDC chicken meat advisory committee, and has also served as President of the Australian Veterinary Poultry Association (AVPA), member of Therapeutics Subcommittee and Welfare Subcommittee of the AVPA, Queensland executive of the AVA, and divisional committee of the WPSA. Of recent years, Rod has progressed into teaching veterinary students in the area of commercial poultry medicine at the University of Queensland and James Cook University.Professor Jacqueline Norris BVSc MVS, PhD, FASM, MASID Grad Cert Higher Ed.Jacqueline Norris is Professsor of Veterinary Microbiology and Infectious Diseases, and Associate Head of Research at the Sydney School of Veterinary Science, at the University of Sydney. She is a registered practicing veterinarian and is passionate about practical research projects and education programs for veterinary professionals, animal breeders and animal owners. Her main research areas include (1) development of diagnostics and treatments for companion animal viral diseases; (2) Q fever; (3) multidrugresistant (MDR) Staphylococcus species; (4) infection prevention and control in veterinary practices; (5) chronic renal disease in domestic and zoo Felids and (6) factors influencing antimicrobial prescribing behaviour of vets and health professionals.Dr Stephen Page BSc(Vet)(Hons) BVSc(Hons) DipVetClinStud MVetClinStudMAppSci(EnvTox) MANZCVS(Pharmacology)Stephen Page is a consultant veterinary clinical pharmacologist and toxicologist and founder and sole director of Advanced Veterinary Therapeutics a consulting company that provides advice on appropriate use of veterinary medicines to veterinarians, veterinary organisations (Australian Veterinary Association, World Veterinary Association, World Organisation for Animal Health), state and national government departments and statutory bodies (APVMA, Department of Agriculture, Department of Health, US Environmental Protection Agency), and global organisations (OIE, FAO, Chatham House).He is a member of the AVA Antimicrobial of Resistance Advisory Group (ARAG), a member of the ASTAG committee on antimicrobial prioritisation. In 2017, he became the President of the ANZCVS Chapter of Pharmacology, and is a member the World Veterinary Association Pharmaceutical Stewardship Committee.He has more than 100 publications on which he is author or editor, including chapters on antimicrobial stewardship, clinical pharmacology, adverse drug reactions, use of antimicrobial agents in livestock, and antimicrobial drug discovery and models of infection.Stephen Page has been a teacher and facilitator of courses at the University of Sydney on food safety, public health and antimicrobial resistance since 2003.He is regularly invited to speak nationally and internationally at a broad range of conferences and symposiums, especially on the subjects of antimicrobial use, antimicrobial stewardship and risk assessment. He gave his first presentation on veterinary antimicrobial resistance and stewardship at the AVA Conference in Perth in 2000 and remains passionate about improving the use and effective life span of antimicrobial agents.Professor Glenn Browning BVSc (Hons I) DipVetClinStud, PhD, FASMGlenn Browning is Professor in Veterinary Microbiology, Director of the AsiaPacific Centre for Animal Health and Acting Head of the Melbourne Veterinary School at the University of Melbourne. He completed the Bachelor of Veterinary Science with First Class Honours at the University of Sydney in 1983, a postgraduate Diploma of Veterinary Clinical Studies in Large Animal Medicine and Surgery at the University of Sydney in 1984 and a PhD in Veterinary Virology at the University of Melbourne in 1988.He was a Veterinary Research Officer at the Moredun Research Institute in Edinburgh from 1988 to 1991, investigating viral enteritis in horses, then joined the staff of the Faculty of Veterinary Science at the University of Melbourne, and has been a member of teaching and research staff there since 1991.Professor Browning teaches in veterinary and agricultural microbiology. He is a Life Fellow of the Australian Veterinary Association, a Fellow of the Australian Society for Microbiology and Chair Elect of the International Organisation for Mycoplasmology.He has coauthored 235 peerreviewed research papers and book chapters, has edited two books on recent progress in understanding the mycoplasmas and has cosupervised 50 research higher degree students. His research interests include the molecular pathogenesis and epidemiology of bacterial and viral pathogens of animals, the development of novel vaccines and diagnostic assays to assist in control of infectious diseases, and antimicrobial stewardship in veterinary medicine.Derived from: Page S, Prescott J and Weese S. Veterinary Record 2014;175:207208. Image courtesy of Trent Hewson, TKOAH.Core principles of appropriate use of antimicrobial agents4Introduction6Interactions contributing to pharmacokinetic variability9Conclusion11Disease investigation general approach11Diseases of the digestive tract12Diseases of the respiratory system34Diseases of the locomotory system37Systemic diseases39Diseases of the reproductive system41Diseases of the nervous system44Immunosuppressive diseases45Diseases of the young chick46Treatment48Diseases of turkeys, ducks and other poultry48Considerations for choice of first priority antimicrobials49References49While the published literature is replete with discussion of misuse and overuse of antimicrobial agents in medical and veterinary situations there has been no generally accepted guidance on what constitutes appropriate use. To redress this omission, the following principles of appropriate use have been identified and categorised after an analysis of current national and international guidelines for antimicrobial use published in the veterinary and medical literature. Independent corroboration of the validity of these principles has recently been provided by the publication (Monnier et al 2018) of a proposed global definition of responsible antibiotic use that was derived from a systematic literature review and input from a multidisciplinary international stakeholder consensus meeting. Interestingly, 22 elements of responsible use were also selected, with 21 of these 22 elements captured by the separate guideline review summarised below.Disease preventionApply appropriate biosecurity, husbandry, hygiene, health monitoring, vaccination, nutrition, housing, and environmental controls. Use Codes of Practice, Quality Assurance Programmes, Herd Health Surveillance Programmes and Education Programmes that promote responsible and prudent use of antimicrobial agents.Professional interventionEnsure uses (labelled and extralabel) of antimicrobials meet all the requirements of a bona fide veterinarianclientpatient relationship.Alternatives to antimicrobial agentsEfficacious, scientific evidencebased alternatives to antimicrobial agents can be an important adjunct to good husbandry practices.4Accurate diagnosisMake clinical diagnosis of bacterial infection with appropriate point of care and laboratory tests, and epidemiological information.5Therapeutic objective and planDevelop outcome objectives (for example clinical or microbiological cure) and implementation plan (including consideration of therapeutic choices, supportive therapy, host, environment, infectious agent and other factors).6Justification of antimicrobial useConsider other options first; antimicrobials should not be used to compensate for or mask poor farm or veterinary practices.Use informed professional judgement balancing the risks (especially the risk of AMR selection & dissemination) and benefits to humans, animals & the environment.7Guidelines for antimicrobial useConsult disease and speciesspecific guidelines to inform antimicrobial selection and use.8Critically important antimicrobial agentsUse all antimicrobial agents, including those considered important in treating refractory infections in human or veterinary medicine, only after careful review and reasonable justification.9Culture and susceptibility testingUtilise culture and susceptibility (or equivalent) testing when clinically relevant to aid selection of antimicrobials, especially if initial treatment has failed.10Spectrum of activityUse narrowspectrum in preference to broadspectrum antimicrobials whenever appropriate.11Extralabel (offlabel) antimicrobial therapyMust be prescribed only in accordance with prevailing laws and regulations.Confine use to situations where medications used according to label instructions have been ineffective or are unavailable and where there is scientific evidence, including residue data if appropriate, supporting the offlabel use pattern and the veterinarian's recommendation for a suitable withholding period and, if necessary, export slaughter interval (ESI).12Dosage regimensWhere possible optimise regimens for therapeutic antimicrobial use following current pharmacokinetic and pharmacodynamic (PK/PD) guidance.13Duration of treatmentMinimise therapeutic exposure to antimicrobials by treating only for as long as needed to meet the therapeutic objective.14Labelling and instructionsEnsure that written instructions on drug use are given to the end user by the veterinarian, with clear details of method of administration, dose rate, frequency and duration of treatment, precautions and withholding period.15Target animalsWherever possible limit therapeutic antimicrobial treatment to ill or atrisk animals, treating the fewest animals possible.16Record keepingKeep accurate records of diagnosis (indication), treatment and outcome to allow therapeutic regimens to be evaluated by the prescriber and permit benchmarking as a guide to continuous improvement.17ComplianceEncourage and ensure that instructions for drug use are implemented appropriately18Monitor response to treatmentReport to appropriate authorities any reasonable suspicion of an adverse reaction to the medicine in either treated animals or farm staff having contact with the medicine, including any unexpected failure to respond to the medication.Thoroughly investigate every treated case that fails to respond as expected.19Environmental contaminationMinimise environmental contamination with antimicrobials whenever possible.20Surveillance of antimicrobial resistanceUndertake susceptibility surveillance periodically and provide the results to the prescriber, supervising veterinarians and other relevant parties.21Continuous evaluationEvaluate veterinarians' prescribing practices continually, based on such information as the main indications and types of antimicrobials used in different animal species and their relation to available data on antimicrobial resistance and current use guidelines.22Continuous improvementRetain an objective and evidence guided assessment of current practice and implement changes when appropriate to refine and improve infection control and disease management.Each of the core principles is important but CORE PRINCIPLE 11 Extralabel (offlabel) Antimicrobial Therapy can benefit from additional attention as veterinarians, with professional responsibility for prescribing and playing a key role in residue minimisation, must consider the tissue residue and withholding period (WHP) and, if necessary, export slaughter interval (ESI) implications of offlabel use before selecting this approach to treatment of animals under their care (Reeves 2010; APVMA 2018).The subject of tissue residue kinetics and calculation of WHPs is very complex requiring a detailed understanding of both pharmacokinetics (PK) and statistics, as both these fields underpin the recommendation of label WHPs. Some key points to consider when estimating an offlabel use WHP include the following:The new estimate of the WHP will be influenced by (1) the offlabel dose regimen (route, rate, frequency, duration); (2) the elimination rate of residues from edible tissues and (3) the maximum residue limit (MRL).Approved MRLs are published in the MRL Standard which is linked to the following A PVMA website page: there is an MRL for the treated species, then the WHP recommended following the proposed off label use must ensure that residues have depleted below the MRL at the time of slaughter.If there is no MRL for the treated species, then the WHP recommendation must ensure that no detectable residues are present at the time of slaughter.Tissue residue kinetics may be quite different to the PK observed in plasma especially the elimination halflife and rate of residue depletion. The most comprehensive source of data on residue PK is that of Craigmill et al 2006.WHP studies undertaken to establish label WHP recommendations are generally undertaken in healthy animals. Animals with infections are likely to have a longer elimination halflife.There are many factors that influence variability of the PK of a drug preparation, including the formulation, the route of administration, the target species, age, physiology, pathology and diet.The following figure provides a summary of typical effects on elimination rates associated with drug use at higher than labelled rates and in animals with infections (Figure 1). An example of the relationship between the maximum residue limit (MRL) and tissue depletion following administration of a veterinary medicine. In a healthy animal (A), tissue depletion to the MRL often occurs at a time point shorter than the WHP that has been established for the 99/95th percentile of the population. In such an individual animal, if the dose is doubled, tissue depletion (B) should only require one more halflife and would most likely still be within the established WHP. However, if the halflife doubles due to disease or other factors, depletion (C) would now require double the normal WHP and may still result in residues exceeding the MRL (adapted from Riviere and Mason, 2011).APVMA. Residues and trade risk assessment manual. Version 1.0 DRAFT. Australian Pesticides and Veterinary Medicines Authority, Kingston, ACT, 2018.Craigmill AL, Riviere JE, Webb AI. Tabulation of FARAD comparative and veterinary pharmacokinetic data. Ames, Iowa, WileyBlackwell, 2006.Monnier AA, Eisenstein BI, Hulscher ME, Gyssens IC, DriveAB. WP1 Group. Towards a global definition of responsible antibiotic use: results of an international multidisciplinary consensus procedure. Journal of Antimicrobial Chemotherapy 2018;73:316.Reeves PT. Drug Residues. In: Cunningham F, Elliott J, Lees P, editors. Comparative and Veterinary Pharmacology. Springer Berlin Heidelberg, Berlin, Heidelberg, 2010;265290.Riviere JE, Mason SE. Tissue residues and withdrawal times. In: Riviere JE, editor. Comparative Pharmacokinetics Principles, Techniques, and Applications. second edn. WileyBlackwell, Oxford, UK, 2011;413424.Commercial poultry veterinary medicine is a unique stream of veterinary science that focuses strongly on preventive medicine. Infectious disease outbreaks are most commonly the result of lapses in biosecurity, which are not always totally preventable and should never be unexpected. Biosecurity in this context is more than quarantine. It has external, internal and resilience components, which include vaccination, preventive medication, optimal nutrition, appropriate genetics, good husbandry and exemplary management.The methods used for diagnostic investigation are quite diverse, even though they are being applied to a single animal species, and often to the relatively uniform context of a commercial farm. Animal behaviour, or ethology, is the most frequently used diagnostic tool, and probably the least acknowledged skill used by a field veterinarian. Gross pathology, histopathology, epidemiology, microbiology, and serology are all important diagnostic tools, while the disciplines of immunology, pharmacology, therapeutics and veterinary medicine in public health are employed by commercial poultry veterinarians in the conduct of their role.The number one consideration is always that the veterinarian is operating within a food production system. Every decision about treatment must incorporate considerations about the wholesomeness of the animal or product as a human food source.Broiler chickens have a very short lifespan relative to antimicrobial treatment regimens. The prescribing veterinarian must be cognisant of the likely slaughter date of the flock before recommending treatments. The use and consequences of antimicrobial therapies must be clearly communicated with both the farmer and the owner/processor of the chickens to ensure that treatment will not contravene the advised WHP.Egg laying flocks are in constant production, so advice on WHPs precludes the sale or supply of eggs into the food sector for the duration of the WHP for any medication that has a WHP longer than 0days (NIL).Treatments are generally applied to an entire flock, rather than to an individual bird. It is costprohibitive to consider hospital pens in largescale operations, but this can be feasible in smaller niche farms, or with high value stock (e.g. rare breeds, genetically superior stock, or during situations of severe shortage). However, even high value commercial stocks are generally replaceable, so it is unusual to treat an individual commercial bird.In contrast, in small backyard poultry flocks, it is common for owners to have a strong bond with their birds. In such instances, the birds may have become part of the family and the owners may be willing to go to extensive lengths to ensure their birds receive individual veterinary medical attention.When treating a flock with an antimicrobial agent, consideration needs to be given to the longterm commercial return, as well as the shortterm response.Valid grounds for antimicrobial medication include animal welfare, managing the risks of disease in susceptible flocks, the zoonotic potential of the disease and true economic loss when there is a no more effective way to control the disease.Medication is not justified when it will be ineffective, for example for viral or nutritional diseases.Medication is often not the best approach to disease control, even though in theory, it may be effective. It may be best to process birds early or, in mild cases, let the disease run its course.Medication can sometimes be counterproductive, for example, when it may have an impact on live bacterial vaccines.Medication is unwarranted if the intention is solely to provide nonspecific cover over stressful periods, to be seen to be doing something, to bring peace of mind, or to use up excess drug stocks.It is important to remember that if antimicrobial therapy is being considered, mass medication in water or feed will not only target sick birds, but will be consumed by healthy birds. In addition, sick chickens tend to have reduced feed and water consumption, limiting their antimicrobial intake. Thus, mass antimicrobial therapy is not targeted therapy, but rather, is largely a preventive approach to limiting the spread of bacteria to healthy individuals.Treatment options are severely limited in Australia by the restricted number of registered veterinary medicines available for administration in feed or water, and by food safety considerations, placing more emphasis on the importance of preventive measures.Nonsteroidal antiinflammatory drugs are not registered for use in poultry and are never used in poultry medicine, so therapeutic options are limited to antimicrobials. There are relatively few alternatives to preventive antimicrobial therapy, but options include (with variable evidence of efficacy) mediumchain fatty acids, probiotics, prebiotics (for example, mannan oligosaccharide derivatives), acidifiers, essential oil extracts and many more.The use of antimicrobials in commercial poultry production is under considerable pressure and can be influenced by major customers, with a growing expectation to demonstrate good antimicrobial stewardship, and an emphasis on strategies to reduce use. Veterinary intervention is closely scrutinised, and there is an increasing requirement to justify approaches to flock health when they involve the use of antimicrobial agents. It is essential that a diagnosis, even if only presumptive, is made before considering medication.2Drug susceptibility and resistanceAll infectious organisms have an inherent pattern of susceptibility and resistance to specific drugs. Resistance to certain drugs may also be acquired. Acquired resistance may be determined by laboratory susceptibility tests or inferred by prior clinical experience and previous response to therapy on a particular farm, although it should always be remembered that prior clinical experience can be misleading, as clinical improvement of a flock may not have been a result of successful antimicrobial therapy. Sampling for susceptibility testing prior to antimicrobial use is essential.3Bactericidal vs bacteriostaticBactericidal antimicrobials kill bacteria, thereby reducing the number of organisms, whereas bacteriostatic antimicrobials inhibit the metabolism, growth or multiplication of bacteria, thereby preventing an increase in the number of organisms. In practice, this generally makes little difference, as a functional immune system is essential for resolution of all infectious diseases, regardless of the mode of action of the drug used to treat them. Choosing a drug that will reach the site of infection at an effective concentration for enough time is an important consideration. Having selected a drug that is likely to be effective, an appropriate dose rate must be determined. Dose rates should be selected and calculated using the following guidelines:Water and feed consumption can vary considerably, and is affected by flock health, ambient temperature, species, physiological status and management practices. Therefore, where information is available, antimicrobial dose rates based on bodyweight, in conjunction with known current water or feed consumption, provide the most accurate dosages. The exception is in young rapidly growing birds, where dose rate expressed as a concentration in feed or water provides a more practical calculation method.Treatment should always commence at maximum recommended dose rates for the greatest efficacy.Dose rate may need to be adjusted to allow for spillage or wastage, which can be considerable, especially in ducks.When calculating a dose to be delivered in water, it is necessary to know the:Bodyweight of the flock (determined by weighing a representative sample of birds)Amount of water expected to be consumed during the medication periodRequired dose rateConcentration of the active ingredient in the selected antimicrobial product Normally treatment should commence as soon as a presumptive diagnosis is available when disease is acute and a high mortality rate is expected, for example, in fowl cholera (infection with Pasteurella multocida).For more chronic disease, it is appropriate to wait for the results of susceptibility testing.7Frequency of medicationIn theory, for timedependent antimicrobial agents, the minimum inhibitory concentration (MIC) of a drug should be maintained or exceeded at the site of infection throughout the course of treatment to ensure that the infecting organism remains suppressed and is less likely to acquire resistance. It is critical to ensure that the amount of medicated water supplied each day is sufficient to eliminate the risk of birds running out of water during times when the manager is not on the farm (e.g. overnight). In acute disease outbreaks, medication should continue until mortalities stop and clinical signs are no longer apparent in the flock. Usually this takes at least 3days, and mortalities may continue to rise for the first few days as severely affected birds succumb, especially if they are too sick to consume any medication. However, acute diseases are usually under control within 57days, and if no response is apparent within 35days, the diagnosis and treatment regimen should be reassessed.Some diseases may require ongoing medication in feed or water to suppress clinical disease and potential spread to other flocks.9Routes of administrationOral administration is most effective for infections involving the digestive tract. Drinking water medication is usually more effective than infeed medication, as it can be commenced and altered more quickly, and because sick birds may continue drinking even when they have ceased eating. There is also less risk of consumption by nontarget birds/species. It is important that, as the medicated water is consumed, the dose is not diluted with fresh water. Birds should have no access to other water sources.The efficacy of many antimicrobials can be affected by the route of administration. Once powders are dissolved in solution, or liquids diluted, the drug can lose its activity. As a rule, medications should be prepared daily. Antimicrobials should not be mixed or administered concurrently, as one may interfere with the solubility, absorption or activity of another.Within the critical context of antimicrobial stewardship, it is important to select drug and dosage regimens that reflect the five rights right drug, right time, right dose, right duration and right route.1 There are many physiological, pathological and pharmacological sources of variation in antimicrobial drug exposure within and between birds of the same and different species (e.g. chickens, ducks and turkeys), to which can be added sources of variation within and between routes of administration.There have been several recent reviews of antimicrobial use in poultry2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and key findings are presented in this summary.The potential for distribution of antimicrobial agents into the eggs of laying birds is an important consideration when developing treatment plans for laying birds and this subject has been comprehensively evaluated.12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 As seen in Appendix 2, there are very few drugs approved for use in birds and even fewer for birds currently producing eggs for human consumption. This is primarily a consequence of the presence, often for prolonged periods, of residues of the antimicrobial agent or its metabolites in meat and/or eggs.The antimicrobial agents approved for use in birds in Australia represent wellestablished and aged classes that were developed for use from the 1940s to the 1970s. With the exception of avilamycin, the antimicrobial agents listed in Appendix 2 with antibacterial indications (amoxicillin, apramycin, bacitracin, chlortetracycline, erythromycin, flavophospholipol, lincomycin, neomycin, oxytetracycline, spectinomycin, sulfadiazine, sulfadimidine, tiamulin, trimethoprim, tylosin, virginiamycin) were available for use in poultry in Australia in 1989. Because of the age of the antimicrobial agents available for use and their availability in most cases from a range of generic sources, there has been very little recent investigation of their pharmacology26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56 or efficacy, or optimal dosage regimens57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70 for these agents.When these antimicrobial agents were first approved for use in Australia, it was only necessary to establish the dose regimen based on clinical response to treatment in infection challenge studies and field confirmation studies. The trend in recent decades to define dosage regimens is much more sophisticated and frequently involves an integration of the pharmacokinetic (PK) behaviour of the drug in the target bird species with the pharmacodynamic (PD) response of the target pathogen, often established by in vitro microbiological methods (e.g. the MIC of a representative panel of isolate of the target pathogen).Very few PK/PD studies are available to reexamine the dosage regimens of currently approved antimicrobial agents, although the PK/PD profile of tiamulin in an experimental intratracheal infection model of Mycoplasma gallisepticum in young chickens has been described.71 Although valuable information was obtained in this study, tiamulin is not widely used in Australia, as Mycoplasma gallisepticum is very effectively controlled by vaccination. Application of the mutant selection window approach to the evaluation of the killing of Mycoplasma gallisepticum has been investigated for danofloxacin, doxycycline, tilmicosin, tylvalosin and valnemulin.72 However, none of these antimicrobial agents are registered for use in Australia and the efficacy of vaccination in control of mycoplasmoses in chickens obviates any need for their use.The most practical and common route of administration of antimicrobial agents in poultry in Australia is per os, with drugs being mixed in water or feed. There is only a single class of antimicrob

be used as a treatment of last resort and used strictly according to label directions.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.SituationFirst choice treatmentSecond choice treatmentShortlived flock not producing eggs (e.g. broiler flock)Amoxicillina in the drinking water is the first line treatment. Use at 20 mg/kg for 3days.Chlortetracycline can be used at a dose rate of 60 mg/kg bodyweight in drinking water for 35days.Longlived flock (e.g. layer flock, breeder flock, backyard flock, fancy breeds) up to 8days before commencement of layAmoxicillina in the drinking water is the first line treatment. Use at 20 mg/kg for 3days.Chlortetracycline can be used at a dose rate of 60 mg/kg bodyweight in drinking water for 35days.Longlived flock (e.g. layer flock, breeder flock, backyard flock, fancy breeds) in layIf affected birds are producing eggs for human consumption, chlortetracycline can be used at 60 mg/kg bodyweight in drinking water for 35days.CCD amoxicillin trihydrate for poultry (APVMA # 36443) is currently the only amoxicillin formulation with a NIL WHP for eggs. However, it does have a 14day export egg WHP. Medicate at 20 mg/kg for 35days in drinking water.Dysbacteriosis is an imbalance of the normal bacterial flora, causing mild enteritis with wet droppings, leading to wet floors and dirty feathering, and potentially poor performance. It is mainly seen in broiler flocks. Lesions at necropsy include undigested feed, watery intestinal contents, flaccid intestines with a poor tone and excess caecal volume with gassy contents.Antimicrobial treatment is not recommended for dysbacteriosis. It is important to address the underlying cause.Avian intestinal spirochaetosis (AIS) is caused by Brachyspira spp. (most commonly Brachyspira pilosicoli or Brachyspira intermedia). The typical presentation of AIS is a chronic diarrhoea causing stained vents and manurestained eggs. It is a disease of longlived floorbased flocks. As the presentation is chronic, it is generally not reported in broiler flocks.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.SituationFirst choice treatmentSecond choice treatmentBreeder and layer flocksChlortetracycline as an infeed treatment at 400 ppm for 7days, followed, if necessary, by infeed treatment at 200 ppm for up to 28days.No alternative treatments.Salmonella species do not usually cause clinical disease in poultry, unless there is an overwhelming infectious dose or concomitant immunosuppressive disease. Treatment of commercial broiler flocks is not recommended because of the food safety implications of clinical salmonellosis.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.SituationFirst choice treatment (chicks under 2weeks of age)Second choice treatmentFlocks not producing eggs for consumptionTrimethoprim/sulphadiazine at a dose rate of 25 mg sulphadiazine/kg and 5 mg trimethoprim/kg per day for 35days if the birds are less than 2weeks old, or 12.5 mg sulphadiazine/kg and 2.5 mg trimethoprim/kg per day for 35days if the birds are older than 2weeks of age.Amoxicillina in the drinking water at 20 mg/kg for 3days.Spotty liver disease is caused by Campylobacter hepaticus. It is a disease of longerlived floorliving layer and breeder flocks and is rarely seen in caged birds or broilers. Clinical disease is almost invariably associated with a drop in egg production. The disease can occur throughout the year but tends to result in higher mortalities and greater drops in egg production in summer.Antimicrobial treatment, although effective, should not be relied upon for longterm control, as resistance to commonly used antimicrobials occurs rapidly.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.SituationFirst choice treatmentSecond choice treatmentAll situationsChlortetracycline at 60 mg/kg bodyweight in drinking water for 5days.Lincomycinspectinomycin at 100 g combined antibiotic activity/200 L in drinking water for 35days.Histomoniasis (or blackhead) is caused by a protozoan parasite, Histomonas meleagridis. Turkeys are highly susceptible, but disease is also seen in chickens. It is very rare in broilers. Lesions are commonly found in both the caeca (large caseous casts) and the liver (discrete circular lesions). It is often transmitted by the nematode Heterakis gallinae, so control of Heterakis gallinae will assist in control of histomoniasis in chickens. However, direct transmission occurs readily in turkeys.There is no currently registered treatment for histomoniasis. Consider control of the vector (Heterakis gallinae) and earthworms to reduce the incidence of disease.There is a wide range of nematodes and cestodes that can affect poultry, some of which are almost invisible to the naked eye. Intestinal worms should always be considered as a differential diagnosis, particularly in freerange flocks. Faecal flotation can be used to detect eggs or tapeworm segments and assess the severity of an intestinal worm burden.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.SituationFirst choice anthelminticSecond choice anthelminticAscaridia galliLevamisole at 28 mg/kg live weight. As a guide, assuming a medicated water intake of 35 mL/bird over the treatment period, use 800 g levamisole per 9001000 L drinking water, or 8 g per 10 L water for a small number of birds. The amount of solution prepared should be the volume that will be consumed over 12 h. Remove other sources of water during the treatment period. Note there is a 7day WHP for meat.Piperazine (adult worms only). The recommended dose for poultry is 200 mg/kg (1 g per 5 kg bodyweight). Use 1 kg of Piperazine Wormer to treat 2500 birds with a bodyweight of 2 kg. The volume of medicated water provided should be able to be consumed by the birds over a 6 to 8 h period. Discard any remaining medicated water after 68 h. Add the amount required to a small quantity of water first. When it is completely dissolved, add it to the medication tank, mixing thoroughly. When treating a severe worm infestation, repeat the dose 1721days later.All other species of immature and mature nematodesLevamisole at 28 mg/kg live weight. As a guide, assuming a medicated water intake of 35 mL/bird over the treatment period, use 800 g levamisole per 9001000 L drinking water, or 8 g per 10 L water for a small flock. The amount of solution prepared should be the volume that will be consumed over 12 h. Remove other sources of water during the treatment period. Note there is a 7day WHP for meat.Flubenol (flubendazole) in feed at 600 g/tonne of feed, equivalent to 30 g flubendazole (30 ppm) for 7days. Note there is a 7day WHP for meat. Do not use in pigeons or parrots.Cestodes (tapeworms)Flubenol (flubendazole) in feed at 1200 g/tonne of feed, equivalent to 60 g flubendazole (60 ppm) for 7days. Note there is a 7day WHP for meat. Do not use in pigeons or parrotsNo alternative treatmentsJohn Glisson wrote Although much is known about the individual agents responsible for respiratory diseases in poultry, uncomplicated infections with single agents are the exception. Under commercial conditions, complicated infections with multiple aetiologies, with viruses, mycoplasmas and other bacteria, immunosuppressive agents, and unfavourable environmental conditions, are more commonly observed than simple infections.This combination makes antimicrobial treatment in the face of a disease outbreak both challenging and often unrewarding.It is important to systematically step through all potential predisposing factors including:Interactions between respiratory pathogensEffects of immunosuppressive factorsEnvironmental factorsManagement of vaccination (including adverse reactions)The respiratory system relies on cilia, mucus and phagocytic cells to protect against infections. High levels of dust and/or high ammonia reduce cilial motility and thus clearance of pathogens trapped in mucus, as well as the function of phagocytes.As a result, disease presentations can be complex, but can be subdivided into the following categories:ConjunctivitisSinusitis/rhinitisTracheitisPneumoniaAirsacculitisAs in mammals, the respiratory system in birds is involved in:absorption of oxygen (O2)release of carbon dioxide (CO2)release of heat (temperature regulation)vocalisationIn contrast to mammalian species, the lungs in birds do not expand. On inspiration air passes through the lungs and into the air sacs, and then on expiration returns through the lungs, taking excess heat and CO2 and exchanging it with O2. The transfer of heat in the air sacs is responsible for a considerable proportion of a bird's heat loss under high temperature conditions. As a result, birds with respiratory disease are much more susceptible to mortality in hot, humid environments.Another unique feature is the intimate association of the air sacs with the some of the bird's bones. Consequently, respiratory infection may also result in a related osteomyelitis (Figures 3 and 4). Schematic anatomy of the avian respiratory system (Cruithne9/CC BYSA; . Path of airflow through a bird's respiratory system during inhalation and exhalation (Wikimedes/CC BYSA; .General approachSpecific considerations for respiratory tract disease investigationsAssessment of ventilation is very important. Overnight ventilation, especially in winter, can be compromised, leading to high levels of dust and ammonia. If visiting during the day, try to assess the capacity of the farm to ventilate effectively without chilling the birds during night hours. Records of minimum temperatures will assist the investigation.Disease presentations/differential diagnosisConjunctivitisConjunctivitis, keratitis, photophobia, excess lacrimationDifferential diagnosisViralInfectious laryngotracheitis virusInfectious bronchitis virusAvian influenza virusTurkey rhinotracheitis virusBacterialChlamydiosis (Chlamydia psittaci)Mycoplasma gallisepticumFungalAspergillus speciesToxic/irritantHigh levels of ammoniaNutritionalVitamin A toxicityRhinitis and sinusitisSneezing and nasal discharge, facial swelling, periorbital swelling and epiphoraDifferential diagnosisViralInfectious laryngotracheitis virusInfectious bronchitis virusAvian influenza virusTurkey rhinotracheitis virusBacterialChlamydiosis (Chlamydia psittaci)Mycoplasma gallisepticumInfectious coryza (Avibacterium paragallinarum)Fowl cholera (Pasteurella multocida)Ornithobacterium rhinotrachealeRiemerella anatipestiferTracheitisCoughing, gaspingDifferential diagnosisViralInfectious laryngotracheitis virusInfectious bronchitis virusAvian influenza virusTurkey rhinotracheitis virusNewcastle disease virusBacterialMycoplasma gallisepticumEscherichia coliBordetella aviumOrnithobacterium rhinotrachealeFowl cholera (Pasteurella multocida)Toxic/irritantHigh levels of ammonia and/or dustPneumoniaCoughingDifferential diagnosisViralAvian influenza virusTurkey rhinotracheitis virusBacterialEscherichia coliOrnithobacterium rhinotrachealeFowl cholera (Pasteurella multocida)FungalAspergillus speciesAirsacculitisGasping, coughingDifferential diagnosisViralInfectious bronchitis virusAvian influenza virusTurkey rhinotracheitis virusNewcastle disease virusBacterialMycoplasma gallisepticum/Mycoplasma synoviae/Mycoplasma meleagridisEscherichia coliBordetella aviumOrnithobacterium rhinotrachealeFowl cholera (Pasteurella multocida)Chlamydiosis (Chlamydia psittaci)Infectious serositis (Riemerella anatipestifer)FungalAspergillus speciesNecropsy and SamplingNecropsy 510 birds with typical clinical signs or 510 birds that have recently died and note findings. If birds that have recently died cannot be submitted to the laboratory, sample the choanal cleft/trachea/affected tissue of 510 affected birds with swabs for viral and bacterial isolation, as well as plain swabs. Alternatively, collect fresh affected tissue in a sterile jar. If Chlamydia psittaci is suspected also collect the spleen. Collect a minimum of 10 blood samples from live affected birds for serology.The history will be important in determining a differential diagnosis. This will include the vaccination and flock history, along with overall flock and necropsy signs.Most causes of respiratory disease are highly contagious, so quarantine of the affected flock is critical.As mortality can be exacerbated by stress and poor ventilation, these adverse management factors should be minimised.Many causes of respiratory disease can be prevented by vaccination, so vaccination should be considered as a key control strategy for future flocks, along with thorough cleanout and disinfection, strict biosecurity and improved management to ensure high air quality and lower stress.Respiratory disease is very common in backyard poultry flocks. Outbreaks are most commonly attributable to poor biosecurity.It would be prudent to delay treatment until a microbiological diagnosis and antimicrobial susceptibility can be established, but this can be affected by concerns for bird welfare, WHPs, economic considerations, the level of mortalities, and the time until slaughter.If treatment is required before a diagnosis can be established, then the treatment of choice would be a tetracycline, as it will have a broad spectrum of activity against the bacterial agents that are most likely to be involved.Treatment is not warranted for any viral infection.Treatment will not eliminate most bacterial respiratory pathogens. Birds will generally remain carriers, so measures to minimise the risk of spread should be considered.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.OrganismFirst Choice TreatmentSecond Choice TreatmentChlamydia psittaciChlortetracycline at 60 mg/kg for 57days in drinking water, followed by chlortetracycline at 400750 ppm in feed for a minimum of 2weeks, depending on the severity of the disease.Oxytetracycline at 70 mg/kg for 57days, followed by infeed medication. Note that this is NOT a suitable treatment for birds producing eggs for human consumption.Mycoplasma gallisepticum/Mycoplasma synoviaeTylosin tartrate at 100 g/200 L of drinking water for 36days depending on the severity of the disease (not registered for birds producing eggs for human consumption).In the case of foodproducing egg layers and where secondary infection complicates the disease picture, use chlortetracycline at 60 mg/kg bodyweight for 35days, depending on the severity of the disease.Infectious coryza (Avibacterium paragallinarum)Chlortetracycline at 60 mg/kg live weight can be used for 35days, depending on the severity of the clinical signs.Relapse often occurs after treatment is discontinued and treatment with chlortetracycline at 100 ppm in feed for up to 28days may be required.Amoxicillina can be used at 20 mg/kg if there is resistance to tetracyclines and sensitivity to amoxicillin has been conformed in vitro.Prior to antimicrobial treatment, collect samples for culture and susceptibility testing.Fowl cholera (Pasteurella multocida)Tetracyclineoxytetracycline at 70 mg/kg for 57days, or chlortetracycline at 60 mg/kg for 57days. Note that oxytetracycline is NOT suitable for treatment of birds producing eggs for human consumption.Fowl cholera outbreaks can recur after cessation of treatment, so in the case of severe disease, chlortetracycline may be required infeed at 100 ppm for up to 28daysAmoxicillina at 20 mg/kg for 35daysOrnithobacterium rhinotrachealeAmoxicillina at 20 mg/kg for 35days.Chlortetracycline at 60 mg/kg for 57days.Riemerella anatipestiferCulture and susceptibility testing are necessary to determine an appropriate antimicrobial for treatment because of variation in patterns of resistance. However, the most consistently effective treatment in ducks has been amoxicillina at 20 mg/kg for 35days.Escherichia coliAmoxicillina at 20 mg/kg live weight for 35days can be used in broilers with respiratory colibacillosis.Chlortetracycline can be used at 60 mg/kg live weight for 35days, depending on the severity of the clinical signs.Bordetella aviumNonresponsive to antibioticsThe avian skeletal system is similar to that of mammals but must balance the requirement for reduced weight to enable flight and the tensile strength needed for structural support. Consequently, the skeleton of a bird has some unique features.The bones of birds are lighter in weight than those of mammals. Some bones are hollow and are part of the avian respiratory system. These bones, called pneumatic bones, include the humerus, clavicle, keel, pelvic girdle, and lumbar and sacral vertebrae.Other important bones in the avian skeleton are the medullary bones. These include the tibia, femur, pubic bone, ribs, ulna, phalanges and scapula. Medullary bones are an important source of calcium when hens are laying eggs. Eggshells are primarily composed of calcium salts, and a hen's body mobilises approximately 47% of its body calcium to make an eggshell. When in production, a commercial laying hen cannot obtain enough dietary calcium to support daily egg production. Without medullary bones from which to draw calcium, the hen would produce eggs with very thin and weak shells (Figure 5). The skeleton of the Fowl.169 1. Skull; 2. Cervical vertebrae; 3. Furcula; 4. Coracoid; 5. Uncinate process; 6. Keel; 7. Patella; 8. Tarsometatarsus; 9. Digits; 10. and 11. Tibiotarsus; 12. Femur; 13. Pubis (innominate bone); 14. Ischium (innominate bone); 15. Illium (innominate bone); 16. Caudal vertebrae; 17. Pygostyle; 18. Synsacrum; 19. Scapula; 20. Lumbar vertebrae; 21. Humerus; 22. Ulna; 23. Radius; 24. Carpus; 25. 3rd digit; 26. 2nd digit; 27. 1st digit (Alula) (Squelette_oiseau.JPG: BIODIDACderivative work: mario modesto/CC BY; .Lameness can have a nutritional, viral, bacterial or traumatic aetiology.170 Therefore, it is important to ask questions about the feed source, access to feed, and changes in feed and its formulation. This applies to commercial and backyard flocks.As bacteria (particularly Staphylococcus species) can enter the birds well before the onset of clinical lameness, a full history, including early chick quality, the donor source, scratching injuries, respiratory insults, gut health issues (including the quality of the water) and traumatic tendon damage should be recorded.Donor flock information is important for assessing potential viral aetiologies and genetic predispositions.Understanding the rapidity of the growth rate (particularly in broilers) and modifications (such as light programs) is important information.It is important to determine the root cause of infection if Staphylococcus aureus or Escherichia coli are involved. They can enter the blood stream through the skin, the respiratory tract, the intestinal tract or during incubation or hatching.Disease presentations/differential diagnosisLameness/reluctance to walkDifferential diagnosisViralReovirusesMarek's disease virusBacterialEscherichia coliFowl cholera (Pasteurella multocida)Mycoplasma synoviae/Mycoplasma iowae/Mycoplasma meleagridisStaphylococcus aureusEnterococcus speciesToxicBotulismDevelopmental/nutritionalDyschondroplasiaRicketsVitamin deficiencyTendon strainCage layer fatigueOtherAmyloid arthropathyIonophore toxicityDog sitting posturedifferential diagnosisBacterialEnterococcus caecorumDevelopmentalKinky backNecropsy and samplingBirds with lameness can often present with varying signs. At least 15 birds with typical clinical signs should be necropsied.Starting at the feet, note the condition of the footpads, any joint swelling (pus or serous fluid), the thickness and firmness of the gastrocnemius tendon, and any erosions in the hips. Slice the top of the hock from the medial side to inspect cartilage formation for dyschondroplasia. Bend the tibia to detect reduced bone strength, which will be affected in rickets. Open the abdomen and check for lesions, especially around the air sacs. Check the keel for breast blisters. Check the sciatic nerve if lameness caused by Marek's disease is suspected. With a sharp knife slice ventrally through the spinal column to look for abscesses, which can be found on the free thoracic vertebrae. Check other joints, such as those of the wing, for swelling or abnormal fluid. Note the findings in each bird to determine the predominant cause.If a bacterial aetiology is suspected, swab the affected joints and place the swabs in bacterial transport medium.Collect blood samples from 10 birds for serology. Collect feed and water samples. If feed retention samples are kept by the farm, collect samples from the time when leg problems were first noted.As lameness due to bacterial infection can often be chronic, antimicrobial treatment will often not resolve the problem. Infection will often be secondary to other causes and the penetration of antimicrobials to the sites of infection is often poor. When individual birds are of high value or are considered pets, longterm antimicrobial therapy may improve some less severe cases. Label directions for foodproducing animal usage must still be taken into consideration.The exception to this will be when Mycoplasma synoviae or Pasteurella multocida are involved. The vaccination history and other signs in the birds should help differentiate these from other causes, such as Staphylococcus aureus.Use of antimicrobials can often wait until culture and susceptibility are performed, so appropriate sampling is important.Nutritional stress can also trigger bacterial infections. This stress may be due to an inadequate diet, but any factor that inhibits feed intake in some or all birds in the flock can be responsible.Nonbacterial causes of lameness (e.g. nutritional/developmental) should not be treated with antimicrobials. Correcting the nutritional cause should be the priority.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.OrganismFirst choice treatmentSecond choice treatmentMycoplasma synoviaeRefer to Section 9Staphylococcus aureusAntimicrobial susceptibility testing should be performed to ensure that the most efficacious antimicrobial is used.A number of antimicrobials, including amoxicillina, erythromycin, tylosin, oxytetracycline, and chlortetracycline have been used to treat acute and subacute staphylococcal infections. Clinically affected birds respond well early in the course of the disease, but once lameness is seen in birds, treatment efficacy decreases.Enterococcus speciesAntimicrobial susceptibility testing should be performed to ensure that the most efficacious antimicrobial is used.A number of antimicrobials, including amoxicillina, erythromycin, tylosin, oxytetracycline, and chlortetracycline have been used to treat acute and subacute enterococcosis. Clinically affected birds respond well early in the course of the disease, but once lameness is seen in birds, treatment efficacy decreases.Escherichia coliRefer to Section 9Fowl cholera (Pasteurella multocida)Refer to Section 9Systemic diseases in poultry can be peracute, acute, subacute or chronic.In peracute and acute cases, the challenge when presented with a sudden increase in mortality is differentiation and recognition of exotic and new emerging diseases, so empirical treatment for suspected endemic bacterial pathogens should not be undertaken until exotic and new emerging diseases have been considered. However, if the cause is a primary bacterial infection (such as fowl cholera or erysipelas), then treatment at this stage can be the most successful of any antimicrobial therapy in poultry in terms of reducing morbidity and mortality.In chronic cases, the systemic infection can often be secondary to other factors, especially in the case of colibacillosis, and therefore treatment is often unrewarding until the primary factor is removed.If high rates of mortality with a sudden onset are seen, quarantine should be implemented on the farm prior to the veterinary visit.The veterinarian would be wise to inform government veterinarians of the situation to ensure that laboratory services are ready to perform exotic disease exclusion testing, if necessary.If exotic or zoonotic disease is suspected, ensure that laboratory staff are aware and that birds are transported and submitted to the laboratory in biosecure containers.Disease presentations/differential diagnosisPeracuteSudden increase in mortality with or without clinical signs or postmortem lesionsDifferential diagnosisViralAvian influenza virusNewcastle disease virusDuck viral enteritis (duck plague)BacterialErysipelas (Erysipelothrix rhusiopathiae)Fowl cholera (Pasteurella multocida)Necrotic enteritis (Clostridium perfringens)Spotty liver disease (Campylobacter hepaticus)ProtozoalCoccidiosis (Eimeria tenella/Eimeria brunetti/Eimeria necatrix/Eimeria maxima)ManagementHeat stress/anoxiaSmotheringNutritionalCalcium tetany in broiler breedersMetabolicSpiking mortality syndrome (hypoglycaemia)Sudden death syndrome in broiler breedersAcute death syndrome in broiler chickensTraumaticAortic rupture in turkeysPerirenal haemorrhage in turkeysSubacute/chronicIncrease in mortality/depression with chronic signs of septicaemia, such as pericarditis/perihepatitis/focal liver necrosisDifferential diagnosisBacterialChlamydia psittaciErysipelas (Erysipelothrix rhusiopathiae)Fowl cholera (Pasteurella multocida)Spotty liver disease (Campylobacter hepaticus)Escherichia coliStaphylococcus aureusRiemerella anatipestiferSalmonella speciesNecropsy and samplingNecropsy 510 birds with typical clinical signs or 510 birds that have recently died and note findings. Depending on the findings, collect: Swabs of heart blood from 510 affected birds and place into bacterial transport medium The femur from 510 affected birds Samples from affected tissues (e.g. lung/liver) from 510 affected birdsIf avian influenza or Newcastle disease are suspected, collect swabs from the palatine cleft or trachea and cloacal swabs from 10 affected birds (into viral transport medium).If sudden deaths are seen, collect a sample of feed and any retention samples from the previous week.The history will be important for determining the differential diagnoses. This will include vaccination and flock history, as well as clinical signs in the flock and the necropsy findings.In cases where there is a rapid onset of mortality and a primary bacterial disease is suspected, then treatment with antimicrobials prior to the return of laboratory results is justified on welfare grounds, as the antimicrobial therapy can effectively and fairly rapidly minimise mortalities. Refer to Appendix 1 for the preferred choice of antimicrobial.However, laboratory samples must be taken prior to treatment to confirm the diagnosis and determine the susceptibility of the organism responsible.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.OrganismFirst choice treatmentSecond choice treatmentErysipelas (Erysipelothrix rhusiopathiae)Amoxicillina at 20 mg/kg live weight for 35days can be used in chicken and turkey breeders and broilers.Chlortetracycline at 60 mg/kg bodyweight for 35days.Spotty liver disease (Campylobacter hepaticus)Refer to Section 8Chlamydia psittaciRefer to Section 9Fowl cholera (Pasteurella multocida)Refer to Section 9Escherichia coli (colibacillosis)Do not treat with antibiotics in most cases of colibacillosis. Instead, try to investigate and correct the root cause.If treatment is undertaken, in young birds trimethoprim/sulphonamide combinations can occasionally have a beneficial impact on early omphalitis/yolk sac infection.Treat with trimethoprim/sulphadiazine at a dose rate of 25 mg sulphadiazine/kg and 5 mg trimethoprim/kg per day for 35days if the birds are less than 2weeks old, or 12.5 mg sulphadiazine/kg and 2.5 mg trimethoprim/kg per day for 35days if the birds are older than 2weeks of age.In older birds amoxicillina can be used at 20 mg/kg live weight for 35days in broilers with respiratory colibacillosis or birds with reproductive tract colibacillosis.Colibacillosis in young birds can be treated with lincomycinspectinomycin at 100 g combined antibiotic activity/200 L of drinking water.Colibacillosis in older birds can be treated with chlortetracycline at 60 mg/kg live weight for 35days, depending on the severity of the clinical signs.Staphylococcus aureusRefer to Section 10Riemerella anatipestiferRefer to Section 9Salmonella speciesRefer to Section 8 Refer to Appendix 1 for further information, including dose rates, duration of treatment, preferred treatment choice/s and any contraindications.Because of the potentially devastating impact of acute systemic bacterial disease, once an outbreak is controlled with antimicrobials, a future preventive control program must be discussed. This discussion should be held with the diagnosing veterinarian, and a government veterinarian may assist in development of future biosecurity plans.These plans should include biosecurity measures, cleaning and disinfection, rodent control and possible vaccination strategies.This is critical to ensure that antimicrobials are not relied upon as a future preventive strategy.Reproductive tract disorders can have several sequelae, including loss of production, loss of egg quality (both external and internal), and reduced fertility and/or hatchability. A good understanding is needed of the development of both an egg and an embryo in order to gain insights into the location and timing of developmental abnormalities.Records of production are usually readily available and are extremely useful tools when investigating egg production problems.Specific records related to egg production include:Henday egg production ratesHenhoused egg production ratesEgg weightsFertility (%)Hatchability (%)Egg recovery rates (percentage of first grade eggs)Eggshell defects thin shells, pale shells, other shell deformitiesShellless egg residues noticed in shedsRequest that the farm keep:Dead birds aside for youDeformed eggs aside for assessmentOvary consists of a cluster of developing ova or follicles, and is fully developed at birth, but follicles only start to develop at the commencement of sexual maturity. Follicles develop sequentially, usually one every 24 h, which allows for daily production of a single ovum, or egg.Infundibulum the infundibulum is like a patent funnel that engulfs the follicle and feeds it into the oviduct. Fertilisation of the ovum occurs in the infundibulum.Magnum this is the largest part of the oviduct, and it is here that thick albumen is laid down.Isthmus this is where inner and outer shell membranes form.Tubular shell gland this is where shell calcification commences.Shell gland pouch the majority of shell deposition and, finally, shell pigment is laid down in this section of the oviduct.Vagina the shell cuticle is deposited on the fully formed egg as it passes through the vagina during the process of laying.Cloaca is the single cavity receiving faeces, uric acid and eggs prior to discharge.Vent the external opening of the digestive and urogenital tracts.Vestigial (persistent) right oviduct this blind sac serves no functional purpose, but often fills with clear, waterlike fluid (Figure 6). Schematic anatomy of the avian female reproductive tract.The reproductive system of a layer or breeder hen is highly active, cycling daily to produce an egg as often as every 24 h.Hens can store sperm for up to 10days, so daily mating is not required. Semen is stored in sperm storage tubules in the oviduct. Fertilisation of the ovum occurs after ovulation, in the infundibulum.Dietary and environmental changes can have significant effects on reproductive performance in hens and should always be considered when investigating egg production problems.Reproductive disease is seen most frequently, but not exclusively, in high egg production commercial poultry breeds over 2years of age.Reproductive disease is common in backyard poultry.Some of the most commonly seen reproductive diseases in clinical practice include egg yolk coelomitis, egg dystocia, pyometra, oviductal prolapse, and ovarian and oviductal neoplasia.Disease presentations/differential diagnosisPrimary egg production dropsIn all instances of egg production drops, husbandry, lighting, feed and water intake, nutrition and environmental stresses must be considered early in the investigationDifferential diagnosisViralEgg drop syndrome virus (adenovirus)Infectious bronchitis virusLow pathogenic avian influenza virusInfectious laryngotracheitis virusNewcastle disease virusAvian encephalomyelitis virusBig liver and spleen virus (avian hepatitis E virus)BacterialNonspecific salpingitis (trauma, ascending infection)Fowl cholera (Pasteurella multocida)Mycoplasma gallisepticumMycoplasma synoviaeBrachyspira speciesProtozoalCoccidiosis (Eimeria tenella/Eimeria brunetti/Eimeria necatrix/Eimeria maxima)Histomonas meleagridis (histomoniasis)NutritionalCage layer fatigueFatty liver haemorrhagic syndromeEnvironmental/managementInternal layersBroodinessToxicIonophoresNicarbazinMycotoxinsEgg peritonitisInternal laying can occur as a result of a sudden stress event/frightDifferential diagnosisViralNewcastle disease virusTurkey rhinotracheitis virusAvian influenza virusBacterialFowl cholera (Pasteurella multocida)Escherichia coliErysipelas (Erysipelothrix rhusiopathiae)Chlamydiosis (Chlamydia psittaci)EnvironmentalFeather pecking leading to cannibalismShell deformitiesShell deformities are often early indicators of underlying issuesDifferential diagnosisViralEgg drop syndrome virusInfectious bronchitis virusNewcastle disease virusBacterialMycoplasma synoviaeNutritionalInadequate or surplus calciumInadequate Vitamin DCalcium/Phosphorus imbalanceInternal qualityAlbumen quality, yolk colourDifferential diagnosisViralEgg drop syndrome virusInfectious bronchitis virusInfectious causesYolk colour is artificially managed with feed additives, but changes in yolk colour can be indicative of disease and need investigation.Caecal infections with protozoa can cause a loss of yolk colour Histomonas meleagridis (histomoniasis) or coccidiosis (Eimeria tenella/Eimeria brunetti/Eimeria necatrix/Eimeria maxima).Egg handlingOld eggsPoor storage conditionsNutritional:Lack of artificial yolk colouring in dietPasty ventDifferential diagnosisVisceral goutAscending salpingitis due to cannibalismInfertilityDifferential diagnosisManagement/husbandryExcess weightNecropsy and samplingNecropsy 510 birds with typical clinical signs or 510 birds that have recently died and note findings. Swab typical lesions and submit swabs for laboratory testing by polymerase chain reaction and/or culture and susceptibility testing.Collect blood samples from 10 birds for serology to detect evidence of viral or mycoplasma infection. Note, if an egg production drop is rapid and unexplained with no other signs, then extra samples (up to 30) may need to be taken from apparently normal birds for detection of pathogens such as low pathogenic avian influenza virus.The history will be important for determining the differential diagnoses. This will include vaccination and flock history, as well as clinical signs in the flock and the necropsy findings. It would be prudent to delay antimicrobial treatment until a bacteriological diagnosis and susceptibility can be established.Most causes of reproductive system disease are noninfectious, so a thorough investigation of noninfectious causes is warranted.Primary bacterial causes of reproductive disease are very uncommon and a decision to use antimicrobials should only be made once a specific diagnosis has been made.Depending on the underlying cause, treatment may consist of medical or surgical therapy. Euthanasia is often required for neoplastic causes of reproductive disease because of the frequent occurrence of metastasis.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.OrganismFirst choice treatmentSecond choice treatmentChlamydia psittaciRefer to Section 9Erysipelas rhusiopathiaeRefer to Section 11Nonspecific salpingitisChlortetracycline at 60 mg/kg bodyweight for 35days in drinking waterNo alternative treatmentsMycoplasma synoviaeRefer to Section 9Pasteurella multocidaRefer to Section 9The avian nervous system is less complex than, but essentially identical in structure and function to, the mammalian nervous system. Consequently, diseases of the central and peripheral nervous systems have similar presentations to those seen in mammals.Diseases causing neurological signs are many and varied. It is important when investigating neurological disease that exotic, transboundary diseases are considered in the differential diagnosis. The major presenting clinical signs for which neurological disease might be a diagnostic consideration are paresis, paralysis, leg misplacement, tonic tremors, incoordination, blindness, opisthotonos and depression.The investigation of neurological disorders should always include exclusion of avian influenza, Newcastle disease and turkey rhinotracheitis. With that in mind, consideration needs to be given to placing the property under quarantine as a precautionary measure until a workup has been conducted.Ask the farm to keep dead and affected birds aside for you do not cull all affected birds as the clinical signs are a significant contributor to making a diagnosis.Check the history of the parent flocks for vaccination against Marek's disease, Newcastle disease and avian encephalomyelitis.The clinical picture is a very important contributor to making a diagnosis, but is not necessarily pathognomonic. It would be prudent to institute quarantine measures until the diagnosis is confirmed.Disease presentations/differential diagnosisParesis/paralysisIt is important to confirm the paresis/paralysis by conducting proprioceptive tests to differentiate it from other causes of immobilityDifferential diagnosisViralMarek's disease virusToxicIonophoresBotulismLeg misplacementDifferential diagnosisNutritional/managementPerosis (slipped tendon)Spraddle legSpondylolisthesis (kinky back)Valgus/varus deformityTonic TremoringDifferential diagnosisViralAvian encephalomyelitis virusNutritionalEpidemic tremor (Vitamin E deficiency)IncoordinationDifferential diagnosisViralAvian influenza virusNewcastle disease virusBlindnessDifferential diagnosisViralMarek's disease virusFungalAspergillus species (ocular aspergillosis)ToxicAmmonia blindnessOpisthotonus/TorticollisDifferential diagnosisViralAvian influenza virusNewcastle disease virusTurkey rhinotracheitis virusBacterialFowl cholera (Pasteurella multocida)Riemerella anatipestiferMiddle ear infectionNutritionalVitamin B deficienciesDinitolmide, 3,5dinitrootoluamide (DOT) toxicityDepressionDifferential diagnosisViralAvian influenza virusNewcastle disease virusOtherAny late stage disease that causes depression and moribunditiesNecropsy and samplingNecropsy 510 birds with typical clinical signs or 510 birds that have recently died and note findings.If no clear gross lesions are identified, or confirmation of diagnosis is required, then collect samples of the brain and/or affected nerves for histopathology.Swab typical lesions and submit swabs for laboratory testing by polymerase chain reaction and/or culture and susceptibility testing.Collect swabs of the heart blood from 510 affected birds and place into bacterial transport medium.Collect blood samples from 10 birds for serology to detect evidence of viral infection.Collect feed samples for testing if vitamin deficiencies are suspected.Specific details on diseases, prevention and specific treatment choices are shown in Appendix 1. In foodproducing species, it is critical that contraindications and WHPs are reviewed as described in the label requirements and guidance in Appendix 2.ConditionFirst choice treatmentSecond choice treatmentRiemerella anatipestiferRefer to Section 9The avian immune system shares many similarities with that of mammals, but also has some fundamental differences.The avian system has a cellmediated and a humoral immune system, essentially as in mammalian systems. The thymus, bursa of Fabricius and bone marrow are primary lymphoid organs, while the spleen, mucosal associated lymphoid tissues germinal centres, and diffuse lymphoid tissues are secondary lymphoid organs. Birds do not have lymph nodes.The thymus, where T cells develop, is a lobulated organ located in the neck, running parallel to the cervical artery and jugular vein. The bursa of Fabricius is an organ that is unique to birds and is the site of B cell development, differentiation and maturation. Located dorsal to the rectum, this organ contains stem cells and is highly active in young birds, but atrophies after about 6weeks. There are diffuse lymphoid accumulations in the head and associated with the respiratory system and gastrointestinal tract, such as the Harderian gland, located behind the eyes, and the Peyer's patches, in each of the caeca, just proximal to the junction of the caecum with the colon.A number of agents, including viruses, bacteria, parasites, toxins, mycotoxins, chemicals and drugs, can cause immunosuppression in birds. The most common immunosuppressive viruses encountered in Australia are infectious bursal disease virus, chicken anaemia virus, inclusion body hepatitis virus, avian lymphoid leukosis virus and Marek's disease virus. Primary immunosuppressive infections increase the susceptibility of birds to secondary bacterial, viral and fungal infections.The presentation of a primary immunosuppressive disease is often complicated by secondary infections, making diagnosis of the primary disease more complex, but also more important. Treatment of secondary infections can be unrewarding if the primary cause of disease is not managed correctly. The secondary pathogen most frequently encountered because of immunosuppressive disease is Escherichia coli.Persistence of immunosuppressive viruses in the environment will result in ongoing secondary infections in subsequent flocks. It is therefore imperative to implement preventive measures, such as thorough cleaning and disinfection of facilities, and vaccination, to minimise the impact of these viruses on subsequent flocks.Disease presentations/differential diagnosisLameness with paralysis, paresisDifferential diagnosisMarek's disease virusChronic wasting, emaciation +/ visceral or lymphoproliferative tumoursDifferential diagnosisMarek's disease virusAvian lymphoid leukosis virusSepticaemia, colibacillosisDifferential diagnosisSecondary infectionsEscherichia coli (secondary to infection with infectious bursal disease virus, inclusion body hepatitis

assess levels of infestation (and monitor effectiveness of treatment).Piperazine is suitable for mature Ascaridia species only.Levamisole is effective against Heterakis gallinarum, Capillaria and Ascaridia species with a nil withholding period for eggs and a 7day withholding period before slaughter. In practical experience, the effectiveness of levamisole against Capillaria species has been variable and new products such as Flubenol may need to be considered.There is currently no registered product in Australia to use against poultry tapeworms.Flubendazole infeed wormer (Flubenol) is expected to be registered and available from mid2020.Infectious coryza (Avibacterium paragallinarum)All ages are susceptible, but susceptibility increases with age.Chickens.Nasal discharge, sneezing and periorbital swelling of the face under the eyes.Biosecurity.Chronically ill or healthy carrier birds are the reservoir of infection. Therefore, there is a greater risk in multiage flocks. Obtain birds from clean flocks.Vaccination with killed bacterins. Because serovars A, B and C are not cross protective, it is essential that bacterins contain the serovars present in the target population. Vaccination should be completed ~4weeks before infectious coryza usually occurs on the farm.Chlortetracycline at 60 mg/kg live weight can be used for 35days, depending on severity of clinical signs.Relapse often occurs after treatment is discontinued and chlortetracycline in feed for up to 28days at 100 ppm may be required.Amoxicillina can be used at 20 mg/kg if there is resistance to chlortetracycline treatment and sensitivity to amoxicillin is determined in vitro.Prior to antimicrobial treatment, collect samples for culture and susceptibility testing.To alleviate effects, reduce other management/disease stressors such as poor ventilation.Miscellaneous bacterial infections (e.g. Pseudomonas infection due to vaccine contamination)4weeks.Chickens, turkeys, occasionally pheasants, partridge, quail.Respiratory rles, coughing, nasal discharge, conjunctivitis, airsacculitis, infraorbital sinusitis (in turkeys).Obtain birds from Mycoplasma gallisepticum free breeders.Biosecurity from surrounding farms and wild birds.Move to single age flocks.Reduce other stressors, for example ensuring good air quality, in case of infection.Vaccination of parent flocks and atrisk flocks.Preventive antimicrobial treatment of progeny from infected parents.Tylosin tartrate at 100 g/200 L of drinking water for 36days, depending on the severity of the disease (not registered for birds producing eggs for human consumption).In the case of foodproducing egg layers and where secondary infection complicates the disease picture, use chlortetracycline at 60 mg/kg bodyweight for 35days, depending on disease severity.Complete elimination of Mycoplasma gallisepticum from all birds in an infected flock by mass antimicrobial therapy is an unrealistic expectation, and treatment should be regarded as a method for shortterm amelioration of disease and economic effects, rather than a longterm solution to the problem.173Infectious synovitis (Mycoplasma synoviae)Chickens: 416weeks.Turkeys: 1024weeks.Chickens, turkeys.Lameness, warm flocculent swelling of one or more joints. Occasional enlargement of sternal bursa (more common in chickens than turkeys).Failure to grow.Respiratory signs not usually observed (more common in chickens than turkeys).Occasional airsacculitis.Apical eggshell abnormalities in chickens and occasional transient egg production drops.Infection from vertical and horizontal transmission.Vaccination with temperature sensitive vaccine.Choose birds from Mycoplasma synoviaefree flocks.Hatch Mycoplasma synoviae positive flocks separately from Mycoplasma synoviae negative flocks.Effective biosecurity measures, including single age flocks.As for Mycoplasma gallisepticum.Complete elimination of Mycoplasma synoviae from all birds in an infected flock by mass antimicrobial therapy is an unrealistic expectation, and treatment should be regarded as a method for shortterm amelioration of disease and economic effects, rather than a longterm solution to the problem.Necrotic enteritis (Clostridium perfringens)Broiler chickens (25weeks old).Turkey broilers (712weeks old).Chicken breeders associated with coccidiosis outbreaks.Primarily broiler chickens and turkeys.Depressed, diarrhoea, peracute mortality.Jejunal and ileal diphtheritic membranes.Small intestine distended and friable.Exacerbated by coinfection with coccidia, wheat or barleybased diets, high fishmeal diets, diets with additional zinc.Reduce exposure to risk factors, control with coccidiostatic drugs, such as ionophores, or with coccidial vaccines.Need good husbandry/management practices and correct diet/nutritional profile +/ preventive alternatives, especially in the absence of antimicrobials.Feed additives such as probiotics, prebiotics.Short chain and mediumchain fatty acids in feed.Water acidification and chlorination.Bacillus subtilis (administered as spores) can competitively exclude Clostridium perfringens from broiler chicks.Amoxicillina in the drinking water is the first line treatment. Use at 20 mg/kg for 3days.Chlortetracycline at 60 mg/kg bodyweight for 35days can be used as a second line treatmentWhere previous flock history suggests that necrotic enteritis is not able to be controlled with other measures as outlined in Table 1 (eg dietary) then preventative treatment with either zinc bacitracin in feed at a rate of 40 ppm (active ingredient) or avilamycin at a rate of 1015ppm (active ingredient) in feed may be required. The preventative treatment period will usually coincide with the times of coccidiosis challenge on the farm and is fed continuously through this risk period. Probiotics could also be considered as a potential alternative to antibiotics in these situations. The choice of preventative treatment option will depend on applicable poultry species and production type, along with previous successful prevention regimes. NOTE: Virginiamycin is also registered for use as a preventative treatment for necrotic enteritis. As it has a HIGH ASTAG rating this antibiotic should only be used as a treatment of last resort and used strictly according to label directions..Omphalitis (navel ill, yolk sac infection, mushy chick disease)7dDNUDNUSemduramicinAnticoccidial IonophorenhuFeedNILDNUDNUDNUDNUSpectinomycin + LincomycinAminocyclitol, LincosamideMediumWater, Injection10D10D10DDNU10DDNUNILDNU10DDNUDucks 10DDNUSulfadimidineSulphonamideLowWater15DDNUDNUDNU15DDucks 15DSulfaquinoxalinecAnticoccidial SulphonamideLowWater14DDNUDNUDNU14DDucks 14DTiamulincPleuromutilinLowFeed, Water5DDNUDNUDNU5DDuck 5DToltrazurilAnticoccidialnhuWater14DDNUE>8wDNUDNUTrimethoprim + SulfadiazineDiaminopyrimidine + SulphonamideMediumWater14DDNUDNU or e>14DDNU14DTrimethoprim + SulfadimidineDiaminopyrimidine + SulphonamideMediumWater14DDNUe>14DDNU14DDucks 14DTylosinMacrolideLowFeedWaterNILNIL, 2DNILDNUNILDNUNILDNU, e>7DNIL5DDucks NILVirginiamycinStreptograminHighFeedNILDNUDNUDNUDNU Gray, P., Jenner, R., Norris, J., Page, S. and Browning, G., and the Australian Veterinary Association Ltd and Animal Medicines Australia. 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