Tutorial Article

Antibacterial drug resistance and equine practice

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Summary

The equine practitioner is in a position to make day-to-day decisions regarding antimicrobial drug (AMD) use for their patients as well as to educate their clients regarding judicious use. General guidelines regarding judicious use of AMDs in equine patients have been developed by the American Association of Equine Practitioners. Detailed guidelines for AMD use in specific equine diseases supported by clinical trials and results of surveillance studies focused on resistance among equine bacterial pathogens are lacking. Studies that could lead to detailed and justifiable use recommendations would allow the equine practitioner to make more informed decisions regarding when to use AMDs, which drugs should be used and how they should be used (e.g. dose, route and duration).

Introduction

The frequency of bacterial infections in equine practice that are resistant to one or more antimicrobial drug (AMD) is unknown as there is no formalised monitoring or surveillance systems to track their occurrence. Although some private practices (Slavis 2006) and veterinary diagnostic laboratories (Anon 2007a, 2008a; Jackson et al. 2008) summarise susceptibility testing results, it is rare that this information is collated with that of other practices or laboratories and disseminated. The number of isolates tested and the representativeness of isolates tested usually limits the generalisability of results from such summaries for a practice in a different geographic location or practice type. Furthermore, laboratories performing bacterial susceptibility tests use a variety of methods for susceptibility testing making aggregation or comparison difficult. Therefore, the extent to which antibacterial resistance is affecting the health of equine patients or the cost of equine health care is not precisely known.

A surveillance system focusing on veterinary pathogens as an early detection tool for changes in antimicrobial susceptibility over time has been created (C.C. Wu, personal communication; Huang et al. 2008) although at this time results are not available from this system for equine isolates. The project was initially funded by American Veterinary Medical Association (AVMA) for one year and supported by member laboratories of American Association of Veterinary Laboratory Diagnosticians (AAVLD). The short-term goals in the year 2001–2002 were to: 1) establish a model surveillance system for selected pathogens in bovine, porcine, canine, equine, and poultry species; 2) set up a veterinary expert system on early resistance detection; and 3) provide analysis and reporting on the collected data regularly. The long-range goal is to establish a functional long-term surveillance system for early detection of changes in antimicrobial susceptibility in veterinary pathogens. The minimum inhibitory concentration of 17 AMDs will be determined for 5 equine bacterial pathogens (Streptococcus zooepidemicus, Escherichia coli, Salmonella spp., Staphylococcus aureus and Actinobacillus spp.). Equine isolates for this project have been contributed by 4 AAVLD accredited State Diagnostic Laboratories encompassing different geographic locations. When the results from this project are available the trend in MIC for each AMD will be available for the 5 selected types of equine origin bacterial isolates. Since all testing will have been conducted at a single laboratory, quality control and comparability will be enhanced.

Although some terms are used interchangeably (e.g. antibiotic, antimicrobial drug and AMDs), a few definitions may serve to orient the reader and to clarify terminology used in this paper as well as others in this series. Antimicrobials or anti-infectives are anything that has a detrimental effect on bacterial, viral, parasitic or fungal agents, and therefore could be drugs, antiseptics or

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disinfectants. Since some antiviral drugs are now being used to treat equine patients there may be some benefit in the future in using the term antibacterial drug instead of AMD, which could include both antibacterial drugs and antiviral drugs. The term antibacterial drug encompasses both antibiotics that are naturally produced substances as well as other antibacterial drugs that are synthetic in nature. In this paper, we will use the term AMD to simplify terminology as AMD has been used extensively in previous publications.

Several agencies including the World Health Organisation (WHO), the US Centers for Disease Control and Prevention (CDC), the US Food and Drug Administration (FDA), and the US Department of Agriculture (USDA), along with others involved in the promotion and/or regulation of health activities around the world, are vigorously engaged in developing programmes intended to monitor the emergence of AMD resistance and to decrease the use of AMDs (Morley et al. 2005). Much of the scrutiny of AMD use in the treatment of animals exists because of the potential for zoonotic transmission of pathogenic and nonpathogenic bacteria to man through direct contact with animals, indirectly through contact with the animals’ environments and through the food chain (Morley et al. 2005). Monitoring systems for AMD use and resistance are in various stages of development around the world. A system in Denmark (Anon 2008a) has been in existence for several years and accumulates data on both bacterial resistance to drugs as well as AMD use levels. However, much of the data in this system are focused on animals produced for food not horses. A monitoring system in Sweden (Anon 2007a) has also been collecting data on bacterial resistance to drugs for several years. However, this system too is focused predominantly on livestock other than equids. The Canadian Integrated Program for Antimicrobial Resistance Surveillance (Anon 2005a) reports no data on the susceptibility of bacterial isolates from equids. In the United States the National Antimicrobial Resistance Monitoring System (Anon 2006) has collected data on the AMD susceptibility of Salmonella spp. isolates from clinical cases including equids.

The goals of this article are to: 1) review judicious use guidelines developed by the American Association of Equine Practitioners (AAEP); 2) describe common uses of AMDs based on a study of the US equine industry and a retrospective study in a university veterinary hospital; 3) describe methods used for testing susceptibility of bacteria to AMDs; 4) use reports of multidrug resistance among selected equine isolates to illustrate mechanisms of resistance; and 5) propose actions that equine veterinarians could consider implementing to reduce risk of development of resistance to AMDs in bacteria and improve the health of their patients.

Guidelines for judicious use of AMDs

Although some AMDs are available to equine owners over the counter, veterinarians in the USA and many other countries are responsible for overseeing much of the AMD use in equids for therapeutic purposes and disease prevention. Therefore, veterinarians have the opportunity to play an important role in decision making related to the use of AMDs. In this capacity the veterinarian should critically evaluate current AMD use to identify ways to optimise patient care while minimising the selection for resistant bacteria. The AAEP executive board approved a list of guidelines for judicious use of AMDs in 2001 (Anon 2001). These guidelines propose that the veterinarian’s primary responsibility is to aid in the design of management, immunisation, housing and nutrition programmes that reduce the incidence of disease and the need for AMDs. The guidelines go on to suggest that the veterinarian avoid use of AMDs in transient viral infections and to have evidence of the pathogen associated with disease in order to best select the AMD(s) for the target organism. These guidelines suggest that the veterinarian plays a key role in assuring that the most appropriate dose and duration of treatment is implemented. In addition the use of AMDs in nonseptic inflammatory airway disease would be ineffective and thus not indicated.

Antibacterial drug use in equids

Few data are available on AMD use in animals. The USDA’s National Animal Health Monitoring System (NAHMS) conducted a survey to collect equine health and management data in the summer of 2005 for equine operations with 5 or more equids in 28 states (Anon 2005b). Based on the Equine 2005 study for operations with 5 or more equids, the most common use of AMDs was for treatment of wounds or injuries. Overall, 7.2% of foals and 3.9% of equids aged ≥6 months received an AMD in the previous year for wounds or injury. AMDs reportedly were given to 7.0% of foals for disease prevention, Diarrhoea or another digestive disorder other than colic (4.6% of foals were treated in previous 12 months to the interview), and respiratory disease (4.1% of foals were treated in the 12 months prior to the interview) were the second and third most common reasons for AMD treatment among foals aged <6 months (Fig 1). For equids ≥6 months the second most common reason for AMD use was to treat respiratory infections (1.6% of equids ≥6 months received an AMD in the 12 months before the interview) and the third most common reason was for lameness, leg or hoof problems (1.4%). Fewer than 1.0% of equids aged ≥6 months were given AMDs for any other reason, from these data it is clear that there are several opportunities for decreasing use of AMDs on equine operations.

Promoting neonatal foal care including assuring passive transfer of immunity and birth into a clean environment may negate the need for prophylactic AMD use. Reducing the risk for injuries and wounds could potentially reduce the use of AMDs in the general equine population. Also, the need for an AMD in such injuries or
wounds, when they occur, should be critically assessed. Superficial wounds that do not involve a joint or tendon sheath may not require the use of systemic AMDs in the treatment if the horses are provided clean and dry housing. Optimising the use of equine vaccines (selection of vaccine type and timing) to protect against respiratory infections and reducing the risk of exposure to respiratory pathogens could potentially reduce the occurrence of respiratory disease and therefore the need for use of AMDs in both age groups of equids described above. Therefore, optimising preventative measures can result in minimising AMD selection pressure, along with the likelihood that both last training and days of use will be minimised. Furthermore, the practitioner should carefully consider whether AMDs are indicated even in the face of infectious respiratory disease or diseases of other systems. Thorough physical examination and diagnostic testing may lead to a diagnosis of uncomplicated viral disease and could negate the need for AMD use. Major efforts have been made along this line in the physician community to decrease the unwarranted use of AMD for patients with viral upper respiratory infections including providing educational information to the general public indicating that AMD will not cure colds and flu and are not indicated in the treatment of these diseases (Anon 2008).

Few studies have documented the amount of use of AMDs in hospitalised horses or evaluated the effect of AMD use on the resistance profile of enteric bacteria. Based on a review of prescribing records from the James L. Voss Veterinary Teaching Hospital at Colorado State University from 1994-2001, 54% of hospitalised equine patients received one or more AMD (Landry et al. 2000). Equine patients were more likely to receive one or more AMDs than any other species. The most commonly prescribed class of AMD in this study was β-lactam drugs (e.g. penicillin or ampicillin). Clearly, AMDs are commonly used in this equine referral hospital population (and probably others) and there is an opportunity for selection of enteric bacteria and environmental flora that are resistant.

Another study by workers at the same veterinary hospital evaluated antimicrobial resistance among faecal

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**Fig 1:** National Animal Health Monitoring System (NAHMS) Equine 2005 study (Anon 2005b). Percentage of foals that received an antimicrobial drug for selected conditions in the 12 months before the interviews conducted in the summer of 2005.

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**Fig 2:** Least squares means of prevalence of resistance of NTSEC isolates to 15 antimicrobial drugs (AMDs) for the 3 groups of horses (Hospitalised, Hosp No-AMD, Community) enrolled in the study. AMC = amoxicillin/clavulanate; AMP = ampicillin; CFX = cefoxitin; CTF = cefotetan; CTR = ceftriaxone; CPH = cephalothin; CHL = chloramphenicol; CIP = ciprofloxacin; GEN = gentamicin; KAN = kanamycin; NAL = nalidixic acid, STR = streptomycin, SUL = sulphamethoxazole, TET = tetracycline, TMS = trimethoprim/sulphamethoxazole. *Indicates AMDs for which there is a significant difference between groups (P<0.05).
Escherichia coli isolates from 3 groups of horses: 1) hospitalised horses receiving AMDs (Hosp-AMD); 2) hospitalised horses not receiving AMDs (Hosp-No AMD); and 3) horses from the surrounding community not receiving AMDs (Community) (Dunowska et al. 2006). There were 68 equids and 256 non-type specific E. coli (NTSEC) in Hosp-AMD group, 63 equids and 220 NTSEC in Hosp-No AMD group and 85 equids and 248 NTSEC in the Community group. The signalment was similar across the groups and was not associated with differences in antimicrobial resistance. Compared to the isolates from the Community group, isolates obtained from Hosp-AMD and Hosp No-AMD horses were 12.6 and 4.6 more likely respectively to be resistant to at least one AMD (Hosp-AMD group odds ratio = 12.6, 95% confidence interval = 6.9–22.8; Hosp-No AMD group odds ratio = 4.6, 95% confidence interval = 2.6–8.2).

Horses in the Hosp-AMD group were treated with one or more of 11 different AMDs prior to collection of the faecal samples (Dunowska et al. 2006). The most common AMDs given to the Hosp-AMD group horses were potassium penicillin, gentamicin and/or trimethoprim-sulph. When isolates were tested for resistance to the 15 AMDs, there were significant differences in the prevalence of antimicrobial resistance among the 3 groups of horses to 12 of those AMDs tested (Fig 2) with prevalence of resistance lowest in the Community group, intermediate in the Hosp No-AMD group and highest in the Hosp-AMD group. In all 3 groups the highest prevalence of resistance was to sulphamethoxazole and trimethoprim-sulph. Use of sulphamethoxazole, aminoglycosides and cephalosporins was positively associated with increased odds of isolates being resistant to the AMD of the same class. In addition use of cephalosporins and metronidazole was positively associated with increased risk of resistance to other classes of AMDs. Use of penicillin was not associated with resistance to any of the AMDs.

This study illustrates the impact of AMD use and hospitalisation alone on the resistance patterns of NTSEC which are a part of the normal faecal flora (Dunowska et al. 2006). Although these E. coli may not be pathogenic while in the intestinal tract they could become part of an infection in the uterus, a wound or surgical site or potentially share resistance factors with more pathogenic organisms.

**Susceptibility testing**

Empiric AMD use relies on recommendations from others based on reported success or personal experience in treating similar types of disease. For some bacteria the susceptibility to various AMDs is predictable while for others it is very difficult to predict the susceptibility based on the clinical presentation or by a culture alone (Papich 2001). The susceptibility testing of bacteria to a panel of AMDs is performed *in vitro* as a first step in determining the optimal treatment of a confirmed bacterial infection. Subsequent to susceptibility testing, selection of the drug treatment is contingent on multiple factors including the site of the infection and patient factors that are covered in other sections of this series in Equine Veterinary Education. Bacterial isolates can be tested for susceptibility to one or more AMDs using the disk diffusion method, a broth microdilution method, an Epsilometer (E. test) or the agar

**Fig 3:** Disk diffusion method of measuring bacterial susceptibility. The specialised agar plate is inoculated with the isolate to produce a lawn of growth and small disks impregnated with the antimicrobial drugs (AMDs) are placed on the agar. The AMD then diffuses from the disk into the agar. In the case of the organism that is sensitive to the AMD being tested, a zone of inhibition of bacterial growth can be seen around the disk. The size of this zone of inhibition is often determined with an automated reader. The size of the zone of inhibition, used to determine susceptibility, varies by AMD as the diffusion dynamics vary by drug.

**Fig 4:** Ninety-six well plate used in broth microdilution testing of bacterial susceptibility to a panel of antimicrobial drugs (AMDs). A series of wells contains 2-fold dilutions of the AMD and a standardised amount of the bacterial isolate are added to each well and then incubated for a set amount of time. The bacterial growth is assessed based on the amount of turbidity in the well, often determined using an automated plate reader. The lowest dilution of the AMD that inhibits the growth of the organism is the minimum inhibitory concentration or MIC.
dilution method (Walker 2000). The most common method used to test equine bacterial isolates, based on a survey of American Association of Veterinary Laboratory Diagnosticians (AAVLD) accredited laboratories, is the disk diffusion or Kirby Bauer method (Brooks et al. 2003). Results of the Kirby Bauer disk diffusion zone of inhibition sizes (Fig 3) are generally translated into categories and reported as susceptible, intermediate or resistant, for each of the AMDs tested. For the broth microdilution method a series of 2-fold dilutions of the drug are tested in a 96 well plate (Fig 4) to determine the minimum concentration (minimum inhibitory concentration, MIC) necessary to inhibit growth of the isolate. Again, the outcome is usually translated and reported into categories of susceptible, intermediate or resistant. The MIC can be used to adjust the dosing regimen in order to achieve optimal concentrations of the drug at the site of infection after taking into account the pharmacodynamics and pharmacokinetics for a particular drug. Interpretive criteria for equine isolates are, for the most part, unavailable and so often the categorisation of susceptible, intermediate or resistant are based on criteria used for human bacterial isolates.

The resistance profile can be referred to as the 'antibiogram' for the organism. Antibiograms can be useful as a first step in determining the relatedness of isolates (Hartman and West 1997); however, this method of comparing isolates is not nearly as precise as molecular typing techniques, such as pulsed field gel electrophoresis (PFGE) or ribotyping for making such comparisons but can give some general indication of the relatedness of isolates (Dunowska et al. 2007).

The Clinical Laboratory Standards Institute (Anon 2008c) publishes standards related to AMD susceptibility testing with periodic updates to these guidelines. These standard procedures for AMD susceptibility testing include quality assurance recommendations that relate to testing of isolates with known AMD susceptibility to assure that the testing methods being used return expected results. False reported resistance among Streptococcus equi ssp. zooepidemicus as a result of failure to use the appropriate quality assurance organisms in validation of the susceptibility testing illustrates the importance of laboratory compliance with recommended methods and performance of quality assurance testing using recommended organisms (Feary et al. 2005). For the aforementioned example, resistance of Streptococcus equi ssp. zooepidemicus of equine origin was reported to trimethoprim-sulpha by a veterinary diagnostic laboratory because of a failure to follow recommended guidelines for quality assurance testing of the blood agar being used.

**Mechanisms of bacterial resistance and examples of equine pathogens**

Most resistance among bacteria is either innate (inherent or intrinsic) or acquired. Innate, inherent or intrinsic resistance indicates resistance that is the norm for a type of bacteria and thus is present in all or most of the strains of that bacterial species. Inherent resistance occurs when there is low affinity of the drug for the target site in the organism (e.g. nalidixic acid and Enterococci), inability of the drug to reach the interior of the cell (e.g. glycocipptides and Gram-negative bacteria), active export of the drug (e.g. tetracycline and Pseudomonas aeruginosa), or inactive production of inactivating enzymes (e.g. β-lactamases in some members of the Enterobacteriaceae family) (Gaurabasri and Couvain 2006). Among the many examples of inherent (intrinsic) resistance is the resistance of Enterobacteriaceae to vancomycin and of Gram-positive bacteria to polymyxin B (Pescott 2000). In addition it is important to acknowledge that in vitro testing results do not necessarily equate to in vivo response. For example, Gram-positive bacteria may lose their cell wall and subsequently persist as the L forms, resulting in resistance to β-lactam antibiotics (Pescott 2000). Also, intrinsic resistance is exhibited by enterococci (Tannock and Cook 2002), as shown by their ability to exhibit in vitro and in vivo low-level resistance to many clinically useful AMDs such as β-lactams, aminoglycosides, trimethoprim sulpha, early quinolones, such as ciprofloxacin, and glycocyptides (Tannock and Cook 2002). This intrinsic resistance to several AMDs may have conferred a cumulative advantage on the enterococci for further acquisition of genes encoding for high-level resistance to other drugs. The mechanism for inherent resistance of enterococci varies by the type of AMD; for example resistance to β-lactams is by overproduction of low affinity penicillin binding protein. Furthermore, enterococci may appear susceptible to trimethoprim in vitro when using standard media devoid of folates; however, a 360-fold increase in the MIC may be seen when susceptibility testing is performed in media containing fresh urine (Wisell et al. 2008). The mechanism of the enterococci resistance to trimethoprim sulpha in
vivo is their unique ability to use preformed exogenous folates such as folic acid (Tannock and Cook 2002).

Acquired or exogenous resistance among bacteria is the result of acquiring genes from other bacteria that confer resistance rather than as a result of mutation (Guardabassi and Courvalin 2006). Genes that confer resistance can result in the production of enzymes that degrade or alter the antimicrobial, or code for altered configurations of cellular structures inhibiting binding site attachment of the antimicrobial, or code for structures that facilitate the export of antimicrobials from within the cell (Guardabassi and Courvalin 2006). Genes that confer resistance to antimicrobials can reside on plasmids which are mobile genetic elements that can move from cell to cell, or they can reside in the chromosome of the bacterium (Mascaretti 2003). Acquisition of new resistance genes by a bacterium is often accomplished by the movement of a plasmid from one bacterium to another via conjugation. Such transfer of plasmids can occur even among highly unrelated bacteria such as those from entirely different genera (Prascott 2000). Resistance genes can accumulate in specialized structures called integrons. The result of accumulation of resistance genes in an integron is that these resistance determinants are closely associated and therefore are transferred together to new host cells either vertically or via conjugation (Mascaretti 2003). Furthermore, selection pressure caused by exposure to any of the agents coded for in the integron tends to select for resistance to all the agents coded for in the integron (Guardabassi and Courvalin 2006). This process is called co-selection and can result in the persistence of resistance among a population of bacteria despite a lack of exposure to that antimicrobial agent for a prolonged period (Guardabassi and Courvalin 2006).

Multi-drug resistance (MDR) can be defined as resistance to at least 2 AMDs. Multi-drug resistance can be maintained or even selected for despite use of a narrow selection of AMDs. When resistance genes are present within integrons they are closely associated and tend to be selected for as a group rather than individually. This means that use of any of the drugs these genes encode resistance for tends to select for resistance to all the drugs (Guardabassi and Courvalin 2006). Furthermore, genes in the integron can code for resistance to products such as disinfectants raising the possibility that their use may select for resistance to AMDs. Comparison of the antibiogram along with results of other techniques such as pulsed field gel electrophoresis (PFGE) or ribotyping for isolates can be used in assessing the potential linkage between isolates (Hartmann and West 1997; Dunowska et al. 2007).

Two equine pathogens, multi-drug resistant salmonellae and methicillin resistant Staphylococcus aureus (MRSA) will be used to illustrate some points regarding AMD resistance. Multi-drug resistant salmonellae of several serotypes have been associated with equine clinical cases and in some situations with outbreaks. Many of these outbreaks have occurred in veterinary hospitals. An outbrea associated with Salmonella Infantis caused the closure of a veterinary teaching hospital in Colorado (Tillotson et al. 1997). As the outbreak progressed, the Salmonella Infantis isolates from later in the outbreak were determined to have broader resistance than those from earlier in the outbreak and to now only be susceptible to amikacin and enrofloxacin, complicating treatment in some cases. Other multi-drug resistant salmonellae infections in equids include those associated with serotypes Anatum (Hartmann and West 1997), Agona (Castor et al. 1989), Saint Paul (Powell 1988), Typhimurium (Weese et al. 2001) and Newport (Aceto et al. 2006). While most studies suggest that there is not increased virulence associated with MDR strains of Salmonella, there is some evidence to suggest that there is a linkage between multi-drug resistance and increased virulence among E. coli from pigs (Boerlin et al. 2005). At the very least the increased number of resistance attributes of these organisms can complicate the selection of appropriate antimicrobials to be used as either empirical treatments or treatments directed by susceptibility testing. Furthermore, a more limited spectrum of susceptibility may be associated with increased costs of care either due to prolonged courses of treatment while pursuing appropriate AMD treatment or due to increased expense of specific antimicrobials that might remain effective. Prior antimicrobial use has been implicated as a risk factor for acquisition of resistant Salmonella infections in man (Glynn et al. 2004) and horses (Hird et al. 1986).

Another concern associated with these outbreaks of multi-drug resistant organisms is the potential for transfer of resistance from the pathogen to commensal organisms or vice versa. For example, resistance genes potentially within an integron could be transferred between commensal E. coli and salmonellae. The concern is that these commensal E. coli could then become a covert reservoir of resistance genes for potential pathogens. Finally, the zoonotic potential for salmonellae must be recognised. Few of the equine salmonellosis outbreaks described in the literature have made specific reference to either the occurrence of or the search for human cases. But certainly human infections with these organisms would present similar clinical issues as are faced by veterinary clinicians in treating their equine patients.

A second equine pathogen that has been recognised relatively recently is MRSA. These organisms are often associated with wound infections, catheter infections or post operative infections and can be either hospital acquired (nosocomial) or community associated. MRSA infections are notable both because of the resistance to an AMD of expected efficacy for this organism and because of the zoonotic potential. By definition these MRSA organisms are resistant to methicillin and all other classes of β-lactam AMDs, which would include penicillin, ampicillin and the cephalosporins. However, frequently these organisms are also resistant to other AMDs. Again, more extensive resistance complicates the selection of an
appropriate AMD and may result in increased costs of care for these patients. The diagnosis of MRSA can present some special challenges in that some laboratories do not test for methicillin susceptibility and some strains may show weak reactions on some tests used for identification. As with Salmonella, there are additional methods for typing MRSA isolates that may be useful in investigating linkage of cases. These include PFGE and DNA sequencing of certain regions of the genome (Weese et al. 2005).

The zoonotic potential of MRSA infections has been highlighted in a few recent studies. In one, 13% of equine personnel were colonised with the same strain as seen in the horses on those premises. In a survey of veterinary personnel attending a large equine conference 10% of those sampled were colonised with MRSA (Anderson and Weese 2007). Human clinical disease due to MRSA infection has been reported in association with equine contact (Weese et al. 2005).

Options for good stewardship related to AMD use in equine patients

1. Assess the need for use of AMDs as a first step in judicious use. Be a visible resource of information for equine owners related to judicious use of AMDs for their animals. For example, the use of systemic AMDs in superficial wounds not involving a joint or tendon sheath or uncomplicated primary viral respiratory disease is unwarranted (Southwood 2006). Cleansing of superficial wounds by local lavage and if deemed necessary the use of a topical antimicrobial is probably adequate. For uncomplicated viral respiratory disease supportive treatment with ongoing monitoring would be indicated. Advising equine clients on the most appropriate management of such conditions would potentially have a major impact on the extent of AMD use. The CDC have produced information for the public related to viral respiratory disease and the lack of efficacy of AMDs in the treatment of such human infections (Fig 5). Development of more detailed guidelines for treatment of equine patients by equine veterinary associations along with the distribution of information related to judicious use of AMDs in equine patients to their owners by organisations with credibility related to equine health could assist practitioners in justifying most appropriate management of equine patients.

2. Perioperative AMD treatment should not be used to compensate for less than optimal sterility at surgery or for prolonged or traumatic surgical technique (Southwood 2006).

3. Ensure that perioperative drugs are dosed so that optimal tissue levels are present at the time of surgery, then determine the need for further AMDs based on the likelihood of infection (Southwood 2006).

4. Collection of samples to perform culture and susceptibility testing is optimal in any patient when bacterial disease is suspected; particularly in cases where the initial condition is severe or life threatening, where the condition has failed to respond to empiric treatment or where there is evidence of nosocomial infections occurring.

5. Implement a de-escalating antimicrobial regimen that involves initial treatment with broad spectrum antimicrobials in patients with life threatening or severe infections followed by a narrower spectrum of AMD(s) once results of culture and sensitivity testing are obtained.

6. Periodically assess AMD use practices as well as compile culture and susceptibility testing results. After comparison of these data, assess the need for any change in protocols for AMD use.

7. Ensure that equine clients have detailed instruction of proper handling, administration and dosing of prescribed AMDs.

8. Participate in clinical trials to assess if duration of treatment of nonbacteraemic equine patients can be shortened without compromising outcome of treatment. For example, studies of nonbacteraemic human patients have shown that treatment of ventilator-associated pneumonia for 7–8 days, pyelonephritis for 7 days, and community acquired pneumonia for 5 days is as efficacious as treatment with the more traditional 14–21 days of AMD treatment (Talan et al. 2000; Dunbar et al. 2003; Micek et al. 2004).

9. Practitioners could consider requesting that their professional veterinary organisations develop consensus statements regarding specific criteria regarding when the use antimicrobials is unnecessary and therefore not recommended.

References


