Methicillin-resistant *Staphylococcus aureus* (MRSA) is a critically important human pathogen and an emerging problem in equine medicine. It is associated with various opportunistic infections in horses, in both veterinary hospitals and the general population, and can be transmitted readily between horses and humans. MRSA isolates are resistant to β-lactam antimicrobials (penicillins, cephalosporins, carbapenems) because they have a gene (*mecA*) that encodes for production of a penicillin-binding protein with low affinity for all β-lactams. In addition, MRSA isolates are often resistant to other antimicrobials. In some situations, there may be few treatment options.

The incidence of MRSA infection in horses is unclear; however, anecdotally, it seems to be on the rise. MRSA is endemic in the equine population and can be carried by a small percentage (up to 5%) of healthy horses through colonization, mainly in the nasal passages.1–3 The ability of MRSA to reside in healthy horses can allow the organism to silently increase in a population, with opportunistic infections occurring sporadically or in outbreaks. People who work with horses, particularly veterinarians, have abnormally high rates of MRSA colonization (10% to 15%),4,5 and zoonotic infections have been reported.6,7

**Clinical Presentation**

Like methicillin-susceptible *S. aureus*, MRSA is an opportunistic pathogen that can cause a wide range of clinical presentations—from mild skin infection to rapidly fatal septicemia.1,6 Wound and surgical infections are most common,6,8,9 but MRSA needs to be considered as a possible cause of any opportunistic infection.

**Diagnosis**

The diagnosis of MRSA infection is relatively straightforward if culture specimens are collected and the diagnostic laboratory uses adequate procedures to identify MRSA. Identification of MRSA is critical for early implementation of appropriate treatment and infection control measures. The need for collecting appropriate culture specimens cannot be overemphasized. Swabs or samples should be collected from infected sites as early as possible in the disease process. To reduce the risk of contamination by commensal microflora, aseptic technique should be used when collecting samples from normally sterile sites.
Principles of Treatment
There has been no objective evaluation of different treatment approaches for MRSA infection in horses. Treatment decisions should be based on a variety of factors, including infection severity and location as well as antimicrobial susceptibility of the MRSA strain. Although MRSA receives much attention, it is important to remember that MRSA is still S. aureus, but just more resistant to antimicrobials.

Antimicrobial Therapy
In general, in vitro antimicrobial susceptibility results are reliable; however, a few points must be considered (Box 1). Fluoroquinolone susceptibility is commonly reported in vitro for equine MRSA6,8,9; however, response to fluoroquinolones is unpredictable in humans, despite in vitro susceptibility, and resistance can develop quickly, even during treatment. Therefore, fluoroquinolones are not considered appropriate for treating MRSA in humans, and there is no reason to think that the situation would be different in horses. Otherwise, antimicrobial choices should be made based on the antimicrobial susceptibility in conjunction with relevant factors, such as infection site (ability of the drug to penetrate), infection character (presence of organic debris), patient age, and patient health status (e.g., renal compromise).

Currently, there is typically at least one reasonable antimicrobial option for treating MRSA infection in horses. Chloramphenicol is commonly used because of its efficacy, cost, oral route of administration, and safety. The main concern regarding chloramphenicol is human health risks from exposure to the drug; therefore, it is important to ensure that farm personnel can safely handle the drug. Trimethoprim–sulfonamide susceptibility is uncommon in equine isolates,1,6,8 but when it is present, this drug combination is an excellent treatment option because it can be administered orally and is relatively safe for use in equine patients. Aminoglycosides may be effective in some situations, but resistance is common.1,6,8,9

Consideration of the infection site is important to ensure that the drug has a reasonable chance of reaching therapeutic levels at the site and is less likely to be inactivated by organic debris. In humans, drugs such as vancomycin and linezolid are commonly used. In addition to being expensive, use of these drugs in horses is controversial because of the importance of these drugs in human medicine and concerns about further emergence of antimicrobial resistance. It is questionable whether these drugs should be used in veterinary medicine; if they are used, it must be only when absolutely necessary.

Many MRSA infections may be amenable to local therapy, either as a sole or an adjunctive treatment. Topical application of antimicrobials such as mupirocin or fusidic acid could be effective in treating superficial infections, although there are concerns about emergence of resistance to these drugs. Topical application of antiseptic solutions such as 0.2% chlorhexidine digluconate or 1% acetic acid may also be useful. Other antibacterial compounds, such as tea tree oil, have anti-MRSA properties, but their in vivo efficacy is unknown.

Adjunctive Therapy
Adjunctive therapeutic measures, such as surgery, joint lavage, or fluid therapy, may play an important role in successful treatment of MRSA infection. The success of these therapies depends on the location and severity of the infection, not the presence of MRSA.

Colonization
It is logical to want to eliminate MRSA colonization because colonized horses are at increased risk of developing a clinical infection in certain situations and may be a source of infection for other horses or humans. However, the need for this approach and methods of decolonization therapy are unclear. Transient MRSA colonization seems to be the norm in horses, and most, if not all, horses eliminate MRSA colonization naturally if reinfection is prevented.10 Furthermore, there is no evidence that antimicrobial therapy is effective at eliminating MRSA colonization in horses.
and nebulized antimicrobials were ineffective in one uncontrolled study, and it is difficult to envision how to adequately treat the nasal passages of a horse with a topical antimicrobial, which is the standard approach in humans. Because colonization appears to be transient and antimicrobial use could further contribute to the development of resistance, the use of antimicrobials for active decolonization is not currently recommended. Colonized horses should be handled using appropriate infection control precautions and retested periodically to determine whether they are still colonized.

Infection Control
Careful application of infection control practices is important in reducing the risk of MRSA transmission from infected horses to other horses or to people who work with them (BOXES 2 AND 3). Additional measures, including active screening of horses to identify carriers, may be useful in some circumstances. Prudent antimicrobial use is also important.

Prognosis
It is important to understand that the prognosis for MRSA infection in horses depends more on the severity and location of the infection than on the fact that MRSA is involved, as long as MRSA is identified early and appropriate antimicrobial therapy is initiated. A recent multicenter study reported that 84% of horses with MRSA infection were discharged. This study did not compare this outcome with the outcome for infections caused by other bacteria but highlights the fact that treatment of MRSA infection is certainly not hopeless. With appropriate treatment, it is likely that the prognosis for MRSA infection is no different than that for infections caused by susceptible strains.

Conclusion
MRSA is an emerging problem that will, unfortunately, become more common in coming years.

Important Aspects of MRSA Control
- The use of contact precautions (gloves, protective outerwear) when handling infected animals
- Isolation of infected animals
- Careful attention to personal hygiene (especially hand hygiene)
- Proper application of routine cleaning and disinfection practices

Ontario Veterinary College MRSA Control Program
- All horses are screened for MRSA by nasal swab at admission, weekly during hospitalization, and at the time of discharge.
- Infected or colonized horses are isolated and handled with contact barrier precautions (i.e., gloves, gown, overboots).
- Gloves are worn when contact with mucous membranes, wounds, and possibly infected sites is expected and when invasive devices (i.e., intravenous catheters) are used.
- The diagnostic laboratory immediately contacts Infection Control when MRSA is isolated. The Infection Control practitioner then notifies all relevant personnel.
- MRSA isolates are saved and typed to provide more information about the epidemiology of MRSA in the hospital and community.
- Farms with a history of horses with MRSA are asked if they are interested in trying to eradicate MRSA through testing and infection control practices.
- People are not regularly screened for MRSA. The only indication to institute voluntary and confidential screening is when epidemiologic evidence of personnel-borne transmission exists and when improvements in infection control practices have not had an effect.

Critical Point
While MRSA infection appears similar to infections caused by susceptible bacteria, treatment of MRSA infection is complicated by limited antimicrobial options. Prompt diagnosis by culture and susceptibility testing and early implementation of appropriate treatment are critical.

Have something to say about this topic? Let us know:
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A combination of good infection control and prudent antimicrobial use may limit the effect of this pathogen in horses and their human contacts, but the ability of MRSA to reside in the nasal passages of healthy horses makes eradication of MRSA from the equine population unlikely. However, despite the potential severity of MRSA infection, most infections are treatable with prompt diagnosis and implementation of a logical treatment regimen.

**References**