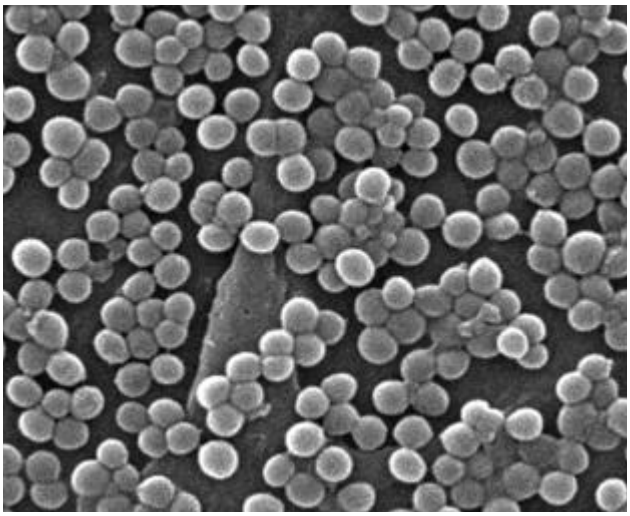
Methicillin- resistant Staphylococcus aureus

A Growing Concern for Animal and Human Health

Introduction

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major human pathogen, having emerged first in hospitals during the 1970's and then expanding into a worldwide public health problem. Now MRSA is becoming an animal health threat, too.

Scanning electron micrograph of MRSA – magnified 9560x



Source: CDC Public Health Image Library

Over the past decade, a growing number of MRSA cases have been reported in companion and food animals and in their human associates, including pet owners, farmers and veterinary personnel [2, 11, 15, 20, 22, 25, 29, 33, 36]. MRSA in animals was first detected in milk from cows with mastitis [6] and since then has been found in dogs, cats, horses, pigs, sheep, rabbits, chickens, and several exotic species [15, 20].

The evolution of MRSA and other drug-resistant pathogens has been linked to extensive antibiotic use in medicine and food animal production [15, 16]. MRSA strains have acquired resistance to the beta-lactam class of antibiotics, which includes penicillin and derivates such as methicillin, oxacillin, and amoxicillin. Beta-lactam resistance is promoted by the mecA gene, which expresses a protein in the bacterial cell wall that has a weak affinity for beta-lactam antibiotics. Most MRSA isolates are also resistant to other antimicrobial classes, and some multi-drug resistant forms are extremely difficult to treat, requiring new or experimental drugs. A number of MRSA strains also produce specific virulence factors that disable immune system responses, leading to more serious diseases and even death [21, 30].

MRSA in Humans

S. aureus is a common species of bacteria living on the skin and mucous membranes of humans and other animals. An estimated 25-30% of people in the United States carry *S. aureus* in their nasal passages [3]. Usually the bacteria are benign, but they can cause disease when they enter the body through breaks in the skin or mucosal lining.

MRSA can produce a host of conditions ranging from mild to severe skin infections to fatal pneumonias and bacteremias. In the United States, the prevalence of MRSA among staphylococcal infections in intensive care units rose from 2% in 1974 to 64% in 2004 [3]. Similar patterns have arisen in other countries [15]. Recently, a string of MRSA outbreaks in U.S. schools, including the death of a student, drew widespread public attention. Community-associated MRSA now ranks as the leading cause of skin and soft tissue infections resulting in trips to U.S. emergency rooms [18, 30].

MRSA infections are classified primarily as healthcare associated (HA-) or community associated (CA-) based on origin, phenotype, and genotype. HA-MRSA generally causes invasive disease following surgery or other medical procedures and is often multi-drug resistant. In contrast, CA-MRSA cases have consisted primarily of skin and soft tissue infections in otherwise healthy people with no recent healthcare exposure. CA-MRSA infections are typically susceptible to a broader range of antibiotics than HA-MRSA infections.

MRSA in Companion Animals

Since the 1990's, a growing number of studies have documented MRSA infections in animal patients at veterinary hospitals, often accompanied by identical strains of MRSA isolated from human associates. Research in Europe found matching strains of MRSA in dogs, cats, and veterinary staff [2, 20] as did a Canadian study which also recovered identical MRSA isolates from owners and their infected pets [34]. The predominance of human MRSA strains in household pets suggests that animals become colonized through contact with infected or colonized people, and that pets could in turn pass MRSA back to humans or other species [15, 34].

Similarly, equine studies in North America and abroad have reported MRSA infections in hospitalized horses over the past two decades [1, 2, 24, 31]. In some cases, healthy human contacts of these horses have carried MRSA in their nasal passages [4, 20, 22, 33, 35]. Horses may also carry MRSA without being ill; nasal colonization rates of 0-5% have been reported in the general horse population although MRSA prevalence on some farms has exceeded 50% [32]. Problems can arise when horses pass MRSA on to other horses or to people.

Equine workers seem to be at relatively high risk of contracting MRSA; a recent Canadian survey found that 14% of equine veterinary contacts and 12% of people working with horses on a farm were colonized with MRSA [33]. As with dogs, the majority of clinical MRSA cases in horses have been wound and post-operative infections [15, 20, 22, 33, 34, 35]. It is noteworthy that the predominant MRSA strains isolated from horses and equine workers differed from the MRSA strains typically shared by dogs, cats, and their human associates [2, 4, 15, 20, 33].

MRSA in Food Animals and Products

Although MRSA has occasionally been reported in cattle [14, 17], most of the concern right now focuses on the swine industry. In a recent study of 20 Ontario pig farms, MRSA-colonized pigs were found on 45% of the farms and prevalence of MRSA in pigs was 25% [11]. The MRSA carriage rate among pig farmers was 20%, with individuals affected on more than half the farms where MRSA was detected in pigs. Humans on farms without MRSA in pigs did not test positive for MRSA. Likewise, a recent survey in the Netherlands found MRSA in nearly 40% of pigs and on more than 80% of pig farms [5]. In another study, Dutch pig farmers were estimated to be 760 times more likely than the general public to be colonized with MRSA [29].

MRSA-colonized pigs in the Netherlands were implicated as a source of infection which spread to farmers, their families, and hospital staff [9, 29]. Most of the swine and human MRSA isolates in Europe and Canada were sequence type (ST) 398, suggesting that this particular MRSA clone (family) may be especially capable of colonizing pigs and transferring to people [11]. Some of these infections can be severe [7, 11, 36]. A recent study in the Netherlands found that swine-associated MRSA cases were twice as likely as non-swine related cases to be admitted to hospitals [28]. Besides health risks to pig personnel, MRSA has been linked to exudative dermatitis in pigs [26] raising concerns for potential impacts on swine health [11]. MRSA in pigs may be more widespread than recognized; in addition to Canada and the Netherlands, MRSA has been reported in swine populations in France, Denmark and Singapore [8, 11, 23].

Although *S. aureus* is among the leading causes of food-borne bacterial infections [19] MRSA appears to be relatively rare in foods originating from animals. Two studies detected MRSA in less than 1% of meat, milk and cheese samples [14, 19] and a third found it in less than 3% of meat samples [27]. Food-borne MRSA outbreaks have occurred through contamination by infected food handlers [10, 13], but such risks can be minimized by pasteurization and proper food handling.

Consequences for Animal and Human Health

Although the recent increase in MRSA cases among animals may be partly due to greater awareness and testing, it is evident that MRSA infection is an important emerging disease in dogs, cats, and horses [15, 33] and in pigs [11, 28, 29]. The growing prevalence of MRSA in some occupations and exposure groups is troubling, especially in light of evidence that MRSA moves freely between animals and humans. In 2005, it is estimated that MRSA may have caused more deaths than HIV/AIDS in the United States [12]. While the majority of invasive MRSA cases had healthcare risk factors, such as hospital or nursing home stays, this could change if new foci of MRSA continue to emerge.

MRSA has been isolated from horses on several continents and evidence supports both human-to-horse and horse-to-human transmission [33, 35]. The emergence of MRSA as an equine pathogen, coupled with the extensive movement of horses within and between the United States and Canada, could lead to wider distribution of MRSA among equine populations [33]. In fact, MRSA may already be more widespread than recognized, not only in horses but also in other companion animals, especially dogs and cats. Given the close contact between people, their pets, and animal workers, the role of companion animals as potential reservoirs of MRSA infection in humans deserves further research. Several U.S. veterinary teaching hospitals are beginning to explore this issue.

Surveys have not been conducted to determine the prevalence of MRSA in U.S. swine and other food animals. MRSA has emerged in swine herds in Canada and Europe [5, 8, 11] and considering the extensive international transport of pigs, MRSA could be more widespread in swine than recognized [28]. Recent studies have shown that persons working or living in close contact with pigs have a much greater risk than the general public of becoming colonized or infected with MRSA [9, 28, 29]. Yet, apart from such high-risk exposure groups, it is not known how MRSA in pigs, and perhaps other food animals, could affect public health in the broader sense. In addition, there is evidence that MRSA may pose a risk to swine health [11]. As a first step, the U.S. pork industry has funded research to determine if MRSA is present in U.S. swine herds.

Despite a lack of basic research on the epidemiology of MRSA, it is likely that crowded living conditions and close contact between people and their animals have played major roles in the spread and persistence of MRSA on farms, in homes, and in veterinary clinics. Many common disease control practices used to protect public health may apply equally well to controlling MRSA

at the animal-human interface. Proper hand washing, together with cleaning and disinfection of contaminated surfaces, are simple and effective mitigation measures that can be used to reduce MRSA risk in most situations. Depending on the circumstances, additional biosecurity measures could include screening of animals and animal care staff for MRSA, isolation of suspect cases, and strict asepsis during surgery [15]. Prudent use of antibiotics is also warranted given the prevalence of antimicrobial resistance and its impact on human health.

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