

Evaluation of methicillin-resistant *Staphylococcus aureus* (MRSA) colonization in pigs and people that work with pigs in Ontario Veterinary College

Final Report – September 2007

This research has been possible through the financial support of Ontario Pork and the Canada-Ontario Research and Development (CORD) Program, an initiative of the federal-provincial-territorial Agricultural Policy Framework designed to position Canada's agri-food sector as a world leader. The Agricultural Adaptation Council administers the CORD Program on behalf of the province.

Executive Summary

Methicillin-resistant *Staphylococcus aureus* (MRSA) is an important cause of disease in people and certain animal species. Often termed a 'superbug', MRSA is a highly drug resistant bacterium that is an important cause of infections in hospitals and in people in the general population. Recent evidence from Europe has identified a link between carriage of MRSA in pigs and MRSA infection and carriage by people that work with pigs. Further, there is now evidence that MRSA may also cause disease in pigs. This study evaluated MRSA carriage by pigs and pig farmers in a group of farms in Ontario. MRSA carriage by pigs was common, with MRSA being found on 45% of farms and in 25% of pigs. The rate of MRSA carriage by pig farmers was very high (25%). However, none of these people or pigs had evidence of an MRSA infection. The main MRSA strains found in pigs and people were the same that have been found in pigs in Europe. There is currently minimal concern about MRSA as a cause of foodborne disease, and the concerns regarding MRSA in pigs mostly relate to people that have contact with pigs. In Europe, there are concerns that pigs may be a source of human MRSA infections. The role of pigs in human disease in Canada is unknown and requires further study. While the widespread presence of MRSA in this study is concerning, it is important to realize that it is unclear whether this is a new finding (ie MRSA has just emerged in pigs in Ontario) or whether this has been present undetected for years. While MRSA infection may be an occupational risk for people that work with pigs, further study is required to determine whether this is truly a significant concern and what measures should be taken to reduce any risks.

Objectives

- 1) To determine the prevalence of MRSA colonization of pigs in Ontario.
- 2) To compare sites of colonization in pigs, to facilitate design of screening programs.
- 3) To determine the prevalence of MRSA colonization of pig farmers.
- 4) To compare MRSA isolates from pigs with their human contacts (pig farmers) and to compare porcine and pig farmer isolates with MRSA from humans and other animals in North America and Europe.

Background

Methicillin-resistant *S. aureus* (MRSA) is a critically important cause of illness and death in people. Recently, there has been increasing evidence that MRSA may be

transmitted between animals and humans, on both directions. Much attention has been paid recently to the potential role of pigs in human MRSA infections, particularly risks for pig farmers, pig veterinarians and their families. Various studies from Europe have identified high rates of MRSA carriage by people that have contact with pigs, and have identified MRSA infections that are linked to pigs. The association is so strong that in some countries, people with pig contact are considered MRSA infected until proven otherwise and are isolated upon admission to hospital. Therefore, there is significant concern about MRSA being an occupational risk in people that have contact with pigs. There has been no investigation of MRSA in pigs in North America, and therefore there is no information regarding whether this may be a similar concern in Ontario.

Study Overview

A cross-sectional prevalence study was conducted, based on a convenience sample of 20 pig farms from south-western Ontario, Canada. Nasal and rectal swabs were collected from pigs of three different age groups (suckling pigs, weanling pigs and grower-finisher hogs). Whenever possible, five pigs from each age group were selected using a convenience sampling scheme that avoided sampling more than one pig in co-mingled groups. At the same time as pigs were sampled, nasal swabs were collected from all consenting individuals working on the farm. A brief questionnaire regarding possible risk factors for MRSA colonization was also administered to participating farm personnel.

Swabs were cultured for MRSA using standard methods. Isolates were typed using pulsed field gel electrophoresis (PFGE) and spa typing.

Results

Nasal and rectal swabs were collected from 285 pigs: 85 (30%) suckling pigs, 95 (33%) weanlings and 105 (37%) grower-finishers. MRSA was isolated from one or more pigs on 45% (9/20) of farms. The overall prevalence of MRSA colonization in pigs was found to be 25% (71/285); 20% (17/85) in suckling pigs, 28% (27/95) in weanlings and 26% (27/105) in grower-finishers. There was not a significant difference in prevalence between the different age groups ($P=0.41$). Of farms where at least one pig was colonized, the prevalence ranged from 6.6% to 100% (mean= 58.8% and median= 70%). Results from nasal and rectal samples were found to be significantly different ($P=0.0001$), with 16% of pigs positive only on nasal swabs, 7.4% of pigs positive at both nasal and rectal samples, and only 1.4% positive at the rectal but not nasal swabs. All of those that tested positive only on rectal sites were weanlings.

The prevalence of MRSA colonization in humans was 20% (5/25), with colonized individuals being present on 5/9 (56%) of farms where MRSA was present in pigs. No humans tested positive on farms where MRSA was not detected in pigs. The Spearman correlation coefficient between farms with positive pigs and positive humans on the farm was 0.63 ($P= 0.0025$), indicating a significant association between the presence of colonized pigs and colonized humans on a farm. None of the risk factors identified in the questionnaire were found to have a significant association with human MRSA colonization. Of the five humans who were colonized, all had contact with one or more animal species, one had participated in team sports and none had a history of antimicrobial use, hospitalization or other putative risk factors. Of the twenty people who

tested negative, all were in contact with one or more animal species, none had a history of recent hospitalization, two had been treated with antimicrobials, four participated in team sports, two had been diagnosed with soft tissue infections and three had family members who had recently been admitted to hospital.

Ten different *spa* types were identified. Between 1 and 4 different *spa* types were identified on individual farms, with a mean of 2 types per farm and a median of one. The most common strain in both pigs and humans was *spa* type 539 (Ridom t034). The second most common strain was a similar *spa* type, with the difference being a deletion of a series of repeats in the less common strain. One other strain (*spa* type 109/Ridom t571) differed from *spa* type 539 by deletion of only one repeat. Combined, these closely related strains accounted for 75% (53/71) of pig isolates and 80% (4/5) of human isolates. The second most common group consisted of *spa* type 2 or related strains (*spa* type 2/ Ridom t002, *spa* type 268/ Ridom t067, *spa* type 387/ Ridom t653) which accounted for a further 14% (10/71) of pig isolates and the remaining human isolate. Four other *spa* types were identified, with three being similar. On all farms with colonized humans, one or more pigs were identified as carrying the same strain as the colonized human. On the 3 of the 4 farms with colonized pigs but no colonized humans the prevalence in pigs was low, with only 1-3 colonized pigs identified. The prevalence of colonization in pigs on the remaining farm was 47%.

All *spa* type 539 and related strains were untypeable by PFGE. *Spa* type 2 and related strains were classified as Canadian epidemic MRSA-2 (CMRSA-2), also known as USA100 (Christianson et al., 2007). The remaining *spa* types had unrelated PFGE patterns that were not consistent with recognized Canadian epidemic clones.

Milestones

All milestones outlined in the proposal have been completed.

Publications

A manuscript has been submitted for publication in *Veterinary Microbiology*.

Presentations

Results have been presented at the following conferences:

- American Veterinary Medical Association Conference, Washington DC, July 2007
- Saskatchewan Veterinary Medical Association Conference, Regina, Sept 2007
- Intersciences Conf on Antimicrobial Agents and Chemotherapeutics, Chicago, Sept 2007

Results will also be published in the University of Guelph newsletter *Pig Pens* and an article will be submitted to *Better Pork* magazine.

Results will be presented at the following conferences:

- European Conference on Clinical Microbiology and Infectious Diseases, Barcelona, April 2008

- ASM Meeting on Antimicrobial Resistance in Zoonotic Pathogens, Copenhagen, June 2008.

Discussion

This is the first study to identify MRSA colonization in pigs and people that work with pigs in North America. The high prevalence of colonization both at the farm level and the individual pig level on most farms where MRSA was present, was striking. On many farms, most or all tested pigs were colonized, however on some farms only a small number of pigs were colonized. It is unclear whether there are differences in management on farms associated with this variation. It would be interesting to re-test low prevalence farms to determine whether the prevalence of MRSA colonization has increased, as it is possible that the low prevalence could indicate recent introduction of MRSA.

The predominance of the MRSA strain that is present in pigs and people that work with pigs in Europe was somewhat unexpected. Unlike many other animal species, trans-Atlantic movement of pigs is extremely rare and the finding of this clone in Canada raises questions about its origin. Movement of pig farmers and veterinarians is more common, and it is possible that humans were responsible for introduction of this strain into pigs in Canada as independent emergence of this clone in both continents is extremely unlikely. This hypothesis can not be proven, however. There is no way to determine how long this strain has been in pigs in Canada. In Canada most typing involves PFGE and PFGE non-typeable strains are extremely uncommon so it is probable that this strain has not been significantly associated with disease in humans in this country. However, the experience in Europe is that they first found that strain of MRSA in pigs and people that work with pigs, then encountered sporadic MRSA infections in people in contact with pigs, then recognized sporadic MRSA infections in other people, followed by larger outbreaks. Therefore, it is possible that we are just recognizing the emergence of this strain.

This study provides further support to the hypothesis that MRSA can be transmitted between humans and pigs. Although direct comparison cannot be made because a control group was not used in the assessment of human colonization, the prevalence of colonization in pig personnel (20%) was quite high and is much greater than has been reported in the general population in North America. For example, a study using data from the 2001-2002 National Health and Nutrition Examination Survey (NHANES) in the United States estimated a population colonization rate of only 0.84%. Further, a study of science teachers performed in Ontario, Canada at the same time as this study only identified MRSA colonization in 2.7% of individuals. Therefore, it is likely that personnel working with pigs are at higher risk for MRSA colonization compared to the general Canadian population, as has been reported in the Netherlands.

Risk factors for MRSA colonization in humans could not be determined in this study because of the small sample size. Studies of larger size are required to determine whether there are any modifiable risk factors that could be addressed with routine infection control or management practices to reduce the risk of MRSA acquisition by pig personnel.

In addition to public health risks to pig personnel, there are other potential concerns regarding the emergence of MRSA in pigs. *Staphylococcus aureus* is not typically regarded as a pathogen in pigs, and even with a high prevalence of MRSA colonization in pigs, clinical infections have not been widely reported in this species.

However, a recent report implicating MRSA in exudative dermatitis in pigs raises potential pig health concerns.

Because pigs are food-producing animals, there are inherent concerns about contamination of food. Staphylococcal food poisoning caused by MRSA has been reported but is very uncommon. Recently, MRSA was identified in food products intended for human consumption, but none were pig-in-origin. Further study regarding the potential for food borne disease is warranted, but the risks are likely low.

The reasons for the high prevalence of MRSA colonization in pigs both in Canada and in other countries remain uncertain. The presence of similar strains in pigs and their human contacts, the high prevalence of colonization of pig farmers and the possible emergence of ST398 strains as a cause of clinical infections in humans indicates that MRSA in pigs may pose a public health risk to human contacts. Further information is required to identify and implement control measures to reduce the impact of this emerging pathogen of public health concern.

Conclusion

This study is the first to identify MRSA in pigs in North America. This is an important finding, particularly for pig farmers and other individuals with contact with pigs. As reports of MRSA infections in pig farmers, their families and other people in contact with pigs continue to emerge in Europe, it is important to determine whether similar risks are present in North America. Identifying MRSA in pigs in Ontario has provided an early warning about the potential for MRSA to become a problem in people that work with pigs, and the general public. This may allow for a faster, more proactive approach towards investigating this potential problem. Further, a recent report has implicated MRSA in disease in pigs, suggesting that there may be pig health and production concerns. Early identification of MRSA in Ontario will also allow for better monitoring to determine whether pig disease is a concern. Overall, this study has provided needed information on the presence of epidemiology of MRSA in pigs and people that work with pigs. These results will provide a foundation for various studies aimed at better characterizing MRSA in pigs and reducing the risk of transmission of MRSA between pigs, and between pigs and humans.