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SELF-REPORTED METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* INFECTION IN USA PORK PRODUCERS

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Abstract: Pork producers selected from the National Pork Board's producer database were surveyed. Five (3.7%) reported being diagnosed with a MRSA infection. Risk factors related to swine farm biosecurity were examined. None were statistically significant predictors of MRSA infection.

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INTRODUCTION

Methicillin-resistant Staphylococcus aureus (MRSA) is increasingly found in the community, although it once was known primarily as a cause of hospital-acquired infection [4]. Overall, 1.5% of the United States general population is colonized with MRSA [5]. Recently, nasal colonization of humans with occupational exposure to livestock has been documented in Europe, North America, and Asia [2, 3, 6, 11, 14, 16, 17]. This has led to the recognition of a new MRSA type with distinct epidemiological and ecologic characteristics.

Livestock-associated (LA-MRSA) has been recognized as a potential pathogen in pigs and pork production workers. In the Netherlands, the prevalence of MRSA in pig farmers is estimated to be 29% [13], compared to a general population prevalence of approximately 0.1% [12, 15]. We conducted a survey to determine if USA pork producers report MRSA skin infection or soft tissue infection (SSTI) in their pigs and workers, and to examine potential risk factors for infection related to swine farm biosecurity, including shower, clothing, laundry, and hygiene practices.

MATERIALS AND METHODS

Pork producers were identified from the National Pork Board's (NPB) producer database and surveyed by paper and e-mail questionnaires. The database contains over 43,000 pork producers that receive the Pork Checkoff's seasonal report and have a current hog count, or are Pork Quality Assurance Plus certified (PQA Plus® is a pork industry continuous improvement program designed to enhance food safety and to ensure that USA pork producers can measure, track, and improve animal well-being) [1]. Samples sizes were based on the guidelines set by Krejcie and Morgan [8]. Because we expected a low response rate, 800 pork producers were randomly selected for the study.

We based our selection of potential risk factors for this study (shower, clothing, laundry, and hygiene-associated practices) on analogous factors previously associated with MRSA infection in epidemiological studies of athletes. These included direct contact with infected wounds and sharing of contaminated personal items, clothing, and equipment [7, 9].

The survey collected information on job type and farm type/production phase (based on pre-defined NPB

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categories); hog count; showering procedures; farm-specific clothing (clothing worn only while working on the farm); laundry procedures; personal hygiene; and diagnosed antibiotic-resistant SSTI (including MRSA) in pigs and workers.

The survey was mailed in November 2008. Twenty-one surveys (2.6%) were returned for failure to deliver, and 17 (2.1%) respondents indicated that they were no longer involved in hog production. Of the remaining 762 surveys, 85 (11.1%) were completed and returned via mail. In July 2009, an e-mail version of the survey was mailed to all 800 selected producers. Because the survey was conducted anonymously, investigators could not determine which producers had previously filled out the paper survey; however, producers were instructed not to submit the e-mail version if they had previously submitted a paper version. Two e-mail reminders were sent at two-week intervals, with the last being in August 2009. Overall, 536 producers had valid email addresses; 50 (9.3%) responses were received. From paper and e-mail responses combined, 135 (17.2%) surveys were received from 783 pork producers who indicated they were actively farming hogs. The true response rate could range from 10.9%–17.2% depending on the number of repeat responses that were received via e-mail.

Pork producer characteristics for e-mail and paper respondents were compared, and potential risk factors for MRSA infection were investigated using the Fisher's exact test. Multivariate modelling of risk factors was performed by exact logistic regression. A significance level of 0.05 was used in the analyses. Statistical analyses were performed using SAS software version 9.2 (SAS Institute, Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

MRSA infection in pigs and pork production workers was assessed by a series of questions that focused on veterinarian-diagnosed skin infections in pigs and physician-diagnosed skin infections in workers. Four (2.9%) respondents indicated they had pigs diagnosed with antibiotic-resistant skin infections. The definitive cause of these infections was unknown. Five (3.7%) respondents reported a history of physician-diagnosed MRSA SSTI. One additional antibiotic-resistant infection was reported, but the cause was undiagnosed.

Bivariate modelling revealed several potential risk factors for MRSA infection in workers, including working as a veterinarian ($p=0.08$), large farm operations ($p=0.19$ for farms with at least 10,001 sows or 200,001 finisher marketed per year; $p=0.10$ for farms with more than 25,000 sows or 500,000 finishers marketed per year), separating work laundry from other types ($p=0.11$), and having workers who express concern regarding MRSA ($p=0.02$). However, in the final model none of these risk factors were found to be significant ($\alpha=0.05$). Similarly, no significant risk factors were identified for veterinarian-diagnosed antibiotic-resistant infections in pigs.

Table 1. Characteristics of pork producers.

Variable	Respondent types					
	E-mail		Paper		Total	
	N	%	N	%	N	%
Job type[a]						
Owner/operator	23	46.0	–	–	23	17.0
Company officer	0	0.0	–	–	0	0.0
Production manager	9	18.0	–	–	9	6.7
Site/farm grower	1	2.0	–	–	1	0.7
Contract grower	2	4.0	–	–	2	1.5
Production worker	0	0.0	–	–	0	0.0
Veterinarian	1	2.0	–	–	1	0.7
Nutrition/ Pharmaceutical Rep	0	0.0	–	–	0	0.0
Consultant	3	6.0	–	–	3	2.2
Other	9	18.0	–	–	9	6.7
No answer	2	4.0	85	100.0	87	64.4
Total	50	100.0	85	100.0	135	99.9
Farm type[b]						
Sow farm	30	60.0	48	56.5	78	57.8
Nursery	31	62.0	48	56.5	79	59.0
Finisher	38	76.0	62	73.0	100	74.0
Other	2	4.0	2	2.4	4	3.0
No answer	2	4.0	1	1.2	3	2.2
Farm size[c]						
<50 or <1000	9	18.0	9	10.6	18	13.3
51–250 or 1001–5000	9	18.0	24	28.0	33	24.4
251–500 or 5001–10,000	2	4.0	10	12.0	12	8.9
501–2500 or 10,001–50,000*	4	8.0	21	25.0	25	18.5
2501–10,000 or 50,001–200,000	4	8.0	12	14.0	16	11.9
10,001–25,000 or 200,001–500,000*	4	8.0	1	1.2	5	3.7
25,000+ or 500,000+	13	26.0	4	4.7	17	12.6
No answer	5	10.0	4	4.7	9	6.7
Total	50	100.0	85	100.2	135	100.0
OHS professional[d]						
Yes*	16	32.0	8	9.4	24	17.8
No	33	46.0	75	88.2	108	80.0
No answer	1	2.0	2	2.4	3	2.2
Total	50	100.0	85	100.0	135	100.0

* Significant difference between e-mail and paper respondents using Fisher exact ($\alpha=0.05$); [a] Job type for e-mail respondents only; [b] Farm type not exclusive; [c] Size in number of sows or number of finishers marketed per year; [d] OHS = Occupational health and safety.

Pork producer characteristics, including job type, farm type, and farm size are shown in Table 1. Information on biosecurity-related practices is shown in Table 2. Most premises (71%) had showers available for workers, but less than half of respondents required workers to shower-in and shower-out. Soap was provided by only two-thirds of producers, and more than half of the respondents shared soap. About one-third of producers had a cleaning schedule for shower facilities; showers were cleaned daily in about 4% of operations and weekly in about 24%. Only 24% of respondents used bleach solutions to clean their showers and few (9%) indicated that shower cleaning is documented.

Nearly two-thirds of workers wore farm-specific, individual clothing. Laundry facilities were reportedly on-site in 60% of locations, but few respondents had policies on laundering frequency (35%) or technique (32%). Laundry was done daily at 36% of farms, and weekly at about 4%.

Hand washing policies were reported by less than half of producers. About 58% of respondents indicated that workers were encouraged to report cuts, scrapes, and wounds to their supervisors, and 72% said that workers were advised to cover wounds. An alcohol-based hand sanitizer use was reported by less than half of respondents.

The number of MRSA infections reported here may be underestimated. Pork producers may not seek medical treatment, or infections may be misdiagnosed by rural physicians. Some producers may not want to disclose MRSA infections in workers or pigs due to fear of identification. We conducted the survey anonymously to reduce the likelihood of this.

The NPB producer database was extremely useful for this study; however, it contains many smaller to mid-size pork producers. Currently, 27 hog producing operations in the USA have 43% of the market share, and these operations each raise more than 500,000 market hogs per year [10]. In our study, only 12.6% of respondents indicated that they raise more than 500,000 market hogs per year. Similarly, 46.6% of our respondents raised fewer than 10,000 market hogs per year, yet they only represent 15% of the market share. Therefore, caution should be used in interpreting these results for the pork industry at large.

Table 2. Biosecurity-related practices among pork producers.

Variable	Respondent types					
	E-mail		Paper		Total	
	N	%	N	%	N	%
Showers						
Shower available on premises for workers	32	64.0	64	75.3	96	71.1
Company has shower-in and shower-out policy	21	42.0	41	48.2	62	45.9
Soap is provided to employees in shower	28	56.0	60	70.6	88	65.2
Liquid soap is used primarily	22	44.0	43	50.6	65	48.1
Soap is shared among employees	28	56.0	45	52.9	73	54.1
Shampoo is shared among employees	21	42.0	51	60.0	72	53.3
Company has cleaning schedule for showers	18	36.0	29	34.1	47	34.8
Showers are cleaned daily	4	8.0	1	1.2	5	3.7
Showers are cleaned weekly	11	22.0	21	24.7	32	23.7
Showers are cleaned with bleach solution	13	26.0	19	22.4	32	23.7
Shower cleaning is documented by workers	6	12.0	7	8.2	13	9.6
Clothing						
Workers have individual, farm-specific clothing	25	50.0	54	63.5	79	58.5
Workers share farm clothing	19	38.0	29	34.1	48	35.6
Workers have individual, farm-specific boots and socks	25	50.0	56	65.9	81	60.0
Workers share farm boots and socks	21	42.0	35	41.2	56	41.5
Workers share towels	31	62.0	34	40.0	65	48.1
Laundry						
Laundry facilities located on farm site	21	42.0	60	70.6	81	60.0
Company has policy on how to launder properly	17	34.0	26	30.6	43	31.9
Company has policy on laundry frequency	17	34.0	30	35.3	47	34.8
Laundry is done daily	21	42.0	27	31.8	48	35.6
Laundry is done weekly	4	8.0	2	2.4	6	4.4
Work clothing is separated from other laundry	27	54.0	48	56.5	75	55.6

Table 2 (continuation). Biosecurity-related practices among pork producers.

Variable	Respondent types					
	E-mail		Paper		Total	
	N	%	N	%	N	%
Hygiene						
Company has policy on hand-washing	24	48.0	31	36.5	55	40.7
Company has policy on wound/abrasion care	16	32.0	30	35.3	46	34.1
Cuts/scrapes/wounds are reported to supervisors	32	64.0	46	54.1	78	57.8
Workers advised to cover open wounds	36	72.0	61	71.8	97	71.9
Alcohol-based hand sanitizer provided to workers	21	42.0	29	34.1	50	37.0
Other						
Company has infectious disease prevention policy*	16	32.0	13	15.3	29	21.5
Kitchen space is separate from shower area	31	62.0	48	56.5	79	58.5
Kitchen space is separate from barn area	30	60.0	54	63.5	84	62.2
Barn has been tested for antibiotic-resistant bacteria	2	4.0	4	4.7	6	4.4

*Significant difference between e-mail and paper respondents using Fisher exact ($\alpha = 0.05$)

This study shows that USA pork producers are self-reporting low levels of MRSA SSTI; however, we cannot determine whether livestock-associated or human-associated strains are the cause. Future collaboration with rural physicians could provide clinical samples from pork production workers and enable molecular typing to occur.

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