Brief communication

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# A four-year summary of air filtration system efficacy for preventing airborne spread of porcine reproductive and respiratory syndrome virus and *Mycoplasma hyopneumoniae*

Scott Dee, DVM, MS, PhD, Diplomate ACVM; Andrea Pitkin, BS, MS; Satoshi Otake, DVM, PhD; John Deen, DVM, PhD, Diplomate ABVP

## Summary

A 4-year study evaluated the ability of commercial air filters to protect susceptible populations against airborne transmission of porcine reproductive and respiratory syndrome virus and *Mycoplasma hyopneumoniae*. All filter types equally reduced the risk of airborne transmission of both pathogens, compared to non-filtered controls, supporting further application in the field.

**Keywords:** swine, porcine reproductive and respiratory syndrome virus, airborne, transmission, filtration

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**Resumen - Un resumen de cuatro años sobre la eficacia del sistema de filtración de aire para prevenir la propagación aérea del virus del síndrome reproductivo y respiratorio porcino y del *Mycoplasma hyopneumoniae***

Un estudio de 4 años evaluó la habilidad de filtros de aire comerciales para proteger a las poblaciones susceptibles contra la transmisión aérea del virus del síndrome reproductivo y respiratorio porcino y del *Mycoplasma hyopneumoniae*. Todos los filtros redujeron de manera similar el riesgo de transmisión aérea de ambos patógenos, comparado con los controles no filtrados, apoyando su implementación en el campo.

**Résumé - Bilan de quatre années d'évaluation de l'efficacité d'un système de filtration d'air à prévenir la transmission aérienne du virus du syndrome reproducteur et respiratoire porcin et de *Mycoplasma hyopneumoniae***

Une étude d'une durée de quatre années a permis d'évaluer la capacité de filtres à air commerciaux à protéger les populations susceptibles contre la transmission aérienne du virus du syndrome reproducteur et respiratoire porcin et *Mycoplasma hyopneumoniae*. Tous les types de filtres ont réduit de manière égale le risque de transmission aérienne des deux agents pathogènes, comparativement aux témoins exposés à de l'air non-filtré, militant ainsi en faveur d'une application ultérieure au niveau du terrain.

In today's global swine industry, control and elimination strategies for porcine reproductive and respiratory syndrome virus (PRRSV) and *Mycoplasma hyopneumoniae* (M hyo) are crippled by our inability to prevent their spread between herds via the airborne route. Therefore, we conducted a 4-year study to evaluate the efficacy of air filtration to reduce this risk of airborne transmission. While results from years 1 to 3 of the study have been reported,[1,2] a comprehensive summary of the 4-year study has not been published. Therefore, this brief communication will attempt to summarize data regarding the efficacy of commercially available air filters for reducing the risk of airborne transmission of PRRSV and M hyo over the entire study period.

## Materials and methods

The study was conducted using the University of Minnesota Swine Disease Eradication Center production region model using protocols approved by the University of Minnesota Institute of Animal Care and Use Committee. As the location, design, and methodologies employed in the model have been documented, readers are directed to review previous publications to obtain further details.[1,2] Briefly, the model represented a "neighborhood" of swine production, consisting of a cluster of buildings each with a specific purpose (Figure 1). Building 1 served as a source of PRRSV-positive and M hyo-positive bioaerosols for the surrounding region. Building 2 was the control facility, which lacked an air filtration system in order to document airborne spread of pathogens throughout the production region. Buildings 3 and 4 contained various air filtration systems (treatments) designed to reduce the risk of airborne transmission of PRRSV and M hyo. Changes in design and components of the model, the health status of the source population, and the filter systems employed over the 4-year time period are summarized in Table 1. As described, multiple samples were collected daily to monitor the spread of PRRSV and M hyo throughout the model.[1,2] Samples collected included sera and nasal swabs from 20-kg pigs in Buildings 2 through 4, exhausted air from the Building 1 source population, and air entering Buildings 2 through 4, as well as swabs of fomites (footwear, clothing, and supplies) and personnel (hands) entering Buildings 2, 3, and 4, and insects collected internally. An airborne transmission event was defined as the recovery of homologous PRRSV or M hyo from pigs in Buildings 2 through 4, as well as detection of infectious PRRSV in units of median tissue culture infectious doses ($TCID_{50}$) per mL, or the presence of M hyo DNA as determined by polymerase chain reaction (PCR) in air

Swine Disease Eradication Center, University of Minnesota College of Veterinary Medicine, St Paul, Minnesota.

**Corresponding author:** Pipestone Veterinary Clinic, PO Box 188, Pipestone, MN 56164; Tel: 507-825-4211; Fax: 507-825-3140; E-mail: sdee@pipevet.com.

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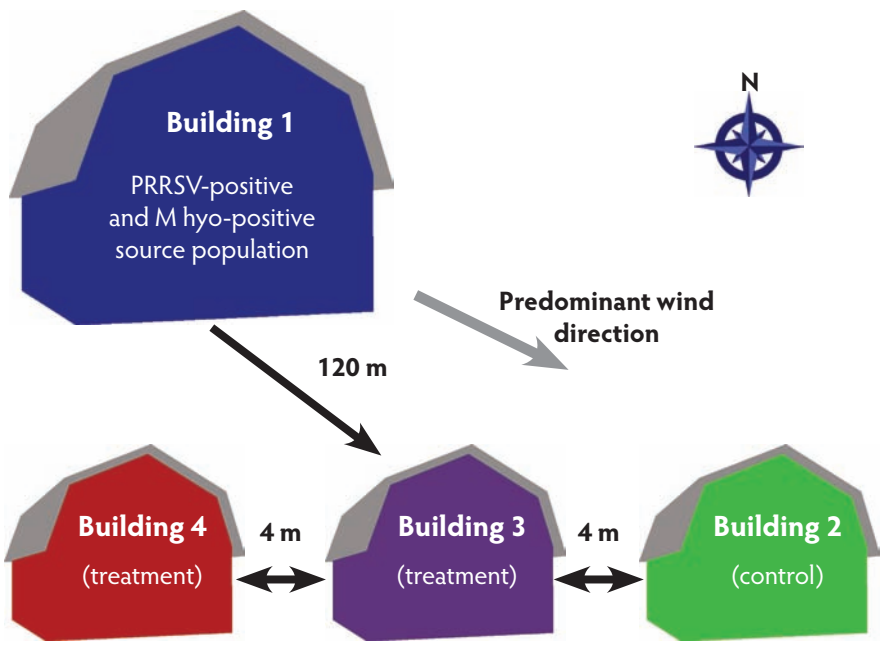
**Figure 1:** Placement of buildings within a model representing a "neighborhood" of swine production during years 1 through 4 of a study evaluating the efficacy of air filtration to reduce risk of airborne transmission of porcine reproductive and respiratory syndrome virus (PRRSV) and *Mycoplasma hyopneumoniae* (M hyo). Buildings 1 to 3 were used during years 1 to 2 and Buildings 1 through 4 were used in years 3 to 4. Building 1 served as a source of PRRSV-positive and M hyo-positive bioaerosols for the surrounding region. Building 2, the control facility, lacked an air filtration system. Buildings 3 and 4 contained various air filtration systems.




samples collected from outgoing air from Building 1 and incoming air into Buildings 2 through 4.[1,2] Throughout the course of the study, multiple replicates (10 to 20 pigs per building in Buildings 2 to 4, housed for a 2- to 4-week period) were conducted. Differences in airborne transmission of PRRSV and M hyo between treatment and control facilities were analyzed for significance using one-way ANOVA.

## Results

The study was conducted for 1438 days and utilized 4744 pigs. In total, 38,556 samples were collected, including 1417 and 1227 air samples which were tested for PRRSV and M hyo, respectively. Airborne transmission of PRRSV and M hyo was documented in 43% and 34%, respectively, of the replicates conducted in Building 2; however, no evidence of infection was documented in Barns 3 or 4, independent of treatment (Table 2). In support of these data, the number of positive replicates (ie, evidence of aerosol transmission of PRRSV or M hyo) was significantly lower ($P < .001$) in all treatments than in controls.

## Discussion

The purpose of this brief communication was to summarize data from a 4-year study evaluating the ability of a variety of air filtration systems to prevent airborne transmission of PRRSV and M hyo. The choice of air filtration system depends on the system of production, the available budget, the location of the farm, and the acceptable level of risk. Currently, this technology has been applied, with promising results,[3] to large breeding herds located in swine-dense regions, and studies are now underway to evaluate its cost-benefit ratio across larger numbers of farms over longer periods of time.

## Implications

- Data from controlled studies evaluating the efficacy of air filtration systems for reducing the risk of airborne spread of PRRSV and *Mycoplasma hyopneumonaie* are now available.
- Under the conditions of the novel experimental model used in this 4-year study, mechanical, antimicrobial, and electrostatic filters are equally effective at preventing aerosol transmission of PRRSV and M hyo.

## References

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2. Dee SA, Otake S, Deen J. Use of a production region model to assess the efficacy of various air filtration systems for preventing the airborne transmission of porcine reproductive and respiratory syndrome virus and *Mycoplasma hyopneumoniae*: Results of a 2-year study. *Virus Res.* 2010;154:177–184.

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**Table 1:** Summary of pathogens and filter types tested over the 4-year study period investigating the efficacy of air filtration systems in preventing airborne transmission of PRRSV and M hyo*

| Year | Pathogens tested† | Filter types tested |
|---|---|---|
| 1 | PRRSV-184 | Building 2: non-filtered control |
| | | Building 3: MERV 16‡ |
| 2 | PRRSV-184, M hyo | Building 2: non-filtered control |
| | | Building 3: MERV 16 |
| 3 | PRRSV-184, M hyo | Building 2: non-filtered control |
| | | Building 3: MERV 14§ |
| | | Building 4: antimicrobial (new) ¶ |
| 4 | PRRSV-184, M hyo | Building 2: non-filtered control |
| | PRRSV-1-26-2 | Building 3: electrostatic** |
| | PRRSV-1-18-2 | Building 4: antimicrobial (old)‡‡ |

* Neighborhood of four buildings used in the study is described in Figure 1.

† Pathogens inoculated into Building 1 source population.

‡ A system of mechanical fiberglass filters having a MERV 16 (EU9 classification) with an efficiency of 95% for capturing particles 0.3 to 1.0 µ in diameter.

§ A system consisting of mechanical fiberglass filters having a MERV 14 (EU8 classification) with an efficiency of 75% for capturing particles 0.3 to 1.0 µ in diameter.

¶ A system consisting of 10 layers of polypropylene fabric impregnated with a mixture of virucidal and bactericidal compounds. During year 3, a new set of filters was tested.

** A system consisting of mechanical fiberglass filters impregnated with an electrostatic charge resulting in a MERV 16 (EU9 classification), providing an efficiency of 95% for capturing particles 0.3 to 1.0 µ in diameter.

‡‡ A system consisting of 10 layers of polypropylene fabric impregnated with a mixture of virucidal and bactericidal compounds. During year 4, an old set of filters, which had previously been used to filter a swine unit for a 2-year period, was tested.

PRRSV = porcine reproductive and respiratory syndrome virus; M hyo = *Mycoplasma hyopneumoniae*; MERV = minimum efficiency reported value

**Table 2:** Summary (number of positive replicates/number of replicates conducted) of airborne transmission events across pathogens, filter types, and 4-year study period in an investigation of the efficacy of air filteration systems in preventing airborne trnsmission of PPRSV and M hyo*

| Pathogen | Non-filtered control | Filter type | | | | |
|---|---|---|---|---|---|---|
| | | MERV 16 | MERV 14 | Antimicrobial | | Electrostatic |
| | | | | (new)† | (old)‡ | |
| PRRSV | 28/65 | 0/39 | 0/13 | 0/13 | 0/13 | 0/13 |
| M hyo | 17/39 | 0/13 | 0/13 | 0/13 | 0/13 | 0/13 |

* A replicate was defined as a 2- to 4-week period and involved 10-20 pigs in Buildings 2-4 (buildings described in Figure 1). A transmission event was defined as the presence of infectious PRRSV or M hyo DNA in air samples collected from exhausted air from the source population, air entering the inlets of Buildings 2-4, and subsequent infection of pigs housed in these facilities. All treatments were significantly different from controls by ANOVA ($P < .001$).

† A "new" antimicrobial filter was defined as a filter that had never been used in a swine farm.

‡ An "old" antimicrobial filter was defined as a filter that had been used on a swine farm for a 2-year period prior to the study.

PRRSV = porcine reproductive and respiratory syndrome virus; M hyo = *Mycoplasma hyopneumoniae;* MERV = minimum efficiency reporting value