INFRARED THERMOGRAPHY OF SWINE BODY SURFACE TEMPERATURES AND ASSOCIATED RECTAL TEMPERATURES DURING AN ACUTE RESPIRATORY DISEASE CHALLENGE

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Summary

An acute *Actinobacillus pleuropneumonia* challenge was used to study changes in rectal and radiant surface temperatures over 18 h. From 3.5 to 15 h after challenge, rectal temperatures were elevated in challenged pigs compared to nonchallenged controls. From 6 through 18 h after challenge, infrared surface temperature was higher for challenged pigs versus control nonchallenged pigs. Correlation coefficient analysis indicated that surface temperature and rectal temperature were moderately correlated. These results indicate that infrared thermography will detect changes in body surface temperature associated with the acute phase febrile response and has potential as a diagnostic tool for assessing systemic changes in radiant heat production.

(Key Words: Fever, Infrared Thermography, Rectal Temperature.)

Introduction

Recent interest has been shown regarding the potential of infrared thermography (IRT) to detect the febrile response during the onset of disease or inflammation prior to expression of severe clinical symptoms. Infrared thermography measures changes in radiant body surface temperature caused by alterations in blood flow underlying the skin that lead to variation in the heat flow to the skin surface. It has the advantage of being a passive, noninvasive, remote temperature-sensing device. The use of IRT as a screening tool would enhance the diagnostic capabilities of veterinarians and producers to assess an animal's clinical condition during an acute disease outbreak. Because of these characteristics, IRT may be a better temperature-sensing tool for pigs in group housing that are not conditioned to prolonged human contact associated with more traditional temperature sensing methods like rectal probes.

During the rising phase of fever (i.e., as the body temperature is increasing), an animal's heat production is increased by heat-generating physiological reflexes and behavioral changes. Simultaneously, the amount of heat loss is decreased, primarily by peripheral vasoconstriction. Because of the decrease in initial heat loss, it is unknown if the changes in internal heat production can be detected by measuring changes in surface body temperature. In this study, an infrared radiometer was used to measure radiated, photonic energy at the skin surface following challenge with the respiratory pathogen, *Actinobacillus pleuropneumonia*. The characterization of the febrile response at the body surface was compared to thermal profiles of nonchallenged pigs under similar environmental and nutritional conditions.

Procedures

The experimental protocol used in this study was approved by the KSU Institutional Animal Care and Use Committee. Twenty-four pigs (initially 65 ± 2 lb) were blocked by initial weight in a randomized incomplete

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block design with pig as the experimental unit. Each pig was allotted to either the disease challenged or unchallenged control treatment. Within the disease challenge treatment, pigs were subdivided further into two treatments based upon febrile response. Pigs exhibiting a 3°F increase in rectal temperature after challenge were categorized as the febrile-challenged group, and the remainder were categorized as the nonfebrile-challenged group. There were 12 unchallenged controls, 6 febrile-challenged, and 6 nonfebrile-challenged pigs. All pigs were housed in stainless steel metabolism crates in an environmentally controlled room held at 70°F with constant lighting. Pigs were given a 3 d acclimation period and were allowed feed and water ad libitum. Diet composition is shown in Table 1. Feed was removed 4 h before challenge to minimize differences in body temperature associated with different feed-intake patterns among the pigs.

Table 1. Diet Composition

Ingredient	Percent
Corn	64.04
Soybean meal, 46.5% CP	32.89
Monocalcium phosphate	1.22
Limestone	1.10
Salt	.35
Vitamin premix	.25
Trace mineral premix	.15

[a]Diet was formulated to contain 1.15% lysine, .75% Ca, and .65% P.

The pigs were verified *A. pleuropneumonia* negative by serological testing prior to being selected for this experiment. *Actinobacillus pleuropneumonia* was administered via intranasal inoculation of 3 mL of culture medium containing 10^7 cfu *A. pleuropneumonia*, and control pigs were given 3 mL of sterile media via intranasal administration.

Infrared thermographs were taken approximately 9 ft perpendicular to the left side of each pig using a stationary thermal imaging camera (3-5 μm wavelength) equipped with a 16° FOV lens having images displayed as a 256 × 256 pixel focal plane array. Images were analyzed by a certified technician to determine mean surface body temperature. Rectal temperatures were taken simultaneously, and both IRT and rectal temperatures were collected at -2 and -1 h before challenge, and 0 h (at challenge), every 15 minutes until 6 h after challenge, then every 3 h from 9 to 18 h after challenge.

All data were analyzed as a randomized incomplete block design using a mixed model with repeated measures. Pigs were blocked by initial weight and time, with individual pig as the experimental unit. Time period was used for the repeated measures. Rectal and IRT surface temperatures were analyzed for time × treatment interactions and their associated main effects. A Spearman correlation analysis measured the strength of the relationship between increases in rectal temperature and surface temperature.

Results and Discussion

A treatment × time interaction was observed for rectal temperature (P<.01; Figure 1). The interaction was due to observed differences in rectal temperature from 3.5 h to 15 h after challenge. In that period, rectal temperatures for febrile and nonfebrile pigs were elevated compared to those of the control pigs (P<.02). In addition, from 5.25 to 18 h after challenge, rectal temperature for febrile pigs remained elevated compared to those for both control and nonfebrile pigs (P<.01).

Treatment and time effects were observed for pig surface temperature (P<.01; Figure 2). From 6 through 18 h after challenge, surface temperature was higher for febrile versus control pigs (P<.01), and except for 9 h after challenge, for febrile versus nonfebrile pigs (P<.05). Surface temperature was not different for control versus nonfebrile pigs (P>.12) throughout the experiment. The Spearman correlation of rectal temperature and surface temperature was r = .52 (P<.01) throughout the 18 h period. Additionally, a linear relationship was observed for increasing surface temperature as rectal temperature increased in febrile pigs r = .50; P<.01; Figure 3).

Our results indicate that although differences exist in the time course of increasing rectal and surface temperatures, use of IRT appears to be an effective method to detect changes in body temperature associated with the febrile response. The 2.5 h time difference between rising rectal and surface body temperatures is due to the cooler skin temperatures while body heat is retained internally during the building fever and the time necessary for the increased internal heat to migrate to the external surfaces.

Rectal temperatures typically have been associated with assessment of the febrile state in domestic livestock. However, obtaining an accurate indication of temperature in animals not conditioned to frequent handling often is difficult. Anecdotal evidence from our laboratory suggests that rectal temperatures taken in clinically normal 30 lb pigs that were removed from their pen and restrained typically exceeds 103.5°F within 1 min of restraint. Because of this variability, rectal temperatures may not be collected in group-housed suspect pigs that are still active and avoiding human contact. The use of rectal temperatures typically is associated with individually penned pigs or group-housed pigs that are exhibiting lethargy, somnolence, and other indicators of severe clinical stress.

The use of IRT to detect changes in body temperature provides an avenue of early temperature assessment that is noninvasive, rapid, and positively correlated with changes in core body temperature. In conclusion, this research indicates that IRT can detect changes in body temperature associated with a febrile response to disease and has potential as a diagnostic tool for assessing systemic changes in radiant heat production.

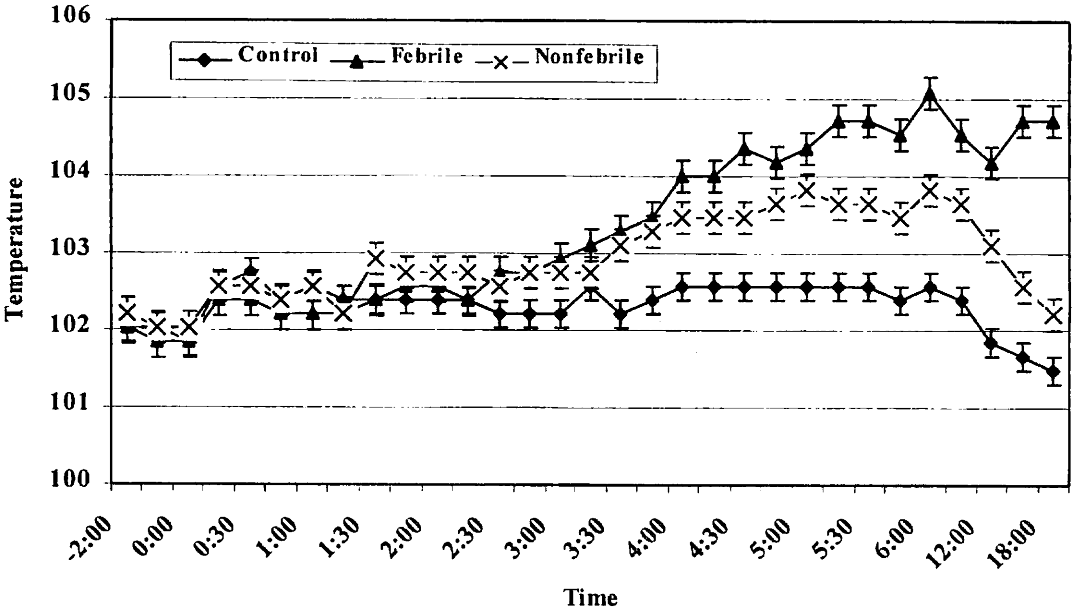

Figure 1. Effect of an Acute Respiratory Disease Challenge in 65-lb Pigs on 18-h Changes in Rectal Temperature, °F.

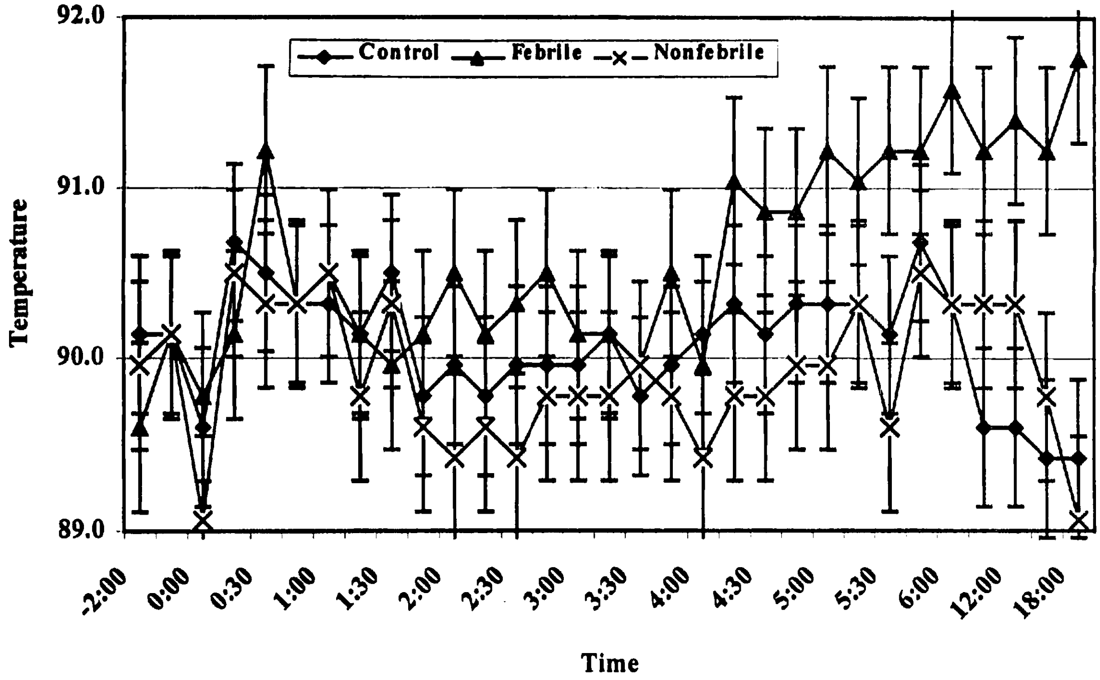

Figure 2. **Effect of Acute Respiratory Disease Challenge in 65-lb Pigs on 18-h Changes in Radiant Surface Temperature, °F.**

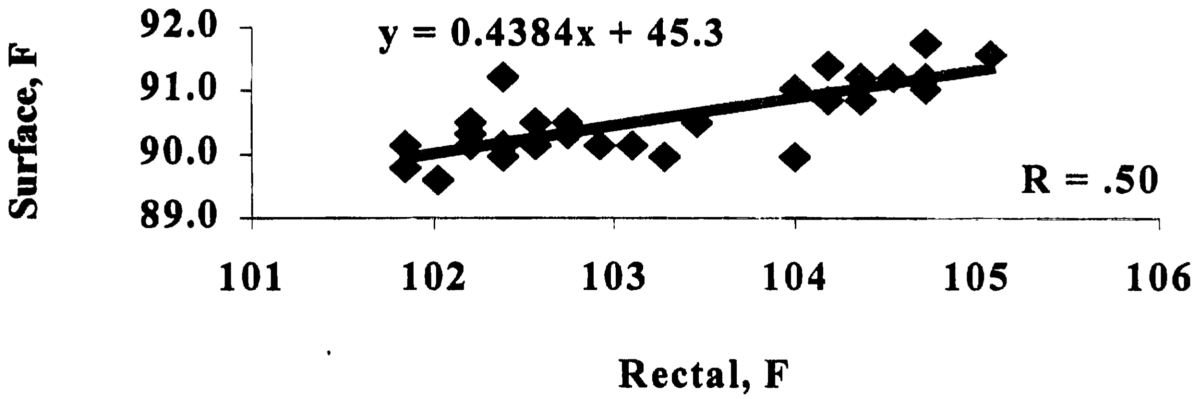

Figure 3. **Relationship between Increased Rectal Temperature and Increased Body Surface Temperature in *A. pleuropneumonia*-Challenged Pigs Exhibiting a Fever.**