

The use of infra-red thermometry for the detection of fever in pigs.
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Summary:

To avoid time-consuming and unpractical rectal temperature measurement, alternative methods for detection of fever in pigs are searched for. To evaluate the suitability of infra-red (IR) thermometry, the results of IR body surface temperature (BST) measurements on four different places, were compared to rectal temperatures in 16 weaner pigs. The results indicate that in three measuring places a relation exists between the BST and the rectal temperature, however this relation is too weak to be able to make reliable predictions of the rectal temperature based upon the BST. Therefore it can be concluded that IR thermometry is no good alternative for the rectal temperature measurement to detect fever in pigs.

Introduction:

For many diseases, an early diagnosis is crucial. Often, fever is one of the earliest detectable clinical symptoms. Therefore the measurement of the body temperature is a standard part of the clinical examination. Conventionally, this is done by rectal temperature measurement. This is however time-consuming and often practically unfeasible, especially in fattening pigs. Therefore, an alternative is searched for reliable, fast and practical measurement of the body temperature of pigs. Determination of the body temperature through measurement of the body surface temperature (BST) by infra-red (IR) thermometry could be a possibility. The working mechanism of IR thermometry is based upon the detection of electromagnetic waves radiated by a body that has a higher heat than the surroundings. In human medicine it is described that using IR thermometry up to 95% of all persons with fever can be detected (Hughes et al., 1995). Also in veterinary medicine IR thermometry has been used successfully for the detection of local inflammations (Yang en Yang, 1992).

Objectives:

The aim of the experiment was to evaluate whether it is possible to predict if a pig has fever, based upon the BST measurements detected by IR thermometry.

Material and methods:

Sixteen weaner pigs, of which some were infected with classical swine fever, were followed between 14 and 48 consecutive days resulting in 549 measurements. Rectal temperature was recorded using a mercury thermometer. BST was recorded using an IR thermometer "Raynger® MX4" (Raytec®, Thames Medical, UK) at ear, side, feet and anus. The experiment was executed in an isolation unit with a constant

room temperature of 20°C. To examine the relation between BST and rectal temperature, data were analyzed using a linear mixed model with pig as a random component and an autoregressive correlation structure of the first order (S-plus, 2000). Using the obtained coefficients (b_0 , b_1) a linear model was constructed to predict the rectal temperature based upon the BST. For each recording place (ear, side, feet, anus) a model was constructed. Additionally the 95% prediction interval around the linear model was determined (Neter et al., 1996).

Results:

The average rectal temperature over the entire experiment in all pigs was 39.3 °C with a minimum of 37.9 °C and a maximum of 42.1°C. In 79 of the 549 recordings, the rectal temperature was equal to or above 40°C (= fever). In 87% of these observations, the fever occurred shortly before, during or shortly after a CSF virus positive period, indicating that the fever was related to a CSF infection. The average results of the BST are presented in table 1.

Table 1: Average results of the BST, the average difference with the rectal temperature, and the standard deviation (SD) of the difference.

	Average temp.	Average diff.	SD
Ear	33.2 °C	6.1 °C	2.2
Side	34.0 °C	5.4 °C	1.6
Feet	33.6 °C	5.7 °C	1.7
Anus	34.1 °C	5.2 °C	1.5

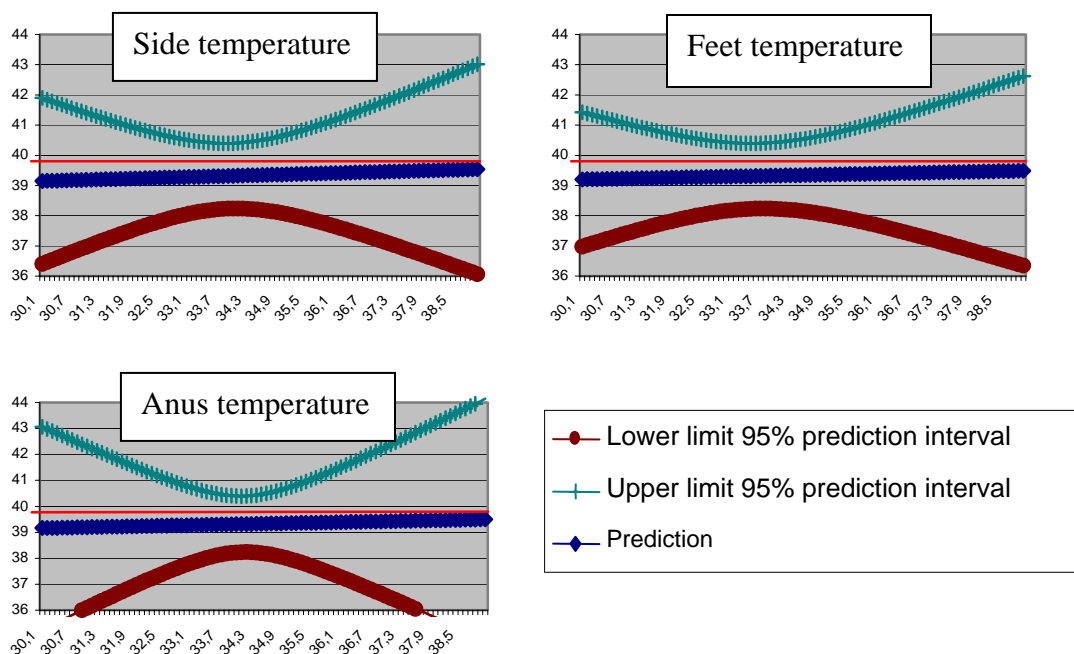
The results of the linear mixed model indicate that there is a significant relation ($p < 0.01$) between the BST temperature of side, feet and anus and the rectal temperature. Although the slope of the fitted curve (b_1) is significantly different from 0 in these cases, the absolute values are very small, resulting in a very slow rise of the curve (Figure 1). For those measuring places where a significant relation is found between BST and rectal temperature (all except the ear), a prediction of the expected rectal temperature was made based on the observed BST (Figure 1).

Discussion:

The first important finding is that there is a significant relation between the BST of side, feet, and anus and the rectal temperature. For the ear this relation is not present. This is probably due to the fact that the ear has an important function in the thermoregulation of the pig and therefore has a highly varying temperature (Ingram et al., 1973). However, when it is tried to predict the rectal temperature based upon the BST, it is found that the predicted temperature never exceeds 40°C, whereas in reality 79 observations with a rectal temperature $\geq 40^\circ\text{C}$ were recorded. As a result, using this method, a pig is never identified as having fever ($\geq 40^\circ\text{C}$). On the other hand, the upper limit of the prediction interval is always above 40°C, indicating that it never can be concluded with certainty that a pig has no fever. Additionally it should

be mentioned that the measuring fault on the recordings of the BST (accuracy of the IR thermometry device) was not taken into account in the analysis. Including this additional source of variation would certainly result in an even wider prediction interval.

Figure 1: Prediction of the rectal temperature (y-axis) based upon the BST (X-axis) and prediction interval.



Based upon the results of this experiment it can be concluded that although a significant relation exists between BST and rectal temperature, this relation is too weak to allow predictions of the rectal temperature based upon measurements of the BST. Therefore, IR thermometry as used in this experiment is not suitable for the detection of pigs with fever.

References:

Hughes, W.T., Patterson, G.G., Thornton, D., Williams, B.J., Lott, L., Dodge, R. (1995) Detection of fever with infrared thermometry: a feasibility study. *The Journal of Infectious Diseases* 152, 301-306.

Ingram, D.L., Legge, K.F., Mount L.E. (1973) Onset of fever in a pig. *British Veterinary Journal* 129, 32-33.

Neter J, Kutner MH, Nachsheim CJ, Wasserman W. (1996) Inference in Regression Analysis. In: Applied Linear Statistical Models, Irwin Publishing, Chicago, USA,; pp 44-94.

Yang, W-J. en Yang P.P.T. (1992) Literature survey on biomedical applications of thermography. *Biomedical Materials and Engineering*, 2, 7-18