Evaluation of contactless methods for temperature measurement in neonatal puppies

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INTRODUCTION

Hypothermia is described as one of the major causes of neonatal mortality in puppies (1,2), making temperature measurement a basic criteria for evaluation of neonatal health. The standard method currently is the rectal thermometry.
The aim of this study was to evaluate two contactless methods for temperature measurement in puppies, a non contact infrared thermometer and a thermal imaging camera (Fig.1).

Fig. 1. Contactless devices for control of the body temperature used in our study. From the left: thermal camera, infrared thermometer.

Fig. 2. Infrared thermometer pointed at the abdomen of the puppy.

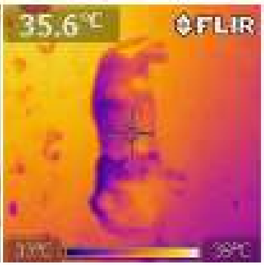

Fig. 3. Image of the thermal camera pointed at the abdomen of the puppy.

MATERIALS AND METHODS

- In one breeding multi-racial kennel, 327 puppies kept with their mother, with free suckling, under an infra-red lamp and on a heated ground (28-30 C at the puppies' level) were followed.
- After identification at birth, temperature was measured within the first 8 hours after birth (Day 0), and at Day 1, 2, 7, 14 and 21 on each puppy successively by a rectal thermometer (Torm 10S; Cooper, Melun, France) and by a non contact infrared (IR) thermometer (New Test Evoluscan; EvoluPharm, Auneuil, France; Fig. 2). IR thermometer was pointed at the caudal part of the ventral abdomen and at the forehead (4-10 cm from the skin).
- A thermal imaging camera (FLIR i7; Flir Systems, Wilsonville, Oregon, USA; Fig. 3) was placed 1 meter above the litter placed in a box, measurements taken on the abdomen or on the forehead.
- T-test on paired values and ANOVA for repeated measurements were used to compare the results obtained through the various techniques and correlation was evaluated through linear regression.

INFRARED THERMOMETER

- Variation coefficients (as calculated from 3 repeated measurements on 15 puppies) were 0.3% and 0.6% for IR thermometer respectively on the abdomen and on the forehead. Only abdominal values were then used in the study.
- IR temperature was at all times significantly higher than rectal temperature but the difference was decreasing with age (Fig.4).

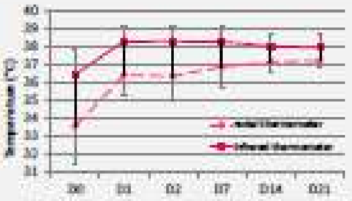

Fig. 4. Decreasing differences between rectal temperature and IR temperature in puppies from 0 to 21 days of age (n=327).

- The differences between IR temperatures and rectal temperatures were compared between yellow and chocolate Labradors and between white and black small breed puppies. No impact of the coat color was evidenced (Fig.5).

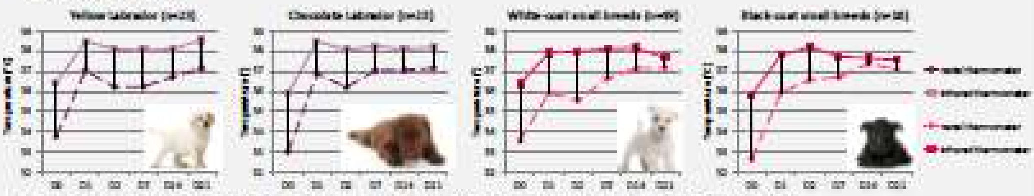

Fig. 5. Decreasing differences between rectal temperature and IR temperature in puppies of different coat color between birth and 21 days of age (n=112).

- Values given by IR thermometer and by rectal thermometer were significantly correlated at all time points, but with high coefficients only until Day 7 (Fig.6; Table 1).

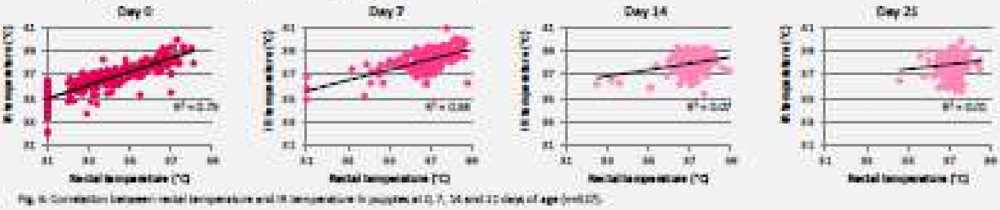

Fig. 6. Correlation between rectal temperature and IR temperature in puppies at 0, 7, 14 and 21 days of age (n=327).

Age (days)	0	1	2	7	14	21
rho	0.86	0.73	0.73	0.82	0.26	0.23
p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Level of correlation	VERY HIGH	HIGH	HIGH	HIGH	VERY WEAK	VERY WEAK

Table 1. Evolution of the correlation between rectal temperature and IR temperature in puppies depending on age (n=327).

THERMAL IMAGING CAMERA

- Variation coefficients (as calculated from 3 repeated measurements on 15 puppies) were 0.8% and 1.3% for the camera respectively on the abdomen and on the forehead.
- Only abdominal values were then used in the study.

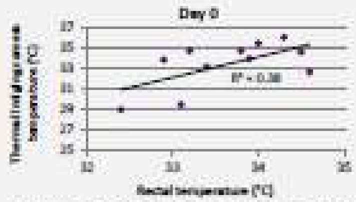

Fig. 7. No correlation between rectal temperature and thermal camera temperature in puppies at birth (r=0.46, p=0.26, n=15).

- Values given by the camera were not correlated with rectal values (Fig.7).
- Camera allowed to identify the coldest puppy within a litter in 48% (13/27) of the litters (Fig.8-10).
- In 70% (19/27) of the litters thermal camera was able to detect the first two puppies with the lowest body temperature within a litter.

Fig. 8

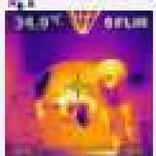

Fig. 9

Fig. 10

DISCUSSION & CONCLUSIONS

- **This study demonstrates that a contactless infrared thermometer is an efficient tool to monitor puppies temperature. However, the values need to be converted differently depending on age in order to use the infrared thermometer in the everyday practice.**
- **The scale allowing the interpretation of IR values was determined (Table 2).**
- **The thermal camera appeared a poorly accurate tool of body temperature measurement in puppies and further investigation is needed to determine its efficient usage in the breeding kennels.**

Infrared temperature (°C)	Corresponding rectal temperature (°C)			
	Day 0	Day 1	Day 2	Day 7
35.0	31.0	30.3	29.5	29.6
36.0	32.8	32.1	31.5	31.8
37.0	34.5	34.0	33.6	34.0
38.0	36.2	35.9	35.7	36.3
39.0	38.0	37.8	37.8	38.5
40.0	39.7	39.6	39.9	40.7
41.0	41.5	41.5	41.9	42.9

Table 2. Conversion of the IR values to the rectal thermometer values.

(1) Münnich A, Küchenmeister U. Reprod Domest Anim. 2014;49:64-74. (2) Lawler DF. Theriogenology. 2008;70:384-392.

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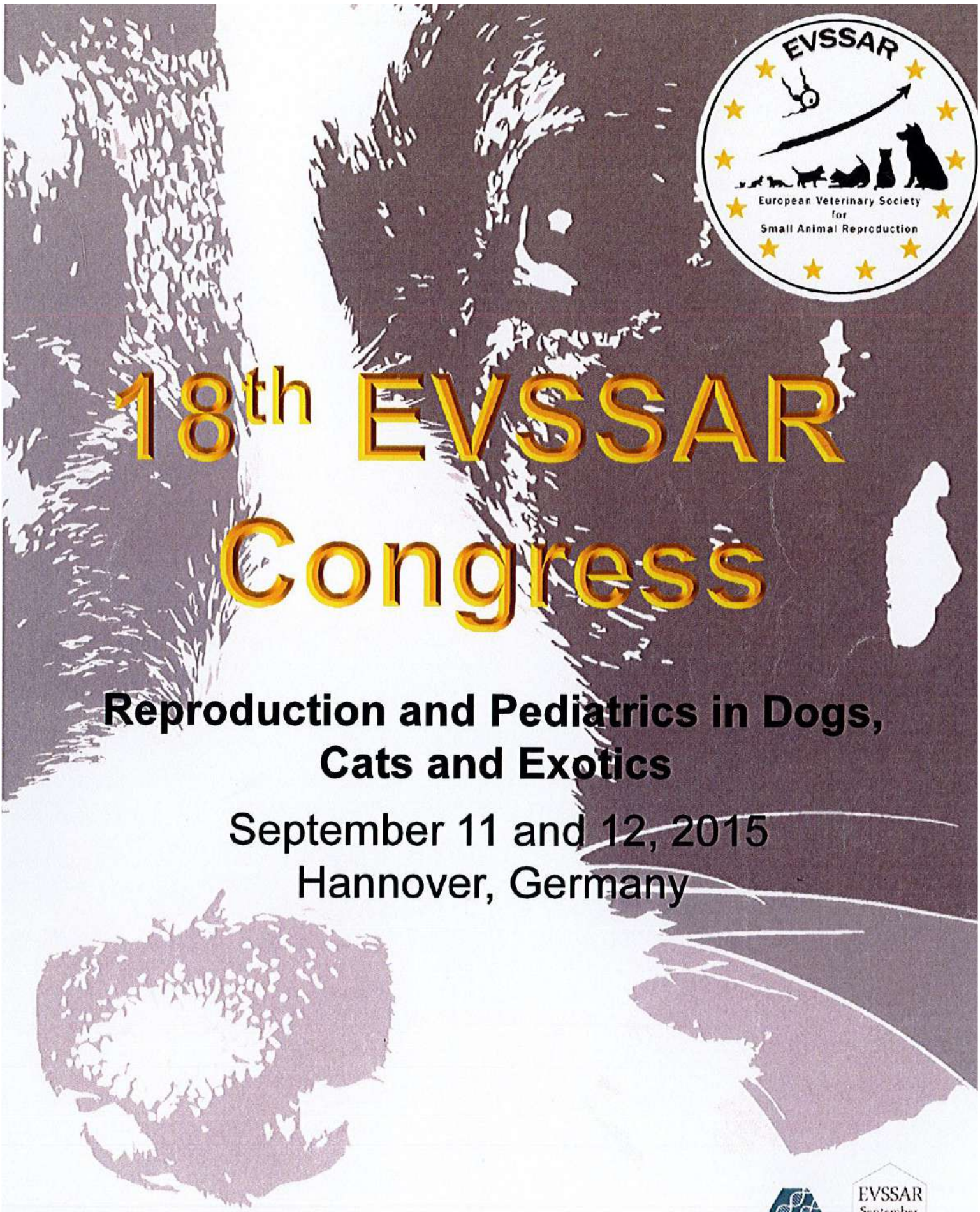
Introduction and aims. Hypothermia is described as one of the major causes of neonatal mortality of puppies (1,2), making temperature measurement a basic criteria of evaluation of neonatal health. The standard method currently is rectal thermometry. The aim of this study was to evaluate two contactless methods for temperature measurement in puppies, a non contact infrared thermometer and a thermal imaging camera.

Materials and methods. In one breeding multi-racial kennel, 327 puppies kept with their mother, with free suckling, under an infra-red lamp and on a heated ground (28-30°C at the puppies' level) were followed. After identification at birth, temperature was measured within the first 8 hours after birth, and at Day 1, 2, 7, 14 and 21 on each puppy successively by a digital rectal thermometer (Torm 10S ; Cooper, Melun, France – accuracy: 0.1°C between 35.5 and 42°C and 0.2°C out this range) and by a non contact infrared (IR) thermometer (New Test Evoluscan ; EvoluPharm, Auneuil, France – accuracy: 0.3°C;). IR thermometer was pointed at the caudal part of the ventral abdomen and at the forehead, at a 4-10 cm distance from the skin. A thermal imaging camera (FLIR i7; Flir Systems, Wilsonville, Oregon, USA) was placed 1 meter above the litter placed in a box, measurements taken on the abdomen or on the forehead. T-test on paired values was used to compare the results obtained through the various techniques and correlation was evaluated through linear regression.

Results. Variation coefficients (as calculated from 3 repeated measurements on 15 puppies) were 0.3% and 0.6% for IR thermometer respectively on the abdomen and on the forehead. Only abdominal values were then used in the study. IR temperature was at all times significantly higher than rectal temperature but the difference was decreasing with age: 1.8±0.04°C Day 1, 1.9±0.05°C at Day2; 1.4±0.05°C at Day 7; 0.8±0.05°C at Day 14 and 0.6±0.15°C at Day 21. Values given by IR thermometer and by rectal thermometer were significantly correlated at all times, but with high coefficients only until Day7 ($r=0.86$, 0.73, 0.73, 0.62 at Day 0, 1, 2, 7, respectively and $r=0.26$ and 0.23 at Day 14 and 21). The differences between IR temperatures and rectal temperatures were compared between yellow and chocolate Labradors and between white and black small breed puppies, and no impact of the coat color was evidenced. Variation coefficients (as calculated from 3 repeated measurements on 15 puppies) were 0.8% and 1.5% for the camera respectively on the abdomen and on the forehead. Values given by the camera were not correlated with rectal values. Camera allowed to identify the coldest puppy within a litter in only 48% of the litters.

Conclusions. This study demonstrates that a no contact IR thermometer is an efficient tool to monitor puppies temperature. The scale allowing the interpretation of IR values was also determined. Other ways of use for the thermal camera remain to be determined for an accurate measurement of the puppies temperature.

References (1) Münnich A, Küchenmeister U. Reprod Domest Anim. 2014;49: 64–74. (2) Lawler DF. Theriogenology. 2008;70: 384–392.



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