Brief Communication Communication brève

Limited efficacy of Fever Tag® temperature sensing ear tags in calves with naturally occurring bovine respiratory disease or induced bovine viral diarrhea virus infection

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Abstract — Temperature sensing ear tags were tested in 1) auction-derived calves with 50% incidence of bovine respiratory disease, and 2) specific pathogen-free calves infected with bovine virus diarrhea virus. There were no false positives, but tag placement, probe displacement, and a high threshold for activation all contributed to failure to reliably detect sick calves.

Résumé — Efficacité limitée des étiquettes d'oreille Fever Tag^{MD} pour mesurer la température chez les veaux atteints de maladies respiratoires d'origine naturelle ou d'une infection induite par le virus de la diarrhée virale des bovins. Les étiquettes d'oreille pour mesurer la température ont été testées chez 1) des veaux provenant d'encans ayant 50 % d'incidence de maladies respiratoires et 2) des veaux exempts d'agents pathogènes spécifiques infectés par le virus de la diarrhée virale bovine. Il n'y avait aucun faux positif, mais le placement des étiquettes, le déplacement de la sonde et un seuil d'activation élevé ont tous contribué à l'échec de la détection fiable des veaux malades.

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Commercial feedlots typically co-mingle cattle from different sources, and arrival at the feedlot is preceded by stressors from weaning and from transport (1). This situation provides appropriate conditions for the occurrence of bovine respiratory disease (BRD), and is the foundation for the current industry practices of metaphylactic treatment with antibiotics and frequent assessment of animals for clinical signs of disease (2,3). In addition to concerns for the welfare of clinically ill animals, BRD has direct financial costs due to reduced weight gain, human resources for monitoring calves, and treatment (4). Diagnosis of BRD requiring treatment typically relies on an elevated rectal temperature determined after suspect calves have been identified during daily clinical assessment, removed from their pen, and restrained for further examination (2). For that reason, several methods of remote temperature assessment have been developed with the expectation that elevated body temperature could be used to detect sick animals before signs of clinical disease were recognizable (5). For example, ruminal temperature boluses can remotely monitor temperature via radio transmission and data loggers (6). However, the animal still needs to be located by numerical ear tag for treatment. Infrared thermography (IRT) can detect changes in the rate of radiated heat loss from the ocular area. It can be coupled to watering stations with the potential to transfer animals to a secondary pen for clinical assessment (7,8). Unfortunately, these systems are not commercially available (8). External auditory meatus (ear canal) temperature can also be remotely monitored, and correlates well with rectal temperatures in non-diseased cattle (9). One advantage of commercially available external ear tags for temperature assessment (10) is that the tags can easily be coupled to a clear visual indicator, such as a flashing light, that can improve the ease of locating animals needing further clinical assessment. This brief communication describes the efficacy of the Fever Tag® (Fever Tags®, Amarillo, Texas, USA) temperature sensing ear tag with flashing light (10) (Figure 1), for the detection of elevated body temperature in 2 experimental settings.

Auction-derived beef calves were tested as a population with a high incidence of BRD. Specific-pathogen-free calves were tested as they responded to experimental infection with

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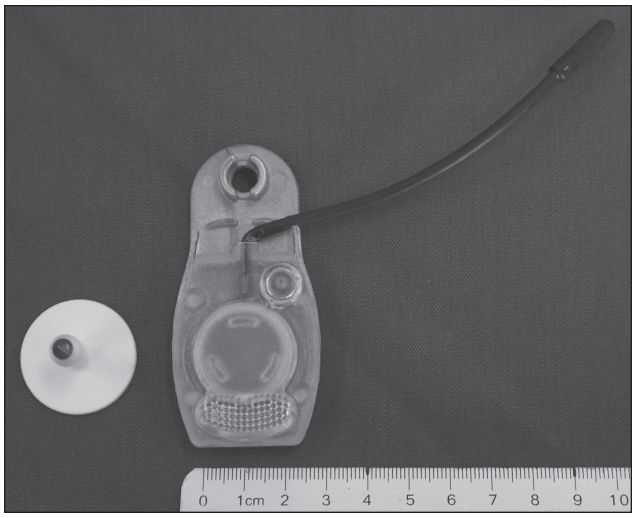

Figure 1. Fever Tag® temperature sensing ear tag used in this study. Installation instructions can be found at http://www.fevertags.com

bovine viral diarrhea virus (BVDV), which can play a role in the clinical syndrome of BRD (11). For both studies the calves were housed in appropriately sized pens equipped with roofed shelters that were located at the north end of the pen and open on their southern side, and bedded with straw or wood shavings. Weather conditions were typical for this area (2011: October, range: 17.2°C to −8.4°C, average: 4.6°C; November, range: 12.2°C to −27.2°C, average: −5.3°C; 2012: September, range: 27.7°C to 1.2°C, average: 14.3°C; October, range: 24.1°C to −8.6°C, average: 2.4°C).

The first study was conducted in October and November of 2011 at the Lacombe Agricultural Research Station, using a facility described previously (7,8). Guidelines under Animal Care Protocol 'LRC Study Plan #200512R' were followed. In a larger study of the use of automated infrared thermography at the watering station, to detect BRD in auction-derived beef calves, 2 groups of calves (n = 56 and n = 57) received Fever Tag® ear tags. The incidence of treated disease was similar in both groups at 32/56 (57%), and 32/57 (56%), respectively. The first group received the ear tags 8 d after arrival at the facility, and data were collected from the 10th through the 20th day after arrival. During the interval before the ear tags were placed, 10 calves were treated, and therefore excluded from analyses. Of the remaining 46 calves, 22 (48%) were identified for diagnostic examination and all were treated (Table 1). Calves were identified for examination either through clinical assessment by experienced pen-checkers, or if the ear tag was flashing. Rectal temperature was measured, a jugular blood sample was collected for hematology, and a clinical score was assigned [modified from Schaefer et al (7) with rectal temperature excluded from the score]. Seventeen of the 22 identified calves had a flashing ear tag at the time. Only 2 identified animals subsequently failed to meet the criteria for true disease positive status (7,8), defined as having a combination of any 2 of the following: total clinical score of 3 or higher, core body temperature of ≥ 40.0°C, blood leukocyte count of < 7 or $> 11 \times 10^9$/L, and blood neutrophil:lymphocyte ratio < 0.01 or > 0.8. All 17 calves with a flashing ear tag were in the group of 20 animals with confirmed true positive diagnosis (85%). Only 1 ear tag flashed in a disease-positive animal that was not also identified by pen-checkers. Thus, in the first group, the ear tags flashed at the time of clinical illness in most, but not all, sick calves.

In the second group, 57 calves had ear tags installed at the time of initial processing, 48 h after arrival. Two calves were excluded from analyses because they required treatment at arrival. Over the course of the study, 30 of the remaining 55 (55%) calves were identified for examination and subsequently treated. Four identified animals failed to meet the criteria for a true positive, leaving 26 calves with disease requiring treatment (Table 1). Only 4 ear tags ever flashed during the daily inspection. Each of those 4 flashing events occurred in the group of 26 calves with confirmed true positive diagnosis (15%). Two of these calves had only a flashing ear tag, and 2 calves had both clinical signs and a flashing tag. Although the second group was intended as a replicate of the first, the results differed. Ear tags in the second group were placed more laterally in the external ear, so the probe was positioned more superficially within the external auditory meatus than in the first group. Thus, the ear tags may not have reflected core body temperature in the second group of calves.

An additional 32 calves received ear tags in the fall of 2012 as 1 component of a larger study (UCVM Class of 2014, unpublished data) involving experimental infection of specific-pathogen-free beef cattle (CFIA Facility, Lethbridge, Alberta) with BVDV (intranasal inoculum of non-cytopathic-type 2a strain 1373 provided by S. van den Hurk of VIDO, Saskatoon, Saskachewan; Animal Care Protocol VM507 AC12-0143). Half of the calves (n = 16) were not infected with BVDV and remained healthy throughout the 37-day study. No ear tags ever flashed in that pen of calves during clinical assessments. Thus, there was no evidence for false positive responses in clinically healthy individuals. The remaining 16 calves were infected with BVDV on Day 0. By 9 d after infection, all calves showed clinical signs of illness. Mean rectal temperature was elevated by 1.5°C relative to the uninfected pen (39.8 ± 0.15°C versus 38.2 ± 0.11°C; $P < 0.0001$), and 15 of the 16 infected calves had an elevated disposition score (anorexic, listless and/or depressed), with respiratory (nasal discharge and/or coughing) and digestive (reduced feed intake, diarrhea, and/or dehydration) signs also occurring commonly. Two ear tags were excluded on removal when it was clear that the probe was displaced outside the external auditory meatus. Only 7 of the remaining 14 ear tags ever flashed (50%), with 17 flashing events recorded (range: 1 to 4 events per animal). All of those flashing events occurred between days 5 and 11 after infection with BVDV, and all occurred on days when the calf's clinical score indicated active illness (based on the same scoring as the 2 BRD groups reported) that would have been treated in a feedlot setting. On the other hand, there were many calf-days with clinical illness that did not have a flashing ear tag. For example, on day 9 after infection, when the infected group was displaying peak clinical signs of illness, only 5 of the 14 functional ear tags were flashing (35.7%). In addition, none of the 7 ear tags that flashed during

Table 1. Clinical illness and ear tag responses in 4 cohorts of beef cattle

	n	After exclusions *(n)*	Clinical illness	Laboratory confirmation	Ear tags ever flashing
October 2011	56	46	22	20 (43%)	17
November 2011	57	55	30	26 (47%)	4
BVDV 2012	16	14	14	14 (100%)	7
Control 2012	16	16	0	0 (0%)	0

the study provided consistent flashing on successive days for the same calf while active illness was evident. Thus, as ear tags never flashed in the control pen of healthy animals and never flashed in the experimentally infected pen, except in the window for clinical symptoms (days 5 to 11 post-infection) in individual calves with active signs of clinical illness that would normally be treated, there was no evidence for false positive events. However, the absence of flash responses in 7 of the 14 clinically ill calves (50%), and inconsistent flash activation within individuals over the window of positive clinical signs, indicate that false negatives were common.

The factory-set threshold temperature on the Fever Tag® used in the trial was 39.8°C. To verify the setting, a subset of 21 tags was tested in January 2013 by incrementally increasing then decreasing the temperature in a water bath (3 thermometers). All tags flashed in a waterbath set to 41°C. Thus, the flashing mechanism was functional in all tags. However, at lower temperatures, fewer tags flashed, and the same tag did not consistently flash (or did not flash) over 3 returns to the same waterbath temperature. Specifically, no tags flashed at 39.5°C, 50% of tags flashed at 40.2°C (repeatability of 57.1%), and 78% of tags flashed at 40.5°C (repeatability of 85.7%). Thus, the consistent activation threshold was considerably higher than the factory-set threshold of 39.8°C.

The initial design of these studies was to test the hypothesis that temperature-sensing ear tags would provide an early indication of illness that preceded the detection of clinical signs. Unfortunately, it was not possible to estimate the potential value of the ear tags as an early detection system for clinical illness in the feedlot setting. Foremost among the concerns was an empirical threshold for tag activation that exceeded the expected threshold of 39.8°C. Temperatures > 40.5°C were required to achieve 100% response rates, and calves with those core temperatures would be expected to show clinical signs of illness. Thus, a tag with a lower activation threshold could potentially provide early detection of increased body temperature. Current models available in the Fever Tag® line of products have multiple preset temperature thresholds that might be more effective means of early identification (10).

Tag placement was also a critical challenge. Although the 2 BRD groups were standardized, and the incidence of confirmed true positive BRD diagnosis was similar, the ability of the flashing ear tags to identify sick calves differed. Placing the tag more laterally within the pinna of the ear most probably reduced the probe depth in the external auditory meatus, and thereby reduced the probability of reaching the threshold temperature for flashing. Standardized insertion according to the specific details provided by the manufacturer (10) could improve the performance of the ear tag. However, there are likely to be challenges consistently ensuring this in commercial feedlot operations. Unfortunately for herd monitoring, displacement of the probe is not readily detectable under daily observation conditions, and would result in false negative data for those calves if they became ill.

There was no evidence of false positive activation from the ear tags. This might be attributable to the high activation threshold of the tags. Daily monitoring was also restricted to the early morning. Thus, it remains possible that the ear tags would have false positive activation under alternate environmental conditions with warmer ambient temperatures and/or direct sunlight, or, conversely, false negatives under extremely cold ambient temperatures. For temperature sensing ear tags to be useful for the detection of elevated body temperature as an early predictor of BRD, improvements in tag accuracy and reliability are required.

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