

## Research Article

**Cite this article:** Gillespie AV, Carter SD, Blowey RW, Staton GJ, Walsh TR and Evans NJ (2021). Measuring the impact of bovine digital dermatitis research on knowledge and practice of biosecurity during cattle foot-trimming. *Journal of Dairy Research* **88**, 60–63. <https://doi.org/10.1017/S0022029921000170>

Received: 12 October 2020  
Revised: 3 January 2021  
Accepted: 3 January 2021  
First published online: 19 February 2021

### Keywords:

Bovine digital dermatitis; foot-trimming; hygiene; knowledge exchange; impact

### Author for correspondence:

Amy V. Gillespie, Email: [amyg@liverpool.ac.uk](mailto:amyg@liverpool.ac.uk)

# Measuring the impact of bovine digital dermatitis research on knowledge and practice of biosecurity during cattle foot-trimming

Amy V. Gillespie<sup>1</sup>, Stuart D. Carter<sup>1</sup>, Roger W. Blowey<sup>2</sup>, Gareth J. Staton<sup>1</sup>, Tessa R. Walsh<sup>1</sup> and Nicholas J. Evans<sup>1</sup>

<sup>1</sup>Department of Infection Biology and Microbiomes, Institute of Infection, Veterinary and Ecological Sciences, University of Liverpool, Merseyside, UK and <sup>2</sup>Appithorne, Minsterworth, Gloucester, GL2 8JG, UK

## Abstract

This research communication reports the results from questionnaires used to identify the impact of recent research into the disinfection of cattle foot-trimming equipment to prevent bovine digital dermatitis (BDD) transmission on (a) biosecurity knowledge and (b) hygiene practice of foot health professionals. An initial questionnaire found that more than half of participating farmers, veterinary surgeons and commercial foot-trimmers were not considering hand or hoof-knife hygiene in their working practices. The following year, after the release of a foot-trimming hygiene protocol and a comprehensive knowledge exchange programme by the University of Liverpool, a second survey showed 35/80 (43.8%) farmers, veterinary surgeons and commercial foot-trimmers sampled considered they were now more aware of the risk of spreading BDD during foot-trimming. Furthermore, 36/80 (45.0%) had enhanced their hygiene practice in the last year, impacting an estimated 1383 farms and 5130 cows trimmed each week. Participants who reported having seen both the foot-trimming hygiene protocol we developed with AHDB Dairy and other articles about foot-trimming hygiene in the farming and veterinary press, were significantly more likely to have changed their working practices. Difficulties accessing water and cleaning facilities on farms were identified as the greatest barrier to improving biosecurity practices. Participants' preferred priority for future research was continued collection of evidence for the importance and efficacy of good foot-trimming hygiene practices.

Whilst the impact of science is often evaluated using quantitative research metrics, others consider research impact in the context of researchers' programme goals and in terms of societal impact (Hicks *et al.*, 2015; Chowdhury *et al.*, 2016). Here, we describe the assessment of the impact of a research programme into reducing transmission of the infectious foot disease of cattle, bovine digital dermatitis (BDD).

A major disease of dairy cattle worldwide, BDD presents as an exudative dermatitis most commonly found at the skin-horn junctions of the heel bulbs (Blowey and Sharp, 1988). Active lesions cause extreme pain and are associated with significant lameness making BDD an important animal health and welfare concern. Current prevention and treatment approaches for farmed animals fail to fully control digital dermatitis spread, with the disease frequently recurring (Krull *et al.*, 2016).

Previous research has identified hoof knives and gloves worn during the routine husbandry procedure of cattle foot-trimming as key infection reservoirs for BDD-associated treponemes (Blowey *et al.*, 2013; Sullivan *et al.*, 2014) which was concerning because of the potential risk for transmitting BDD on and between farms. After informing the foot-trimming community of this issue, we secured funding to develop the evidence base to advise the industry how to solve the problem. We were able to develop and test a disinfection protocol for use during foot-trimming using data from in vitro disinfection experiments and field studies (Gillespie *et al.*, 2019, 2020). To maximize impact from this research, a series of knowledge transfer activities were carried out to ensure that end users of the research would be able to incorporate the study findings into practice.

The value of research-based knowledge has long been recognized in the livestock industry, however, translating this knowledge into strategies that encourage behavioural change often proves challenging (Garforth *et al.*, 2004). There are a number of popular health psychology models which endeavour to explain how individuals make decisions and translate these into action, such as the Theory of Reasoned Action, which considers the decision-makers beliefs and perception of action outcome, as well as recognizing the importance of the influence of the actions and behaviours of others (Garforth *et al.*, 2004). In light of poorly implemented internal biosecurity practices on farms, there has been some exploration of the role of cattle

© The Author(s), 2021. Published by Cambridge University Press on behalf of Hannah Dairy Research Foundation. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.



CAMBRIDGE  
UNIVERSITY PRESS

farmers and dairy veterinarians specifically in on-farm biosecurity (Brennan and Christley, 2013; Sayers *et al.*, 2014). However, there is no information in the literature regarding attitudes and beliefs of foot-trimmers regarding biosecurity. This should be considered especially important in controlling the spread of BDD, as those who carry out foot-trimming include a subset of farmers and veterinarians together with foot-trimming professionals who will frequently bring themselves and their equipment (known key infection reservoirs) into contact with large numbers of cattle feet.

In this study, we set out to measure the impact of our research (and associated knowledge transfer) upon enhancing both understanding and practice of all professionals who trim cows' feet to prevent the transmission of BDD between cattle during foot-trimming, and to identify future avenues of relevant research.

## Materials and methods

The study population were cattle foot health experts comprising dairy farmers, veterinary surgeons, and commercial cattle foot-trimmers. There were three stages in this study: (1) an initial questionnaire and knowledge exchange, (2) dissemination of questionnaire results and further knowledge exchange, and (3) a follow-up questionnaire. The initial questionnaire aimed to gauge current foot-trimming hygiene practices *via* both paper format and electronic format using SurveyMonkey software (SurveyMonkey Inc., San Mateo, California USA). This questionnaire was undertaken between April and October 2019 and was approved by the University of Liverpool Veterinary Ethics Committee (Ref: VREC 786). Prior to opening of the questionnaire, development of a foot-trimming hygiene protocol was undertaken in consultation with the UK dairy industry levy board, AHDB Dairy, based on our previous research findings (Blowey *et al.*, 2013; Sullivan *et al.*, 2014; Gillespie *et al.*, 2019) (Available at <https://ahdb.org.uk/reducing-spread-of-DD>). The protocol was advertised and disseminated at UK industry events attended by the authors to administer the questionnaire. Online methods targeted both nationally and internationally were also used for promotion (April–October 2019). In the second stage of the study, results were disseminated to industry stakeholders and participants *via* a series of knowledge exchange articles in the farming, foot-trimming and veterinary presses, as well as using online delivery (January to May 2020). The third study phase comprised a follow-up survey (approved by the University of Liverpool Veterinary Ethics Committee; Ref: VREC 786a), undertaken between April and June 2020 to assess the impact of this research (enabled by knowledge exchange activities) on foot-trimming hygiene practices. This survey was available only online (due to event cancellations during the coronavirus pandemic) and was advertised to each target group after results from the initial questionnaire had been communicated with that group.

Throughout the study, we aimed to engage with key industry bodies relevant to the target study population. Details of the overall sampling and knowledge exchange strategies are shown in online Supplementary Table S1. The paper questionnaire formats are available in Supplementary Information Figs S1 and S2. Questionnaire replies were downloaded and entered into Microsoft Excel (Microsoft Excel for Microsoft 365 MSO, USA) for descriptive analysis. For the follow-up questionnaire, logistic regression was carried out in STATA v14 (StataCorp, USA) to assess the association between the country the respondent was working in and three outcomes: whether they had seen the

AHDB Dairy hygiene protocol, or other relevant articles, and whether they had changed practice. Univariable logistic regression was also used to assess the association between having seen the hygiene protocol and/ or other articles and whether hygiene management had changed, and the association between number of cows trimmed each week and the outcome of a change in practice.

## Results and discussion

### *Initial questionnaire: assessing current industry practice for hygiene during foot-trimming*

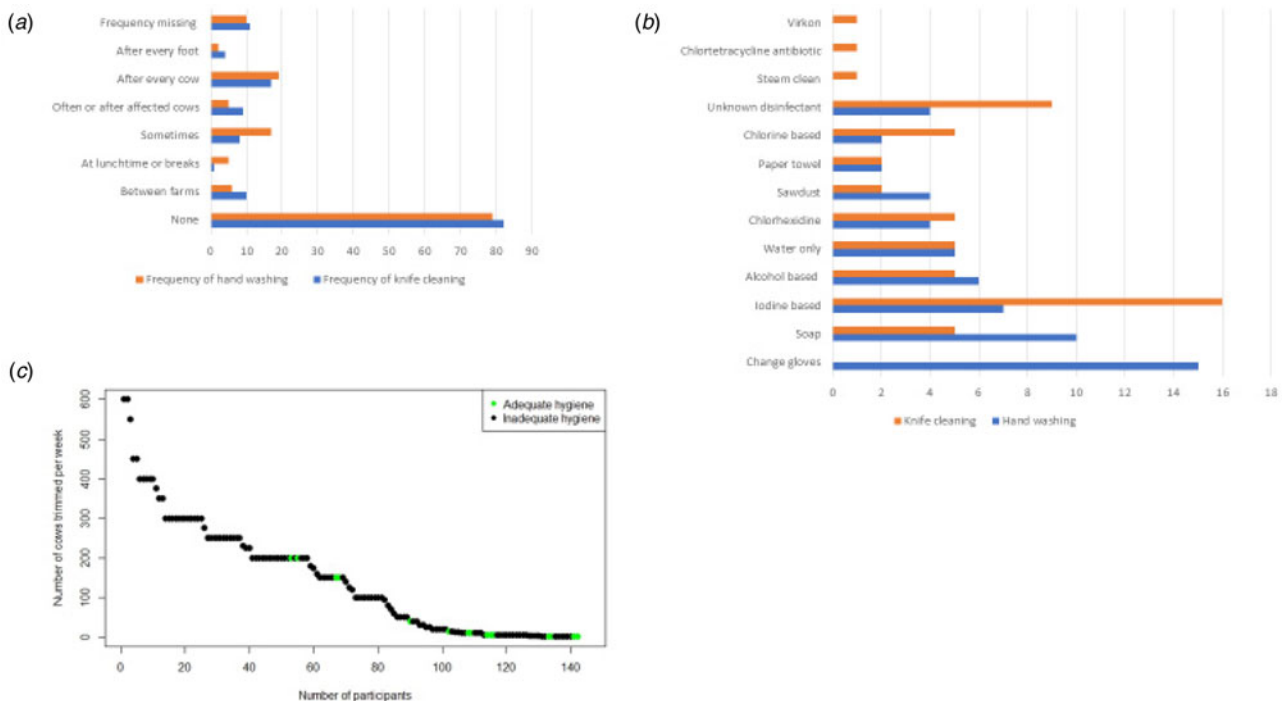
The first questionnaire had a total of 143 respondents: 84 online and 59 *via* paper questionnaire. Respondents reported working on 4951 farms (median 20, IQR 5–42, range 1–500). Collectively, they trimmed an estimated 22 490 cows each week (median 123, IQR 10–250, range 1–2000). Respondents frequently reported that they did not wash their hands or hoof knives during foot-trimming (79/143, 55.2% and 82/142, 57.7% respectively). For those that did report washing hands and/ or hoof-knives, the frequency of these practices is shown in Fig. 1a.

Participants reported using ten different hygiene methods for hand washing and twelve for cleaning hoof knives (Fig. 1b). Study participants came from a variety of career backgrounds with vocational training in cattle foot-trimming having varying degrees of formality. Whilst education concerning practice of good biosecurity between farms to prevent spread of infectious diseases is commonplace, there are no consistent or specific recommendations relating to internal biosecurity. This may partly explain the spectrum of practices reported.

When we considered both their hand washing and knife cleaning procedures, thirteen participants were classified as practicing adequate hygiene (13/143, 9.1%). Hygiene measures were considered adequate if undertaken at least after trimming of infected cows, and the hygiene measure included using soap or disinfectant. Changing gloves was also considered an adequate hygiene measure for hand washing. Collectively these thirteen accounted for trimming only 594/22 490 (2.6%) of the estimated number of cows trimmed by respondents each week and just four of these respondents were trimming more than 15 cows per week (Fig. 1c), suggesting practical difficulties in implementation may be a barrier to widespread adoption of the hygiene protocol.

### *Follow-up questionnaire: assessing the impact of research on foot-trimming hygiene practices*

Eighty farmers, veterinary surgeons and foot trimmers responded to the follow-up survey and reported working on a total of 3800 farms (median 28, IQR 10–50, range 1–600), collectively trimming approximately 12 660 cows per week (median 150, IQR 9–250, range 1–1200). Participants were working in the UK (45/80, 56.0%), Europe (20/80, 25.0%), the USA and Canada (14/80, 17.5%), as well as New Zealand (1/80, 1.3%). Thirty respondents had seen both the foot-trimming hygiene protocol produced by the University of Liverpool and AHDB Dairy, and other articles regarding foot-trimming hygiene in the farming or veterinary press during the previous year. Twelve more (15%) had seen only the foot-trimming hygiene protocol, and thirteen reported seeing other articles only. Thirty-five participants (43.8%) agreed or strongly agreed that their awareness of the potential to spread BDD during foot-trimming had increased during the last year, whilst thirty-six (45.0%) agreed or strongly



**Fig. 1.** Results from the initial questionnaire. (a) Frequency of hand washing ( $n = 143$ ) and hoof-knife cleaning ( $n = 142$ ) amongst professionals trimming cows' feet, displayed in decreasing order of frequency. Some participants reported that they do wash their hands or hoof knives during foot-trimming but did not answer how frequently. (b) Hygiene methods used by professionals for hoof-knife cleaning and hand washing during foot-trimming. (c) Highlighting those participants who were classified as practicing hygiene adequate for preventing transmission of BDD during foot-trimming, plotted against the number of cows they were trimming each week.

agreed that their awareness of appropriate hygiene and disinfection to prevent spread of BDD during foot-trimming had increased. Thirty-six respondents reported making changes to their hygiene management during foot-trimming in the previous year (36/80, 45.0%), totalling 64 improvements to hygiene between them (Fig. 2a), and affecting 1383 farms (1383/3,800, 36.4%) and 5130 cows trimmed each week (5130/12,660, 40.5%). This shows increased awareness of foot-trimming hygiene and changes in practice within the last year, which we attribute to our knowledge exchange work. Two respondents (2/36, 5.6%) reported that they had observed a reduction in BDD cases they attributed to the changed practice.

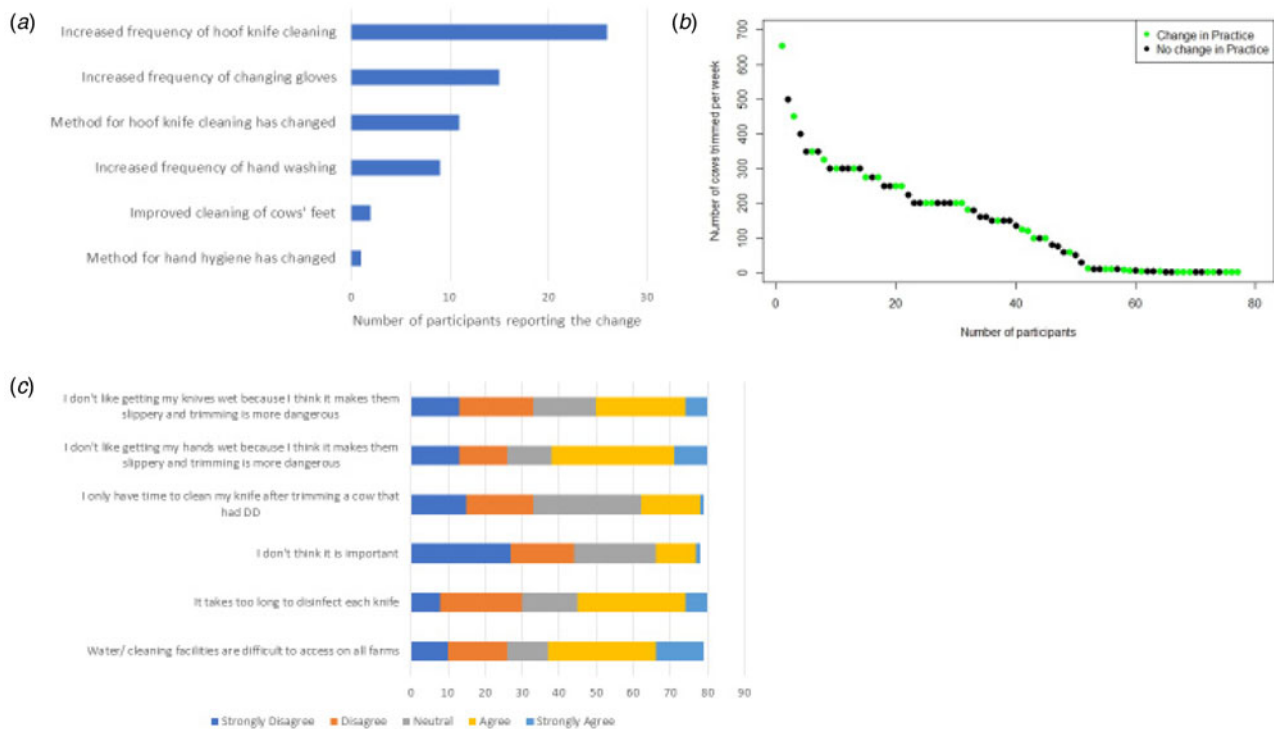
Univariate logistic regression showed that respondents were more likely to have seen the AHDB Dairy hygiene protocol if they were working in the UK ( $P < 0.001$ ), however, there was no association between country of origin and seeing other articles in the farming or veterinary press ( $P = 0.65$ ). Univariate logistic regression showed no association between the country of origin and changes in practice ( $P = 0.32$ ), however, having seen both the AHDB Dairy hygiene protocol *and* other articles increased the odds of changing the working practice (OR 1.49, 95% CI 0.34–2.64,  $P = 0.011$ ), suggesting that University of Liverpool research and knowledge exchange activities were effective, and had international impact, and multiple sources of information were needed. No association was found between the number of cows trimmed each week and changes made in practice ( $P = 0.39$ ) (Fig. 2b).

Respondents were most likely to agree or strongly agree that difficulty in accessing water and cleaning facilities on farms was a barrier to improving foot-trimming hygiene (Fig. 2c), supporting the concept that practical difficulties are problematic and complementing the observation from the initial questionnaire that those

practicing adequate hygiene were mostly trimming small numbers of cows. However, these are not insurmountable problems and will be the next focus of our research, to identify means of improving biosecurity measures and hence enable professionals to use best practice whenever possible during foot trimming.

The main theme in suggestions for future research was to continue investigating transmission routes including ratifying the importance of fomites in BDD transmission (12/30, 40% of suggestions), indicating there is continued uncertainty in the industry surrounding the value of adopting good foot-trimming hygiene. Lack of proof of efficacy has previously been cited by farmers and veterinary surgeons as a perceived barrier to adoption of good biosecurity practices for prevention of spread of other diseases (Gunn *et al.*, 2008). Although the request for future research ideas was presented as an open question, the subject of the questionnaire may have influenced this outcome.

The limitations of this study, including sampling methods, should be acknowledged. There is sample bias in the study population resulting from a non-random sampling strategy and convenience sampling, and therefore whilst we have targeted the major groups trimming cattle feet, the results should not be overly generalized. In particular, the online-only approach for advertising the follow-up questionnaire may have selected for those who are more accustomed to use of social media and the internet. The second questionnaire may also have received biased responses, both in terms of those who responded and in terms of the impact reported on hygiene practices, because industry professionals who are already engaged with our research may have been more likely to participate (volunteer bias) (Eysenbach, 2004). Since both questionnaires were anonymous, however, we are not able to assess how many respondents answered both questionnaires.



**Fig. 2.** Results from the follow-up questionnaire. (a) Number of industry professionals reporting different changes made to their foot-trimming hygiene practices in the last year. (b) Highlighting those participants who reported changing their management of hygiene during foot-trimming, plotted against the number of cows they were trimming each week. (c) Responses collected on a Likert scale to six statements describing barriers to improving foot-trimming hygiene which had been commonly identified *via* conversation with industry stakeholders.

In conclusion and notwithstanding these limitations, we identified that a comprehensive knowledge exchange programme of recent research has helped to rapidly increase knowledge and awareness of improving hygiene management during foot-trimming. The present survey results indicate a substantial uptake of suggestions contained in the foot-trimming hygiene protocol by the dairy industry, with the impact of preventing one possible route of transmission of BDD. There is acknowledgement of the continued difficulties with practical implementation of improved hygiene, and an expression of a continued requirement from industry stakeholders for BDD research. Areas of interest remain focused on transmission routes and control of this important disease with associated knowledge exchange needed to maximize impact and help farmers to improve their herd management.

**Supplementary material.** The supplementary material for this article can be found at <https://doi.org/10.1017/S0022029921000170>

**Acknowledgements.** The authors would like to thank AHDB Dairy, particularly Derek Armstrong and Jenny Gibbons, for support in foot-trimming hygiene protocol development and assistance in knowledge exchange with industry stakeholders. We would like to acknowledge BBSRC Grants (Refs: BB/E018920/1, BB/K009443/1, BB/N002121/1, BB/M011186/1) and funding from AHDB Dairy, AHDB Beef and Lamb, HCC and QMS.

## References

- Blowey RW and Sharp MW** (1988) Digital dermatitis in dairy cattle. *The Veterinary Record* **122**, 505–508.
- Blowey R, Sullivan L, Evans N and Carter SD** (2013) Detection of bovine digital dermatitis on hoof knives and hands and their removal by disinfection. In *27th International Symposium and 9th International Conference on Lameness in Ruminants*. p. 181.
- Brennan ML and Christley RM** (2013) Cattle producers' perceptions of biosecurity. *BMC Veterinary Research* **9**, 71.
- Chowdhury G, Koya K and Philipson P** (2016) Measuring the impact of research: lessons from the UK's research excellence framework 2014. *PLoS One* **11**, E0156978.
- Eysenbach G** (2004) Improving the quality of web surveys: the checklist for reporting results of internet e-surveys (cherries). *Journal of Medical Internet Research* **6**, E34.
- Garforth C, Rehman T, Mckemey K, Tranter R, Cooke R, Yates C, Park J and Dorward P** (2004) Improving the design of knowledge transfer strategies by understanding farmer attitudes and behaviour. *Journal of Farm Management* **12**, 17–32.
- Gillespie A, Carter SD, Blowey RW and Evans N** (2019) Survival of bovine digital dermatitis treponemes on hoof knife blades and the effects of various disinfectants. *Veterinary Record* **186**, 67.
- Gillespie AV, Carter SD, Blowey RW, Staton GJ and Evans NJ** (2020) Removal of bovine digital dermatitis-associated treponemes from hoof knives after foot-trimming: a disinfection field study. *BMC Veterinary Research* **16**, 330.
- Gunn GJ, Heffernan C, Hall M, Mcleod A and Hovi M** (2008) Measuring and comparing constraints to improved biosecurity amongst GB farmers, veterinarians and the auxiliary industries. *Preventive Veterinary Medicine* **84**, 310–323.
- Hicks D, Wouters P, Waltman L, De Rijcke S and Rafols I** (2015) Bibliometrics: the Leiden Manifesto for research metrics. *Nature* **520**, 429–431.
- Krull AC, Shearer JK, Gorden PJ, Scott HM and Plummer PJ** (2016) Digital dermatitis: natural lesion progression and regression in Holstein dairy cattle over 3 years. *Journal of Dairy Science* **99**, 3718–3731.
- Sayers RG, Good M and Sayers GP** (2014) A survey of biosecurity-related practices, opinions and communications across dairy farm veterinarians and advisors. *Veterinary Journal* **200**, 261–269.
- Sullivan LE, Blowey RW, Carter SD, Duncan JS, Grove-White DH, Page P, Iveson T, Angell JW and Evans NJ** (2014) Presence of digital dermatitis treponemes on cattle and sheep hoof trimming equipment. *The Veterinary Record* **175**, 201.