Institution: University of Warwick

Unit of Assessment: A6 – Agriculture, Veterinary and Food Science

Title: Rapid Antibiotic Treatment Reduces the Prevalence of Lameness caused by Footrot in Sheep

1. Summary of the impact

Footrot (FR) causes 90% of lameness in sheep. FR reduces productivity and lowers sheep welfare. Research at the University of Warwick, initiated in 1999 and still active, has led to the development of a novel management strategy for footrot in sheep: prompt antibiotic treatment (PAT) - sheep treated with intramuscular and topical antibiotics within three days of becoming lame with FR. This has resulted in a reduction in the overall prevalence of lameness in sheep flocks in England from 10% (2004) to 5% (2011) and 3% (2013). In 2011, evidence from research at Warwick on PAT was used by the Farm Animal Welfare Council of Great Britain to support their statement that it was feasible to reduce the prevalence of lameness in the national flock from 10% to 2% by 2021. From 2005 onwards, PAT has been disseminated to 50,000 sheep farmers through knowledge transfer (KT) by EBLEX, the levy body for sheep farmers in England using booklets, CDs and more than 100 on-farm events. More than 50% of farmers who had attended an EBLEX KT meeting on lameness stated that they had changed their management of lameness as a result of new information from the event. The Sheep Veterinary Society in the UK has adopted PAT as the recognised management approach for FR and a leading sheep vet in Germany has written a book promoting PAT. The work has been presented in Europe as part of Animal Welfare Research in an Enlarged Europe (AWARE), an EU-funded project educating all countries in the enlarged EU zone on animal welfare (http://tinyurl.com/o6onaxd). In 2012, the lead Warwick researcher Professor Green was awarded the Royal Agricultural Society of England medal specifically for 'impact to the sheep farming community in reducing footrot in sheep'.

2. Underpinning research

Footrot (FR) is listed in the top five most important diseases of sheep in all countries with large sheep industries. Leaving sheep lame reduces body condition, increases the risk of death, infertility or small litter size and reduces lamb growth rates[1]. Research from Professor Green's team at the University of Warwick's School of Life Sciences has shown that interdigital dermatitis (ID) is a mild presentation of FR, caused by the same bacterium, *Dichelobacter nodosus* (Calvo-Bado *et al*., 2010; Witcomb, 2012).

Footrot (henceforward including ID) causes 90% of lameness in sheep in England[2] and reduces productivity and welfare[1]. The cost to the GB sheep industry is estimated at £24 - £80[1] million per year. In 1999, Warwick researchers, together with collaborators at Bristol University, proposed that either the current recommended methods to control lameness were ineffective or that farmers were unable to implement them effectively. Management of FR at that time centred on regular whole-flock managements of foot trimming and footbathing. Individual lame sheep were primarily treated by trimming hoof horn to reveal foot lesions, and spraying feet with topical disinfectant. There was no evidence that this approach was effective and the 1999 study indicated that farmers who were managing FR effectively were treating all individual sheep lame with FR[3] using antibiotic by injection and topical application. The flock managements described above were ineffective.

In a Warwick-led 18-month within-farm clinical trial of 800 ewes (2005 to 2006)[1] the mean prevalence of lameness in 400 ewes that were treated by foot trimming and foot spraying when lame with FR was 7% over 18 months whilst the prevalence of lameness in 400 ewes treated by PAT when lame with footrot fell to 2% after 6 – 12 weeks and remained at this level[3]. A Warwick-only clinical trial (2008)[4] was used to compare PAT and prompt foot trimming with topical disinfectant on time to recovery in a factorial design with 53 ten-month-old ewes. Results were that PAT of sheep lame with FR led to recovery from lameness and active foot lesions in one to ten days in over 95% of sheeep[4] whilst less than 25% of sheep treated with the traditional method of foot trimming and topical disinfectant recovered in ten days[4]. Further analysis of the 2005 – 2006 data indicated that PAT prevented development of poor foot conformation and led to recovery from existing poor foot conformation; it also prevented recurrent lameness[5]. In another Warwick-only study (2005)[6] it was shown that whilst farmers could identify lame sheep accurately (giving confidence to farmer estimates of prevalence of lameness in their flock[1,3]) they did not treat all lame sheep but made a separate decision on whether to catch and treat lame sheep[6,7].

Consequently, some lame sheep are left untreated, rather than being treated promptly.
Farmers that delayed treatment of lame sheep reported a higher prevalence of lameness in their flock than those who treated lame sheep promptly[6].
In conclusion, approximately 80% of the 10% prevalence of lameness in sheep can be explained by delay in treatment of sheep with FR, together with using the sub-optimal treatment of foot trimming and foot spraying. If all farmers adopted PAT the prevalence of lameness in the GB flock would be expected to fall from 10% to 2%, with much of the 2% prevalence of lameness being sheep recovering from FR or lameness caused by conditions other than FR. From the 2005 to 2006 study, in a flock with an average prevalence of 7% lameness, the net loss of failing to use PAT was £6 to £10 per ewe in 2006[1].
Some of this research was carried out in conjunction with the University of Bristol: Warwick led all the research. All KT with EBLEX (talks, development of educational material) was undertaken by Green, Kaler, Wassink and King.

Warwick staff

PI: Professor Laura Green, School of Life Sciences (1999–present). Professor Green is an internationally renowned infectious disease epidemiologist whose motivation is to improve the health and welfare of livestock.
Co-Is: Professor Graham Medley (1995–present); Professor Elizabeth Wellington (1987–present), School of Life Sciences.
Postdoctoral research assistants:
Dr Leo Calvo Bado (2007–2011); funded by BBSRC CEDFAS (Combating Endemic Diseases of Farm AnimalS) project, Dr Jasmeet Kaler (2007–2010); funded by BBSRC CEDFAS. Now a Lecturer in Epidemiology at the University of Nottingham. Dr Geert Wassink (1999–2009); funded by MAFF and Defra projects.
Ph.D. students: Luci Witcomb (2008-2012); Elisabeth King (2009-2013) funded by NERC and BBSRC CASE awards.

Collaborators

Co-I: Dr Lynda Moore (1999–2006) and Dr Rose Grogono-Thomas (1999-present), Lecturer and Senior Lecturer, respectively, University of Bristol School of Veterinary Science.

3. References to the research *(identified in statement by superscript number)*

1. Wassink, G.J., King, E.M., Grogono-Thomas, R., Brown, J.C., Moore, L.J. and Green, L.E. (2010) A within farm clinical trial to compare two treatments (parenteral antibacterials and hoof trimming) for sheep lame with footrot. Preventive Veterinary Medicine, 96, 93 - 103 (0167-5877) ***DOI:10.1016/j.prevetmed.2010.05.006*** [Ref2]
2. Kaler, J. & Green, L.E. (2008) Naming and recognition of six foot lesions of sheep using written and pictorial information: a study of 809 English sheep farmers. Preventive Veterinary Medicine, 83 (1), 52 - 64 (0167-5877). ***DOI:10.1016/j.prevetmed.2007.06.003***
3. Wassink G.J., Grogono-Thomas R., Moore L.J. & Green L.E. (2003) Risk factors associated with the prevalence of footrot in sheep from 1999 to 2000. Veterinary Record, 152, 351 - 358 (0042-4900). ***DOI: 10.1136/vr.152.12.351***
4. Kaler, J., Daniels, S.L.S., Wright, J.L. & Green, L.E. (2010) A randomised factorial design clinical trial to investigate the impact of parenteral long acting oxytetracycline, foot trimming and flunixine meglumine on time to recovery from lameness and foot lesions in sheep lame with footrot', Journal of Veterinary Internal Medicine, 24, 420 - 425 (0891-6640). ***DOI:10.1111/j.1939-1676.2009.0450.x***
5. Kaler, J., Medley, G.F., Grogono-Thomas, R., Wellington, E.M.H., Calvo-Bado, L.A., Wassink, G.J., King, E.M., Moore, L. J., Russell C., & Green L.E. (2010) Factors associated with changes of state of foot conformation and lameness in a flock of sheep. Preventive Veterinary Medicine, 97, 237 - 244 (0167-5877). ***DOI:10.1016/j.prevetmed.2010.09.019***
6. Kaler, J., George, T.R.N. & Green, L.E. (2011) Why are sheep lame? Temporal associations between severity of foot lesions and severity of lameness in 60 sheep. Animal Welfare, 20, 433 - 438 (0962-7286).
7. King E.M. & Green, L.E. (2011) Assessment of farmer recognition and reporting of lameness in adults in 35 lowland sheep flocks in England. Animal Welfare, 20, 321 - 328 (0962-7286).
8. Ph.D. thesis - King, 2013: Lameness in English lowland sheep flocks: farmers' perspectives and behaviour (http://tinyurl.com/o6v3rtc).

Key peer-reviewed grants/awards

- MAFF, "Investigations into the microbiological causes and effective control of footrot" (Grant reference AW1007) PI Green; Amount awarded £198,321 (1999–2003). Grant final report: http://tinyurl.com/qfcvygv.
- DEFRA, "Intervention study to minimise lameness in sheep" (Grant reference AW1021), PI Green; Amount awarded £340,735 (2005–2007). Grant final report: http://tinyurl.com/obr4ubp.
- EBLEX, "Technology transfer to the sheep industry": PI Green: £100K (2006–2008).
- BBSRC CEDFAS, "A molecular epidemiology approach to combating footrot, an important endemic disease of sheep" (Grant reference BB/E01870X/1), PI Green; Amount awarded £901,721 (2007–2012). Grant final report: http://tinyurl.com/neskrt.
- BBSRC, ISIS travel award to Australia for J. Kaler and L.E. Green, linked to BB/E01870X/1, PI Green; Amount awarded £4,000 (2008).
- BBSRC, Partnering India Award, linked to BB/E01870X/1, PI Green; Amount awarded £16,888 (Grant reference BB/G530292/1) (2009 – 2011). Grant final report: http://tinyurl.com/onex28t.
- BBSRC, Industry interchange programme with Eblex, linked to BB/E01870X/1, PI Green; Amount awarded £50,000 (2010–2011).
- Defra, "Motivating change in sheep farmers: the example of footrot"; PI Green; (Grant reference AW0512) Amount awarded £519,106 (2011–2014).

Ph.D.s resulting from the research

Jasmeet Kaler (2004–2008) MLC, competitively awarded, supervisor Green: Luci Witcomb (2008–2012) NERC CASE Pfizer, supervisors Wellington and Green: Vinca Russell (2008–2012) BBSRC Pfizer CASE (linked with Roslin), supervisors Green, Medley and Bishop: Elisabeth King (2009–2013) Pfizer BBSRC industrial CASE, supervisor Green: Mohd Muzafar (2011–2014) Warwick Chancellors Overseas Scholarship, competitively awarded, supervisors Wellington and Green

4. Details of the impact

Animal health and welfare: In 2004, the mean flock prevalence of lameness in England was 10.4% (9.2–11.0% - 95% standard error intervals) and 10% of farmers were always using PAT (prompt antibiotic treatment) to treat sheep lame with FR (including ID), according to 809 farmers randomly sampled from the EBLEX database[2]. By 2011, the median flock prevalence of lameness in England was 5% (interquartile range 2–10%) and 25% of farmers were using PAT, according to 445 farmers randomly sampled from EBLEX[8]. Most recently, results from 1,200 farmers randomly selected from all English sheep farmers gave a median estimated lameness in 2012 of 3% (unpublished data, Green *et al*., available upon request).

Adoption of practice in the GB sheep industry: In 2010, Professor Green was asked to present evidence on managing lameness in sheep to the UK Farm Animal Welfare Council (FAWC). Their "Opinion on Lameness in Sheep" was published in 2011 with the recommendation that the prevalence of lameness should be reduced from the current 10% to 5% by 2016 and to 2% by 2021 using existing knowledge from our research (source A). The Opinion is accessed at a rate of about 300 downloads per month (information can be corroborated by email). Several retailers and quality assurance schemes that are strongly influenced by the FAWC are now monitoring lameness and provide advice to farmers on the appropriate treatment of lame sheep based on the evidence from our research[1-8].

Veterinary practitioners and consultants – Nationally and Internationally: The results from this research have been presented at Sheep Veterinary Society (SVS) meetings and published in SVS proceedings. They have also been published in veterinary professional journals such as UK Vet (Source B), where leading practitioners discuss novel approaches to management, treatment and engaging with farmers and also presented at other professional conferences, raising vets' awareness of our findings.

The Warwick research has created a sea change in understanding how to control FR both in the UK and internationally (sources A–H). At a Sheep Veterinary Society meeting (September 2011) we presented our evidence that ID and FR are the same disease, a concept that was not accepted by many in the UK's veterinary and farming community. As a result of this, the Sheep Veterinary Society drafted new national recommendations on the treatment and control of FR in sheep that are due to be published (source C). Multiple hundreds of specialist sheep vets have been using PAT since 2006 and have seen the benefits for their clients (sources D and E).

At an international level, the major impact has been an increasing acceptance and understanding that management of FR has to vary by country and is dependent on prevalence of the disease and

local climate. In the past, adoption of Australian managements in GB has been a major stumbling block and disenfranchised farmers who became frustrated that the managements they used were ineffective. Warwick's research has been taken up in Germany, where it has been used extensively by their national sheep veterinary society in their national flock health improvement programme and published in a book specifically written about footrot in sheep (source F). National recognition is evidenced: Professor Green was awarded the Royal Agricultural Society for England Research Medal in 2012 for "outstanding scientific work in reducing the impact of footrot in sheep".

Farmers: Professor Green has explained PAT, with supporting evidence, at over 50 farmer meetings since 2005 with audiences of 20 to 200 sheep farmers. She has many individual emails from farmers reporting in their success. An example of farmer success is a letter from a Welsh sheep farmer and member of FAWC (source G). In 2006, Professor Green and her team worked with EBLEX to produce a Better Returns manual on "Minimising Lameness" (distributed to 50,000 producers) and CD (5,000 copies including a library of condition images to help with lesion identification and further details; video footage from this has been on YouTube since January 2012 at http://tinyurl.com/ncymc3r) (source H). Updates and further information were sent to 30,000 producers as a paper bulletin. In a survey of participants carried out for EBLEX by independent survey specialists Noesis in 2010, 57% of sheep farmers surveyed claimed to have adopted at least one of the methods from the research on sheep health (source I). Similar information has been produced by farmers in Wales by HCC and Farming Connect, both by Green and Welsh Vets. Green has spoken at and attended agricultural shows such as The Royal Show, Sheep 2006, Sheep 2008 and Sheep 2010 to promote the new approach to managing footrot to farmers. As a result of the 2009 BBSRC Industrial Partnership, Green initiated "train the trainer" events with EBLEX in 2010, these are professional development days geared towards vets that educate them on lameness and other important issues that sheep farmers want their vet to understand e.g. nutrition and genetics with the aim of reaching out to their clients.

Other approaches to impact

In addition to the dissemination activities mentioned above, the Warwick team has developed and maintains a website on footrot for farmers and vets with a very high hit rate, over 2000 individual visitors per 6 months (http://www.footrotinsheep.org) (source J). Articles were published in veterinary and industry journals (UK Vet, RCVS website, Journal of RASE, 2012). The findings have also been publicised through articles in national and local papers - The Daily Telegraph (16 October 2008), Western Daily Press (25 October 2008) and Western Morning News (22 October 2008) - and in the farming press - Farmers Guardian (14 November 2008), Farmers Weekly (2011) and The Sheep Farmer (2008). Professor Green participated in a webinar hosted by Farmer's Weekly in 2012. The Warwick work has been widely reported internationally (Canada 2011, USA 2011, Ireland 2012).

5. Sources to corroborate the impact *(identified in Section 4 as sources A - K)*

A. FAWC "Opinion on Lameness in Sheep", March 2011 (http://tinyurl.com/n9me38l). Professor Green and the team's input are acknowledged and referenced seven times.
B. Green *et al*. Clinical Forum: "Understanding lameness in sheep: Managements for today", UK Vet: Livestock 16(5), 30–42 (2011).
C. Sheep Veterinary Society, "Advice on best practice for treating and controlling footrot", written 2012 (available from SVS and Warwick).
D. Letter of support: Independent Veterinary Consultant and Farm Skills (LANTRA-accredited) Trainer, Cumbria, UK. (Identifier 1).
E. Letter of support: Practicing Vet, Torch Farm & Equine Limited, Devon, UK. (Identifier 2).
F. Letter of support: Practicing Vet and overseas member of British Sheep Veterinary Society, Deutsche Veterinärmedizinische Gesellschaft e.V., Germany (Identifier 3).
G. Letter of support: Welsh Sheep Farmer and Chair FAWC Ruminant Working Group Identifier 4).
H. EBLEX Sheep Better Returns Programme Manual 7. "Target Lameness for Better Returns", 50,000 pamphlets/5,000 CDs created; content by Professor Green provided in 2008; reprinted in July 2013. Also on YouTube at http://tinyurl.com/ncymc3r.
I. Letter of support: EBLEX, Head of Knowledge Transfer. (Identifier 5).
J. Footrot in sheep website: www.footrotinsheep.org. From October 2012 to March 2013 there were 2,256 unique visitors.