There is currently global concern over rising levels of antibiotic resistance among commensal and pathogenic bacteria in human and animal populations. Unless urgent action is taken by the medical and veterinary professions, it is thought that we will enter a postantibiotic era in which bacterial diseases that were readily treatable with antibiotics will kill once again. Consequently, antibiotic use in both the human and animal health industries has come under intense scrutiny. Long-held ideas and accepted behavioural norms have rightly been challenged. Progress in the agricultural industries has developed apace with the establishment of the Responsible Use of Medicines in Agriculture Alliance Targets Task Force in December 2016 and Defra’s call for the implementation of sector-specific targets on the use of antibiotics. This article describes how veterinary surgeons and sheep farmers can work together to plan, prevent and protect against three specific disease management issues – infectious lameness, enzootic abortion of ewes and neonatal bacterial infections – by replacing, refining and reducing the use of antibiotics on farm, based on guidelines drawn up by the Sheep Veterinary Society.

Areas for concern

Examination of antibiotic use in the sheep sector, led by the Responsible Use of Medicines in Agriculture (RUMA) Alliance Targets Task Force report [RUMA 2017], the Sheep Veterinary Society (SVS) [SVS 2017a] and supported by recent research [Davies and others 2017] (Fig 1), has identified that areas of concern for the veterinary profession with regard to prescribing practices for sheep surround three specific disease management issues:

- Whole-flock prophylactic antibiotic treatments for the control of infectious lameness;
- Whole-flock prophylactic antibiotic treatments for the prevention of enzootic abortion of ewes (EAE);
- Whole-flock prophylactic treatment of lambs against neonatal bacterial infections.

The responsible use of antibiotics in livestock is an ethical issue – we must always balance and justify our decisions in the light of our primary consideration as a profession to uphold animal welfare. Current thinking on responsible antibiotic use in livestock is that while the treatment of individual sick animals with appropriate antibiotic therapy is always justifiable, the metaphylactic treatment of groups of animals can be justifiable, but the prophylactic treatment of whole flocks or lamb crops is rarely justifiable (Boxes 1, 2).

There are many other tools available to manage bacterial diseases besides antibiotics, including biosecurity, vaccination, hygiene measures, nutrition and other management actions. The responsibility lies with veterinary professionals to work closely with clients to encourage
the uptake of these alternative approaches and reduce dependence on prophylactic antibiotic strategies.

To support and encourage the profession in this endeav-our, the SVS, alongside other planned activities, has produced good practice guidelines (SVS 2017b) that detail its view on responsible antibiotic use for the diseases mentioned above and it is these guidelines that form the basis of this article. Quite simply, the primary recommen-
dations are that to replace, refine and reduce antibiotics in these target areas, veterinary surgeons and sheep farmers should work to plan ahead, prevent disease and protect their flocks.

Lameness

Lameness is a common and serious welfare problem for many sheep flocks. In the UK it is largely caused by bacte-

Box 1: BVA’s position on the use of antibiotics in food-producing animals

- The BVA recognises that antimicrobial resistance (AMR) is an issue of critical importance to society as a whole and is committed to providing leadership on this issue. The overall aspiration is to reduce the use of antibiotics in animals under veterinarians’ care, as well as improving these animals’ health and welfare, particularly through disease-prevention strategies.
- It is not possible to raise animals in sterile conditions – infections in animals are a reality and antibiotics will remain vital to treat bacterial infections in individuals and in groups managed within the same environment. Metaphylaxis will continue to be necessary in the face of disease outbreaks in groups of animals to minimise disease spread. Oral antibiotic treatments are effective and efficient methods of medicine delivery in some populations of terrestrial and aquatic animals.
- The BVA does not support the habitual use of prophylactic antibiotics. Animal husbandry systems that are rely on such use must be interrogated and action plans developed to limit repeat disease occurrence and investigate alternative strategies for disease control, which may in turn impact upon the cost of food.
- The BVA opposes the introduction of arbitrary non-evidence-based target setting. Such targets to reduce antibiotic use risk restricting vets’ ability to treat animal diseases, which could have serious public health and animal welfare implications. However, the BVA supports the use of evidence-based targets to reduce antibiotic usage in animal agriculture and these are likely to form part of the solution to address AMR globally.

Box 2: Sheep Veterinary Society policy on the responsible use of antimicrobials in sheep

- It is essential that veterinary surgeons comply with the current veterinary medicines regulations regarding the prescribing of antibiotics, which are regulated by the Veterinary Medicines Directorate (VMD).
- In addition, veterinary surgeons should ensure they are prescribing in accordance with BVA guidance on the responsible use of antibiotics.
- Veterinary surgeons should undertake continuing professional development on antimicrobial resistance and responsible antibiotic use.
- All antibiotics should be prescribed responsibly following current professional guidelines. In addition, the European Medicines Agency and the VMD suggest special attention be paid to the prescribing of antibiotics according to the categorisation in Table 1:

Table 1: European Medicines Agency (EMA) Antimicrobial Expert Group (AMEG) classification of World Health Organization critically important antimicrobials (CIAs)*

| Category | Risk to public health | Antimicrobials included | Advice on use |
|----------|-----------------------|-------------------------|---------------|
| Authorised CIA | | | |
| 1 | Low/limited | Narrow-spectrum penicillins, macrolides, tetracyclines | General principles of responsible use to be applied |
| 2 | High | Fluoroquinolones, systemic third- and fourth-generation cephalosporins, colistin† | Restricted to use when there are no alternatives or the response to alternatives is expected to be poor |

* Based on the degree of risk to humans due to antimicrobial resistance development following their use in animals
† The use of aminoglycosides and broad-spectrum penicillins is also considered by the EMA AMEG to be of higher risk to public health than the use of category 1 CIAs, but they are not currently considered to be high-priority CIAs.

- Veterinary surgeons should work to reduce the total amount of antibiotics used on farms by encouraging farmers to take up alternate methods of disease control wherever possible. These include biosecurity, vaccination, improved farm hygiene and other management actions. Currently, areas where veterinary surgeons may be able to make the most impact to reduce the use of antibiotics on sheep farms are:
  - Whole-flock antibiotic treatments for lameness;
  - Whole-flock antibiotic treatments for enzootic abortion;
  - Blanket treatment of lambs against neonatal bacterial infections.
- All sheep farms should have a health plan written in conjunction with their veterinary surgeon and reviewed at least annually. A review of preventive health strategies and antimicrobial use should be included in the plan.
rrial infections, for example, interdigital dermatitis (scald), footrot and contagious ovine digital dermatitis (CODD) (Fig 2). In the analysis of data from 24 flocks served by one practice, two-thirds of the total antibiotics prescribed were for sheep lameness (Davies and others 2017).

It is entirely appropriate to treat all sheep that are clinically affected with one of these infections promptly, with an antibiotic injection (Duncan and others 2018, Green and Clifton 2018). Indeed, it may also be entirely appropriate to isolate and treat whole groups of clinically affected sheep in a flock. However, whole-flock treatments with antibiotics and antibiotic foot bathing are not considered appropriate strategies (see below). Therefore, the important challenge for dealing with lameness in sheep flocks is to reduce the number of new clinical cases that need antibiotic treatment.

**Plan**

The five-point plan initiated by Clements and Stoye (2014) (Box 3) is the current sheep industry-accepted standard for the control of lameness. It summarises the tools that are available for controlling the condition in sheep flocks. Some or all of these can be applied on an individual farm basis following detailed veterinary investigation and the formation of a farm-specific plan. This should include:

- Diagnosis of the causes of lameness in a flock;
- Assessment of farm-specific risk factors (eg, seasonal trends, hygiene, housing, handling areas and field management);
- Design and application of farm-specific disease control measures.

Reassuringly, research evidence shows that a reduction in new cases of lameness is fully achievable if the current tools available for its control are fully considered and applied by practitioners and farmers when tackling the problem in flocks (Kaler and others 2010, Clements and Stoye 2014, Angell and others 2016). For further information, colleagues are referred to two recent articles for reviews of the current evidence base for the management of footrot (Green and Clifton 2018) and CODD (Duncan and others 2018) in sheep.

**Prevent**

The primary source of *Dichelobacter* species and treponemes is infected sheep, although these agents will survive on pasture to some degree. Reducing the bacterial challenge on farm and thereby preventing sheep from coming into contact with agents causing lameness can be achieved by:

- Optimising the hygiene of buildings and handling areas (by keeping them as clean and dry as possible), and using appropriate disinfection. For high-sheep traffic areas outside, such as gateways and around troughs, it may be appropriate to use lime or hard core;
- Ensuring good hygiene of equipment that comes into contact with sheep feet by cleaning and disinfecting hoof knives and gloves/hands between sheep;
- Paying attention to biosecurity. Effective quarantine procedures are absolutely essential in preventing the incursion of *Dichelobacter* species or treponemes that are novel to the flock;
- Reducing the numbers of infected sheep in the flock by isolating, promptly treating or culling clinical cases.

**Protect**

Protection of the flock can be achieved by:

- Breeding lameness-resilient sheep and culling persistently lame sheep – two practices that require meticulous flock record-keeping;
- Vaccinating against footrot. This tool is often the most immediately useful to practitioners wanting to make a clinical impact. As with all vaccinations, the footrot vaccine is not a panacea and cannot be relied upon in isolation; however, research (Duncan and others 2012), clinical experience and countless farmer testimonies suggest that footrot vaccination has a significant role to play in reducing a flock lameness issue to manageable proportions.

The RUMA targets aim to see an increase in the uptake of the five-point plan by sheep farmers and, as a quantifiable proxy of this, an annual 5 per cent increase in the sales of footrot vaccine by 2023 (RUMA 2017).

**Appropriate antibiotic use**

Oxytetracycline is the most commonly used antibiotic for treating footrot and is generally effective for *Dichelobacter* species. There are no licensed treatments for CODD; however, amoxycillin and tilmicosin have proven efficacy

---

**Fig 2:** Infectious foot disease lesions in sheep. (a) Interdigital dermatitis (scald), (b) footrot and (c) contagious ovine digital dermatitis

**Box 3: Five-point plan for reducing lameness in sheep**

- Cull badly or repeatedly affected animals
- Quarantine incoming animals
- Treat clinical cases promptly
- Avoid propagation of infection on farm
- Vaccinate against footrot biannually

*Clements and Stoye (2014)*
In Practice January/February 2019 | Volume 41 | 23-33

Farm Animals

In Practice January/February 2019 | Volume 41 | 23-33

Farm Animals

in vivo and in vitro for its treatment (Duncan and others 2012; Angell and others 2016). The recent authorisation of both tulathromycin (Draxxin 100 mg/ml solution for injection for cattle, pigs and sheep; Zoetis UK) and gamithromycin (Zactran 150 mg/ml solution for injection for cattle, sheep and pigs; Boehringer Ingelheim Animal Health UK) specifically for the treatment of footrot in sheep has led to their widespread (but unauthorised) use against CODD, with their particular advantage being duration of action. This is currently acceptable within the European Medicines Agency’s (EMA’s) definition of high-priority critically important antibiotics (CIAs), although it would not be surprising if the goalposts were moved in the future.

Inappropriate antibiotic use

Two approaches that have been widely used by some practitioners in recent years for controlling CODD and footrot are whole-flock antibiotic treatments and foot bathing in antibiotic solutions. Whole-flock antibiotic treatment has been shown not to be sufficiently effective to justify its high use of antibiotics (Angell and others 2016) and cannot be advocated. However, whole-group treatment of infected sheep following the careful segregation of lame animals can be beneficial and should be considered.

The lack of published evidence to support the benefit of antibiotic foot bathing, together with its use of high volumes of unauthorised products and insufficient guidance as to effective dose or appropriate disposal, means that this practice cannot be considered an appropriate or responsible use of antibiotics.

Enzootic abortion

Abortions and stillbirths cause significant losses to UK sheep flocks, with 30 per cent of total lamb losses attributed to the period between scanning and lambing (Fig 3) (Hybu Cig Cymru 2011). EAE, caused by Chlamydia abortus, is the most commonly diagnosed cause of abortion in the UK (35 per cent of all ovine abortions from 2012 to 2018 [APHA 2019]). Effective vaccines are available against EAE and should be used as the first line in protecting at-risk flocks. Whole-flock prophylactic antibiotics are not considered necessary or appropriate for the control of EAE in sheep flocks.

Plan

Replacement ewes are the primary source of infection in EAE-naive flocks. If it is necessary to buy in replacements, an effective biosecurity plan is required:

- Source replacements from EAE-accredited free flocks or
- Source animals from as few flocks as possible and from those with a known disease history, and design and implement a flock vaccination strategy.

Ewes from different sources should not be mixed for the first time while they are pregnant; purchased ewes should be kept separate from the home flock until after their first lambing.

Diagnosing the cause of an abortion is essential for ongoing control and, to this end, aborted material should be sent for laboratory diagnosis, with ewes that have aborted identified clearly so that serology can be undertaken.

Prevent

An aborting ewe is the primary source of infection for C abortus, so to reduce the infection load for infectious aborting agents from any aborting ewe:

- Isolate the ewe from the rest of the flock as soon as possible;
- Remove or destroy all aborted material immediately, or send it for laboratory investigation;
- Clean, disinfect, remove or destroy contaminated bedding;
- Do not foster ewe lambs intended to be kept within the breeding flock on to ewes that have either aborted or produced dead lambs;
- Protect all human personnel from aborting ewes (it is not advisable for pregnant women to be involved with either ewes or lambs around lambing time).

Protect

Vaccination against EAE is more effective when undertaken before exposure to disease, so in high-risk flocks it is advisable as a precautionary measure. Closed naive flocks that have neighbours of unknown status, such as those that buy in replacement ewes from flocks of unknown status) it is advisable as a precautionary measure. Closed naive flocks that have neighbours of unknown status with adjacent lambing fields could also be considered at risk and precautionary vaccination would be advisable.

If there is an outbreak of EAE, it is preferable to administer an inactivated vaccine (eg, Mydiavac; Benchmark Animal Health) as soon as possible to reduce the spread of disease in the flock. In the year immediately following abortion due to chlamydia, either a live or an inactivated vaccine (eg, Enzovax; MSD Animal Health or Cevac Chlamydia; Ceva Animal Health) should be given to the whole flock at least three weeks before the ewes are put to the ram, unless the ewes were vaccinated at the time of the outbreak, in which case they are still protected.

Inappropriate antibiotic use

In some areas of the UK there is evidence that farmers still undertake routine prophylactic treatment of all ewes in late pregnancy to control EAE. An unpublished questionnaire survey undertaken in 2015 suggested that this is common practice for 10 per cent of sheep farmers (K. Phillips, K. Wheeler, H. U. Fuller, unpublished observations).

The antibiotic treatment of ewes in late pregnancy (generally using a long-acting oxytetracycline) may help to reduce the number of ewes that abort but it does not reduce the shedding of chlamydia or reduce the incidence of infected ewes within a flock. This is also not a cost-effective approach when compared to vaccination over the medium to long term. It is not acceptable to use antibiotics to control abortion on an ongoing basis.
If it is not possible to use an inactivated vaccine immediately when faced with a new outbreak, it is acceptable to treat the affected group of ewes with injectable long-acting oxytetracycline. It is also acceptable to treat later-lambing ewes within the flock in this way when they reach between day 90 and day 126 of that pregnancy or at the same stage for the affected group of ewes during their following pregnancy.

It is not acceptable to use routine antibiotic treatment in late pregnancy as a control measure for abortion in general, that is, in any flock unless in the face of an outbreak or if there was a confirmed laboratory diagnosis of chlamydia in the immediate preceding year.

**Neonatal bacterial infections**

Lamb morbidity and mortality due to the infectious bacterial syndromes of watery mouth disease (WMD) (Fig 4) and joint ill (Fig 5) are common on UK sheep farms. Over the past 30 years many farms have come to rely on the prophylactic use of antibiotics in whole crops of neonatal lambs to control these conditions (Fig 6). In 2015 10.5 million doses of oral antibiotics (Orojet Lamb Oral Solution; Zoetis, Spectam Scour Halt oral solution 50 mg/ml; Ceva Animal Health) were sold in the UK (CEESA International Sales Survey [www.ciss-ceesa.com]) and farmers report that veterinary surgeons in some regions will also prescribe antibiotic tablets for prophylactic use in neonatal lambs (F. Lovatt, personal communication). There are no antibiotic tablets licensed for use in food-producing animals, so these antibiotic sales are not included in the UK Veterinary Antibiotic Resistance and Sales Surveillance reports. Veterinary surgeons are in the privileged position of being allowed to prescribe medicines under the veterinary cascade (VMD 2015), but the use of any unauthorised products must be fully justified and have clearly auditable clinical evidence (Lovatt and others 2018).

It is clear, therefore, that the routine prophylactic use of antibiotics for the whole lamb crop over the lambing season is no longer considered a sustainable or acceptable solution in most cases. That said, as veterinary surgeons, our first priority must always be the welfare of animals under our care and a change in disease-control policy on a farm should never be implemented without farm-specific risk assessment and management throughout the health-planning process. This is particularly important during the high-risk lambing period.

**Watery mouth disease and joint ill**

WMD is an endotoxaemia of neonatal lambs (Fig 4). The disease is characterised by dullness, depression and salivation from the mouth (with or without abdominal distension), and is typically associated with *Escherichia coli* infection. Morbidity and mortality can be high and, for many years, disease control has relied strongly on the prophylactic administration of oral antibiotics to neonates. Non-antibiotic control measures have centred around ensuring newborn lambs have a timely and adequate intake of ewe colostrum, and establishing good ewe and environmental hygiene (King and Hodgson 1991). Treatment strategies include the use of non-steroidal antiendotoxic drugs, fluids and antibiotics.

Evidence suggests that *Streptococcus dysgalactiae* is the most common cause of joint ill (Fig 5) in lambs under four weeks old in British sheep flocks (Watkins and Sharp 1998). *Erysipelothrix rhusiopathiae* is another agent that can cause septic arthritis in sheep, although typically this is in older lambs or adults and not in lambs less than one month of age; diagnosis is made by positive serology of affected cases. In tick areas, consideration should be given to *Staphylococcus aureus* associated with tick bites as the cause of infectious arthritis. Full consideration of the epidemiology and risk factors for these conditions is beyond the scope of this article; however, Hovers (2014) provides an excellent recent review.

In general terms, for all forms of septic arthritis, early detection and treatment are essential and it is always appropriate to identify the causative pathogen and determine an antibiotic sensitivity profile by arthrocentesis of affected joints and/or the postmortem examination of untreated animals (Fig 7). Ideally, multiple animals should be sampled to improve the chance of a diagnostic result.
Clinical cases that are not treated promptly will respond poorly to antibiotic therapy. Culture and sensitivity results will inform the choice of antibiotic for treatment but it should be noted that oxytetracycline is seldom effective (Rutherford and others 2015). Severely lame lambs that show insufficient clinical improvement within five days of treatment should be euthanased. Common control measures have involved whole lamb crop prophylactic administration of antibiotics but recent research and clinical experience have emphasised the roles that high standards of environmental, equipment and personal hygiene at lambing time, plus adequate and timely colostrum intakes, play in disease prevention (Hovers 2014).

A summary of the plan, protect, prevent approach with respect to controlling bacterial neonatal lamb diseases is shown in Fig 8.

**Plan**

The appropriate nutritional management of pre- and postlambing ewes is absolutely essential for safeguarding lamb and ewe health. It ensures good lamb birth weight, lamb vigour, brown fat stores and quality and quantity of ewe colostrum, and influences a ewe’s maternal behaviour. Therefore, nutritional planning is essential in any preventive health plan for neonatal lamb disease.

This should include obtaining body condition scores as well as determining the quality and quantity of the diet available and its accessibility. Readers are referred to the recent Agriculture and Horticulture Development Board manual for an excellent guide to the topic (Povey and others 2018).

Housing should be planned to meet recommended stocking rates and group sizes, with suitable mothering pens provided (Defra 2002).

Neonatal lambs should be protected from stress by the provision of adequate shelter from inclement weather. Husbandry tasks should also be planned to reduce stress. For example, the need for tailing and castration should be scrutinised as well as when the procedures are to be undertaken (with recommendations of not before 24 hours after birth).

Ewe lameness must be well controlled and there must be sufficient competent staff around to supervise the lambing period.

**Prevent**

To reduce the burden of pathogens the lambs are exposed to, the hygiene status of the ewes, equipment and environment should be optimal. The role of hygiene in preventing joint ill, even on what appear to be farms with good standards, has recently been highlighted (Rutherford and others 2015). Therefore:

- Ewes should be dagged or sheared before lambing;
- When lambing assistance is required, clean gloves should be used for all ewes and hands and equipment should be washed regularly.
- The lambing environment, for both indoor and outdoor systems, should be sheltered and as hygienic as possible, with appropriate stocking densities and a lie-back area;
- Lambing pens should be dry, free from drafts and contain clean bedding; there should be appropriate cleansing and disinfection between occupants;
- Navels should be treated appropriately and effectively as promptly as possible after birth;

**Protect**

- Analyse forage & arrange quality diet
- Sort care of new-borns - Maximise colostrum - Minimise stress
- Monitor colostrum quality & transfer
- Keep good records

**Hygienic**

- Sufficient shelter outside
- Clean, dry, draught-free inside
- Plenty of fresh bedding
- Turn-out as soon as possible
- Good hygiene
- Clean & disinfect equipment

**Fit & Well Fed**

- Good body condition
- Quality balanced diet
- Fully vaccinated
- Sound in foot
- Dagged & clean

**Colostrum**

- Quality
- Quantity
- Timing

**Lambing Success**

- #Colostrum
- #Lambing

**Fig 8:** Infographic depicting the plan, prevent, protect strategy with respect to controlling bacterial neonatal lamb diseases (Picture, Flock Health Ltd 2017)
Husbandry procedures – such as stomach tubing, ear tagging, castration or tailing – should be undertaken with close regard to hygiene. All equipment should be suitably cleansed and disinfected between individual animals.

The RUMA-led campaign '#Colostrum is gold' (www.colostrumisgold.org) has been designed to emphasise to farmers the critical role of ensuring adequate and timely colostrum intakes for neonatal lambs. Current guidelines are that:

- 50 ml/kg bodyweight colostrum should be taken in as soon as possible after birth, with a total intake of 200 ml/kg within the first 24 hours;
- Where there is any doubt about effective passive transfer of colostral immunity, the situation should be monitored by testing blood samples from lambs under five days old (e.g., using the zinc sulphate turbidity test or total protein);
- Pregnant ewes should be vaccinated against clostridial disease;
- Vaccination for joint ill is possible if *E. rhusiopathiae* is confirmed to be the cause of the disease and following due consideration of the risks and responsibilities associated with the prescription of an unauthorised product (Lovatt 2017).

Appropriate antibiotic use

For cases of joint ill and WMD, first-line treatments should be planned ahead with the farmer and reviewed in the health plan. Treatment should be prompt, with full courses given that are ideally based on culture and sensitivity analysis. For farmers who are used to giving prophylactic antibiotic treatment to all lambs within a flock, veterinary surgeons should undertake risk assessments for different groups of lambs in the flock using the flow chart shown in Fig 9; a rough-worked example is shown in Fig 10. Good management and planning is the key to reducing the risk of disease, and control measures should be discussed by the farmer and practitioner well ahead of lambing – ideally at mid-pregnancy – to give sufficient time to assess and implement new actions.

Antibiotic treatments should be targeted only towards highest-risk individuals following a proactive flock health plan. Fig 11 suggests criteria for categorising the risk associated with lamb, ewe and environmental factors.

The investigation of suspected treatment failure should be based on bacteriological culture and monitoring of the sensitivity of the pathogen to the antibiotic used on an individual farm. There are significant levels of resistance in *E. coli* isolates from sheep, with higher levels in neonatal lambs (Fig 12) (VMD 2018). This clearly emphasises the urgent need for farms to employ non-antibiotic preventive strategies and for practitioners to prescribe according to current professional guidance (BVA 2015).
Inappropriate antibiotic use

Whole-flock injectable or oral antibiotic treatment of lambs for the prevention of WMD or joint ill is very rarely appropriate as a routine management action.

The use of unlicensed medicines that are unauthorised for use in food-producing animals, unless justified under the cascade, is also inappropriate, as is the use of high-priority CIAs (fluoroquinolones, systemic third- and fourth-generation cephalosporins and colistin, as designated by the EMA and the Veterinary Medicines Directorate) (Box 2). These are currently used at very low levels within the UK sheep industry (RUMA 2017) and practitioners are urged to use them in sheep under exceptional circumstances only (ie, where culture and sensitivity clearly indicate that there is no alternative appropriate antibiotic) and to follow appropriate licensing regulations.

Implementation

The reduction, replacement and refinement of antibiotic use in sheep flocks should be implemented using a whole veterinary practice-planned approach (Allen and Bellini 2017) and not left for individual practitioners in the practice to address when a client appears at reception with a ‘shopping list’! Otherwise, the practice risks poor animal welfare and damage to relationships with clients. It will require closer engagement with sheep farmer clients in preventive medicine through activities such as flock health planning, regular farmer meetings and vet/farmer clubs (Anon 2016). Practitioners should be encouraged to collate individual flock usage data for auditing purposes, as well as to satisfy recently updated Red Tractor Farm Assurance guidelines (Red Tractor Assurance 2018).

Through improvement in the uptake of preventive medicine in sheep flocks there is considerable potential to improve flock health, welfare and economic performance while addressing the global public and animal health challenge of emergent antibiotic resistance.

Acknowledgements

The authors thank members of the SVS for the development of the SVS Good Practice Guidelines on which this article is based: Tim Bebbington, Peers Davies, Kath Dun, Harriet Fuller, Rebecca Mearns, Philippa Page, Clare Phythin, Iain Richards and Louise Silk. They also thank colleagues who worked on the development of the sheep industry RUMA targets, particularly Charles Sercombe and Liz Genener.

The SVS is grateful to the following organisations that contributed funding to enable work towards the Good Practice Guidelines: SVS, Sheep Health and Welfare Group, MSD Animal Health, Ceva, Norbrook and Zoetis UK.

References

ALLEN, J. & BELLINI, J. (2017) Reducing antimicrobial use: a practitioner experience. In Practice 39, 442-473
ANGELL, J. W., GROVE-WHITE, D. H., WILLIAMS, H. J. & DUNCAN, J. S. (2016) Whole-flock, metaphylactic tilmicosin failed to eliminate contagious ovine digital dermatitis and footrot in sheep: a cluster randomised trial. Veterinary Record 179, 308
ANON (2016) Flock health clubs to be rolled out across the UK. Veterinary Record 178, 645
APHA (2019) GB disease surveillance dashboards. http://apha.defra.gov.uk/vet-gateway/surveillance/scanning/disease-dashboards.htm. Accessed January 8, 2019
BVA (2015) Responsible use of antimicrobials in veterinary practice. www.bva.co.uk/uploadedFiles/Content/News,_campaigns_and_policies/Policies/Medicines/responsible-use-of-antimicrobials-in-veterinary-practice.pdf. Accessed August 2, 2018
CLEMENTS, R. H. & STOYE, S. C. (2014) The ‘Five Point Plan’: a successful tool for reducing lameness in sheep. Veterinary Record 175, 225
DAVIES, P., REMNANT, J. G., GREEN, M. J., GASCOIGNE, E., GIBBON, N., HYDE, R., PORTEOUS, J. R., SCHUBERT, K., LOVATT, F. & CORBISHLEY, A. (2017) Quantitative analysis of antibiotic usage in British sheep flocks. Veterinary Record 181, 511
DEFRA (2002) Code of Recommendations for the Welfare of Livestock. Sheep. Defra Publications
DUNCAN, J., GROVE-WHITE, D. & ANGELL, J. (2018) Understanding contagious ovine digital dermatitis. In Practice 40, 60-65
DUNCAN, J. S., GROVE-WHITE, D., MOKS, E., CARROLL, D., OULTRAM, J. W., PHYTHIAN, C. J. & WILLIAMS, H. W. (2012) Impact of footrot vaccination and antibiotic therapy on footrot and contagious ovine digital dermatitis. Veterinary Record 170, 462
GREEN, L. & CLIFTON, R. (2018) Diagnosing and managing footrot in sheep: an update. In Practice 40, 17-26
HOVERS, K. (2014) Joint ill in lambs. Livestock 19, 298-303
HYBU CIG CYMRU (2011) Making every lamb count. Hybu Cig Cymru/Meat Promotion Wales. pp 2-3. www.hccmpw.org.uk/images/resources/Making_Every_Lamb_Count.pdf. Accessed December 18, 2018
KALER, J., WANI, S. A., HUSSAIN, I., BEG, S. A., MAHDOOMI, M., KABLI, Z. A. & GREEN, L. E. (2010) Randomized clinical trial of long-acting oxytetracycline, foot trimming, and flunixin meglumine on time to recovery in sheep with footrot. Journal of Veterinary Internal Medicine 24, 420-425
KING, T. J. & HODGSON, J. C. (1991) Watery mouth in lambs. In
Self-assessment quizzes

In Practice has partnered with BMJ OnExamination to host the self-assessment quizzes provided with each clinical article. These can be completed online and found at the end of the online version of each article at http://inpractice.bmj.com

1. When introducing control measures against enzootic abortion on farm, it is appropriate to:
   a. Use the vaccines available as a preventive measure
   b. Use whole-flock prophylactic oxytetracycline treatment
   c. Mix infected animals with naive animals during the non-pregnant period
   d. Use vaccines in some animals and prophylactic antibiotics in others

2. When controlling neonatal lamb disease, it is important to:
   a. Ensure the lamb receives 50 ml/kg good-quality colostrum as soon as possible and a total of 200 ml/kg within the first 24 hours of life
   b. Check the passive transfer to the lambs with blood samples in lambs under five days of age
   c. Vaccinate pregnant ewes against clostridial disease
   d. All of the above

3. Which of the following is an inappropriate use of antibiotics in neonatal lambs?
   a. Use of whole-flock prophylactic antibiotics to prevent watery mouth disease and/or joint ill
   b. Routine use of unauthorised antibiotics (eg, pills) to prevent or treat neonatal lamb disease
   c. Use of high-priority, critically important antibiotics to treat or prevent neonatal lamb disease
   d. All of the above

4. Which of the following is not an element of the five-point plan for the control of lameness in sheep?
   a. Quarantine incoming sheep
   b. Treat entire flocks with prophylactic antibiotics promptly
   c. Avoid propagation of infection on farm
   d. Vaccinate biannually against footrot

5. Which of the following foot diseases is the most likely diagnosis based on this image?
   a. Footrot
   b. Scald
   c. Contagious ovine digital dermatitis
   d. White line disease

6. Which of the following is a Responsible Use of Medicines in Agriculture Alliance target for the control of lameness in sheep?
   a. Vaccination against footrot
   b. Reduction in the national sheep lameness prevalence to 2 per cent
   c. Increase in antibiotic sales for prompt treatment of lame sheep by 20 per cent
   d. An overall reduction in antibiotic use in the sheep sector of 20 per cent