Calculation of metrics for benchmarking antibiotic use on sheep farms

Contents

Introduction

The Sheep Antibiotic Guardian Group, a sub group of the Sheep Health and Welfare Group, consulted with sheep industry stakeholders and academics to develop a core set of standard metrics for benchmarking antibiotic use on UK sheep farms. The purpose of the metrics is two-fold, firstly to enable farm benchmarking and secondly to provide a national reporting figure. The conclusions and final recommendations are discussed in this document.

Farm benchmarking refers to the comparison of a farm's antibiotic usage with previous years and similar enterprises in the region/country, with the following benefits:

- It allows farmers to understand their level of antibiotic use and how this is changing over time and relative to the industry

- It stimulates conversations between vets and farmers with the aim of encouraging the consideration of management practices that drive responsible use of medicines

Animal welfare is paramount. Where an animal has been diagnosed with a bacterial infection it is vital they receive the appropriate antibiotic treatment. When interpreting benchmarking data, it is vital to focus on encouraging responsible antibiotic use. Flock health planning and strategies to prevent disease are key to reducing the need to administer antibiotics and improving health and welfare on the farm. It is certainly not responsible to reduce use by, for example, withholding necessary treatment, using lower than recommended doses or switching to an inappropriate antibiotic because it has a lower amount of active ingredient per dose.

The group considered different possible benchmarking metrics that could be used with the aim of choosing the core metrics that are most appropriate for use in the UK sheep sector. While different metrics may be appropriate for other purposes, we have aimed to minimise the required flock information for simplicity and to encourage industry compliance.

The recommendations assume that a 12-month benchmarking period is being produced which should be based on a calendar year (*e.g.* 2019). It is acknowledged that each complete calendar year will overlap with the sheep production year (tupping to tupping) *i.e.* the number of ewes tupped and number of lambs produced in a calendar year will relate to different sheep production years.

The recommendations assume the average weights of a lamb and breeding adult as 20kg and 75kg respectively calculated using the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) principles.

Farm Benchmarking

1. Core Sheep Metric – Total mass of antibiotic per unit of sheep weight (mg/kg)

This metric is calculated as:

$$\frac{\textbf{Total mass antibiotic } \textit{(mg)}}{\textbf{[20 x total numbers of lambs (a+b)] + [75 x number of ewes (c)] } \textit{(kg)}}$$

Total mass of antibiotic relates to the total amount used in the whole flock in the year.

It is recommended that the following five pieces of data are collected from the farm so that the weight component can be both calculated and interpreted.

Key minimum data required from the flock to calculate 2019 data are **a b & c** (with d and e recommended but not essential).

a. **Number of lambs that are finished from this flock in 2019**

(ie either bought-in or home-bred lambs that are sold to slaughter in 2019; N.B. this figure may include some 2018-born lambs)

b. Number of lambs sold (as stores or for breeding) or retained for breeding in 2019

This includes all 2019-born lambs that are either sold within the year to anywhere other than slaughter or 2019-born lambs that remain in the flock of origin at the end of the year for breeding. (N.B. 2019-born store lambs that still on farm at the end of 2019 will be counted in next year's figures).

c. Numbers of adult ewes put to the ram in 2019 (not including ewe lambs)

d. Number of store lambs bought into the flock in 2019

This data is not essential to the calculation but we advise collecting it to act as a check to explain flocks that finish large number of lambs compared to the number of ewes in the flock.

e. Average weight of a ewe in the flock

This data is not essential to collect but it can be useful in the interpretation of the final figure.

Note: For the purposes of simple explanation within this document, 2019 has been taken as an example year. For subsequent years, clearly both the total antibiotic mass and flock figures will relate to the specific year in question.

Total mg antibiotic used in the flock

For calculation of the antibiotic data, all products used in the flock in the year in question needs to be collated in a list.

A master spreadsheet for each licensed antibiotic (linked to the Veterinary Medicine number) will be made available by the Veterinary Medicines Directorate. This contains the amount of active ingredient in mg per item, gram or ml (calculated using European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) principles).

The following categories should be separately identified:

- **Highest Priority Critically Important Antibiotics (HP-CIAs)** as defined by the Antimicrobial Advice Ad Hoc Expert Group (AMEG), *i.e.* fluoroquinolones, 3rd and 4th generation cephalosporins and colistin. **It is essential that the mg/kg should be separately identified for these HP-CIAs.**

  N.B. Data suggests that historically very low levels of HP-CIAs have been used within the sheep industry. It is suggested that they should not be used under anything other than exceptional circumstances and supported by immediately recent culture and sensitivity testing. Note that their use should be justified with supporting evidence that is documented within the farm flock health plan alongside clear preventative action.

- **Topicals (*e.g.* sprays, eye treatments, footbaths).** For this farm benchmarking core metric, it is important to include these topicals in the total mg of antibiotics. However, topicals are not included in the ESVAC calculation (mg/PCU) so it is helpful if they are categorised separately in the farm list of antibiotics.

  N.B. Routine use of antibiotic footbaths is not considered to be responsible use and so any use of these should initiate a farmer-vet conversation.

- **Oral antibiotics given to neonatal lambs**

  - Total mg of licensed oral antibiotics can be easily identified
  - All tablets. *N.B. There are no tablets that are licensed in sheep. It is important that any tablets that are given to the flock are identified.*

Essential reporting of this core sheep metric includes:

- Total antibiotic used (mg/kg)
- Total HP-CIA used (mg/kg)

Ideal additional reporting within this core sheep metric includes:

- Total topical antibiotic used (mg/kg)
- Total antibiotic given orally to lambs (mg/kg)

Sheep weights

The designation of all ewes to be 75kg and all lambs to be 20kg coincides with ESVAC weights for the calculation of the Population Correction Unit (PCU), which are intended to represent the average weight at time of treatment. It is recognised that there will be some flocks where the average ewe body weight is widely different from 75kg and this apparently unfairly inflates or deflates the size of the denominator. For this reason, the final farm figures should be considered alongside the average weight of ewes on the farm.

This core sheep metric of antibiotic use in mg/kg is different from mg/PCU (as defined by ESVAC). However, if the key minimum flock data are collected (a, b & c) then it is possible to use these data to calculate mg/PCU for the purposes of national monitoring.

2. Additional Sheep Metric – Antibiotics given to lambs at less than a week old

This metric is calculated as:

$$\frac{\textbf{Total antibiotic treatment days for lambs of less than one week old (f)}}{\textbf{Total number of lambs born on farm (g)}}$$

f. For this metric, a 'treatment' of antibiotic is a single dose of a short-acting antibiotic (oral or injectable) given on a single day. A long-acting antibiotic counts as 3 treatment days.

g. Total number of lambs born in this flock and surviving to over a day old.

Worked examples:

- If a neonatal lamb was given two doses of one oral antibiotic, a single dose of another oral antibiotic and a single long-acting injection, this would count as 6 treatment days for that one lamb.
- A flock that both injects and doses every lamb at birth would have a score of 2 treatment days per lamb (or 4 treatment days per lamb, if the injection was long-acting).

Note: The farmer is asked for this information separately to the calculation of core metric one. It is not possible to calculate this metric from vet sales data.

Source of the data for calculation of core metric one

These recommendations are intended to be applicable irrespective of the source of antibiotic usage data which may come from the veterinary practice or directly from the producer. The source of data for each flock should be clearly recorded and caution should be exercised when comparing data from different sources.

Veterinary practice data on antibiotics purchased by the farm has a number of limitations, such as:

- It does not take into account possible wastage or discarded products due to expiry date
- A product purchased one year may be used in the next usage year
- A farm may purchase antibiotics from more than one source. For example if a farm has more than one veterinary practice looking after its animals and/or purchases medicines under prescription. In the latter case, prescription data should also be collected
- For mixed enterprises, for example with sheep and cattle, it may be difficult to determine in which species a product has been used

When vet practice derived data is used, the total antibiotic mass relates to all antibiotics *purchased* in the year in question.

Farmer derived data overcomes the issues highlighted above, but relies on accurate and diligent recording of all medicines administered and this may be variable between farms.

When farmer-derived data is used the total antibiotic mass relates to all antibiotic *used* in the year in question.

There is always a balance between improving accuracy and having a metric that as many people as possible can carry out. The recommendations provide a core set of metrics that include standardised average weights at treatment and, in the case of metric 2, standardised treatment courses. The metrics should therefore be considered “technical units” rather than true values, as the standard assumptions may not reflect the actual weights at treatment or treatment courses used on each farm.

Mixed species farms

Where possible, it is advisable that farmers and veterinary practices separate sheep and cattle usage *i.e.* by having two separate sub-accounts. It is advised that the antibiotic is designated to either cattle or sheep at the time of purchase or administration.

Medicine records

In the completion of medicine records, we advise that the following categories of sheep are used. If standard estimates of weights are required for benchmarking purposes, the following should be used (see Table 1)

Table 1: Definitions and standardised estimates of weight for categories of sheep

Category of sheep	Definition	Standardised estimate of weight (kg)*
Ewe	Female sheep over 1 year old	75
Ram	Male sheep over 1 year old	75
Neonatal lamb	Less than one week old	5
Pre-weaned lamb	One week old to weaning	20
Post-weaned lamb	Weaning to one year old	40

* However, for the purposes of actually dosing individuals it should be remembered that the range of sheep weights in the UK varies considerably so a ram may weigh up to 160kg and ewes can vary from 40kg to 130kg.

It is very important that the correct dose is given for the actual weight of the individual sheep.

Reasons for treatment

Where reasons for treatment are given we advise that the following categories are used as standard (see Table 2).

Table 2: Recommended standard categories for reasons for treatment of sheep

Disease relating to	Explanation
Skin, fleece or horns	Abscess, dermatitis, ectoparasite damage, horn-related
Respiratory tract	Pneumonia, laryngitis
Digestive tract	Enteritis, diarrhoea, scours, abdominal surgery, peritonitis, acidosis, anus
Nose or mouth	Mouth, tongue, nostrils but not respiratory
Urinary tract	Diseases of kidney, nephrosis, urolithiasis
Limbs or legs	Joint ill, osteomyelitis, arthritis, fractures, lameness of upper limb, not foot/hoof
Hoof or foot	Footrot, interdigital dermatitis, scald, strip, contagious ovine digital dermatitis, CODD, foot abscess, granuloma, white line disease
Nervous system	Meningitis, diseases of brain, listeria, spinal disease
Eyes or ears	Eye disease, ear tagging infection
Udder or teats	Mastitis, teat injury, diseases of udder skin
Abortion or foetal death	
Lambing associated or post lambing	Dystocia, lambing difficulties, caesarean, prolapse, metritis, retained placenta
Fertility - female	Breeding related, fertility manipulation, synchronisation
Fertility - male	Injuries or inflammation of penis, prepuce, testes, castration
Parasite control	Worms, fluke, lice, mites, flies, coccidiosis
Treatment for metabolic disease	Staggers, mineral/vitamin deficiency
Systemic	Fever, low temperature, septicaemia
Unknown	
Vaccination	
Preventative use	
Other	When ‘other’ is indicated, a specific reason should be given

Questions and answers

Why do we need to measure total use and HP-CIA use?

It is important to measure and monitor the overall use of all antibiotics as this may be used as an indication of the risk of the development of antimicrobial resistance. This includes consideration of the possibility of cross-resistance and co-resistance, which is where the use of one antibiotic class can induce resistance to another antibiotic class.

There is particular scrutiny on the use of antibiotics that are considered highest priority for human medicine (HP-CIA, as defined by the European Medicines Agency). These antibiotics are used as a last resort antibiotic for serious infections in people. Resistance transfer in these antibiotics would have particularly serious consequences.

Why is it recommended to have a 12-month benchmarking period based on a calendar year?

A 12-month period based on a calendar year has been taken as the standard within the sheep industry to allow for within-year seasonal fluctuations in usage. It has been recommended to allow comparison across systems regardless of lambing dates.

Why are topical products being included in the mg/kg metric when they are excluded from the ESVAC mg/PCU metric?

Topical products were shown to account for 12% of antibiotic mass used in sheep flocks[1] so it is therefore considered that they are important to monitor.

Why are unauthorised (off-label) products included?

Unauthorised products are commonly used in sheep under the cascade system where there is not a specific license in sheep but there may be a license in cattle. Where they are used, it is important to keep these products within the calculation.

Why have mg/kg been chosen rather than mg/PCU?

It has been decided that mg/kg is a unit that is more easily understandable than mg/PCU. The data collected for core metric one will allow for a useful estimation of mg/PCU as required for national monitoring.

Why have mg/kg been chosen rather than one based on the number of daily doses or course?

In a study of antibiotic usage on 207 commercial sheep-only farms[1], it was found that daily dose metrics were very closely correlated with mg/kg for sheep. Hence mg/kg was chosen as the core metric as it is simple to calculate and it is becoming increasingly widely understood by the industry.

Won't the use of a core metric measured in mg/kg encourage use of certain antibiotics over others?

It is recognised that there is variation in the mass of active ingredient in different types of antibiotics so that a course of antibiotic for the treatment of lameness in a sheep would be 20-30mg/kg body weight for oxytetracycline or amoxycillin and 2.5-10mg/kg for one of the macrolides. However, it is hoped that responsible prescribing of the most suitable antibiotic for the condition as well as the higher cost of macrolides will mean that the use of this core metric does not drive inappropriate behaviour.

Won't the average weight of a sheep vary by breed and by lowland, upland and hill farms?

The weight of sheep in the UK varies considerably. However for the purpose of calculation of core metrics, there is a benefit in keeping things simple and using a standard weight (ewe 75kg, lamb 20kg). This allows for standardised comparison across enterprises and benchmarking. It is suggested that the average weight of ewes in the flock is recorded so that consideration of the core metric is possible alongside this information.

Why are only breeding ewes used when calculating the total amount of sheep? What about rams?

It is recognised that there will be rams on the farm and that antibiotic will be used in these rams. It is very important that all antibiotics used in the flock are included in the calculation. However only the number of breeding ewes are included in the calculation to keep things simple.

Why is the same weight (20kg) being applied for all lambs, irrespective of whether they were born on the farm or purchased as stores or sold as stores or finished?

It is accepted that there are differences in weight of lambs over their life and the length of time they are on farm depending on whether they were born on the farm or bought as stores or whether they are sold as stores or breeding stock or as finished lambs. It was decided for simplicity to keep the single 20kg weight for all lambs and to consider all lambs on the farm in the calendar year.

It is recommended that the number of store animals brought into the flock is recorded to help inform the farmer-vet conversation in the consideration of the number of lambs finished compared to the number of ewes put to the ram. The inclusion of the number of store lambs purchased also makes it possible. *E.g.* for farms which only buy and sell stores to be benchmarked against similar farm types.

This metric will not be accurate for all flocks, for example pedigree flocks which sell breeding animals at 18 months?

This metric has been designed to work with the majority of flock types, but it is accepted that the weight denominator will not be accurate for more specialist units such as pedigree flocks. It is still important to use the metric as directed to enable benchmarking with the same rules for all flocks.

Why have the group defined categories of sheep and reasons for treatment?

The primary reason for this document is to establish core metrics for comparison of antibiotic usage across UK sheep enterprises. However secondarily, it considers

standard recommendations for the completion of individual flock medicine records. This is particularly of relevance in the development of electronic medicine books.

References

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