Reducing antimicrobial use on dairy farms using a herd health approach

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Introduction

Antimicrobial use (AMU) and antimicrobial resistance (AMR) have received a great deal of media attention, and with the government commissioned O'Neill report calling for a reduction of unnecessary AMU in agriculture (O'Neill 2015), there is a high level of scrutiny of the livestock industry. Concerns exist that increased AMU in cattle might increase the prevalence of resistant pathogens (Saini *et al.,* 2013), and although the importance of agricultural AMU in AMR risk to the human population is largely unknown (Tang *et al.,* 2017), the potential "One Health" consequences of inappropriate AMU to both human and animal health means current and future AMU levels within the dairy industry require careful consideration. Dairy "herd health" is an approach to the veterinary care of dairy cattle applied at a population level, rather than the individual animal level (Green 2012). The focus of herd health is on preventing disease in the herd, often using a data driven approach. It follows that providing effective herd health advice to dairy farms alongside continuous monitoring and analysis has huge potential to reduce AMU on farm, by preventing disease, and therefore avoiding the need for antimicrobials. This herd health approach should also improve animal welfare, reduce cost to the farmer, and increase production – making reductions in AMU achieved by this route very sustainable. This article outlines key herd health approaches to common diseases on dairy farms that will result in a decrease in AMU, with a focus on those interventions most likely to result in the biggest reductions.

Measuring antimicrobial use

Monitoring and benchmarking AMU has been identified as an important intervention to incentivise reduced AMU in livestock (Speksnijder *et al.,* 2015), and farm assurance schemes now often include an antimicrobial monitoring component (i.e. Red Tractor Farm Assurance). Much as clinical disease levels and economic outcomes are commonly calculated to assess the impact of herd health interventions, the reduction of AMU can also provide a straightforward, objective measurement of a key outcome of interest for UK dairy farms (see Figure 1). The freely available University of Nottingham AMU Calculator and Benchmarking Tool provides a simple platform for both veterinarians and farmers to assess AMU by both dose and mass based methodologies, as well as providing analysis of groups of farms (Hyde *et al.,* 2017) (see Figure 2). A summary of approaches to measuring AMU is provided in Box 1. The Responsible Use of Medicines in Agriculture Alliance (RUMA) targets task force have created a series of targets for the UK dairy industry using standard European Medicines Agency metrics (RUMA 2017), as described in

Table 1 The RUMA Target Task Force dairy sector targets compared with the most recent dairy antimicrobial usage (AMU) figures from~31% of the national dairy herd (VARRS 2017).

	Subject	**Current dairy AMU (VARRS 2017)**	**RUMA Target (2020)**
1	HP-CIA injectables (mg/PCU)	0.76	0.54
2	HP-CIA intra-mammary use (DCDVet)	0.22	0.17
3	Intra-mammary tubes – dry cow (DCDVet)	0.68	0.67
4	Intra-mammary tubes – lactating cow (DCDVet)	0.82	0.73
5	Sealant tube usage (average number of courses per dairy cow)		0.70
6	Total antimicrobial usage (mg/PCU)	17	21

HP-CIA: Highest Priority critically important antimicrobials, mg/PCU: milligrams of antimicrobials used per population correction unit, DDDvet: defined daily dose, DCDvet: defined course dose

, and there is continued involvement in this area from organisations such as the Veterinary Medicines Directorate (VMD) and the Cattle Health and Welfare Group (CHAWG).

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Box 1 A summary of metrics used to measure antimicrobial use on dairy farms

Measurements of antimicrobial use

European medicines agency metrics

mg/PCU = Milligrams of antimicrobial used per population correction unit

DDDvet = Defined daily dose for animals

DCDvet = Defined course dose for animals

AMU can broadly be measured in two ways; by mass- or dose-based methodology. Mass-based methodologies measure the milligrams (mg) of antimicrobial used on a farm, per kg of animal at time of treatment; population correction unit (PCU). Dose based methodologies estimate the number of doses or courses of antimicrobial each animal receives, with injectable antimicrobials being assigned a standard dosage (i.e. Amoxicillin; 8mg/kg), and single treatments such as intramammary tubes counting as a single dose, regardless of mg. Detailed, farm level AMU in British dairy farms have recently been reported (Hyde *et al.,* 2017) with injectable, footbath and oral antimicrobial use being shown to be strong drivers of AMU measured by mg/PCU, and intramammary treatments strong drivers of AMU measured by DDDvet and DCDvet. It is worth noting that topical antimicrobials such as sprays are not included in ESVAC metrics, and whilst dry cow therapy is included in DCDvet and mg/PCU metrics, it is not included in the calculation of DDDvet. One particular point to note when calculating AMU via ESVAC methodology is the use of the 425kg adult dairy cow weight, which has the potential to confuse producers if not explained that this is intended to represent the average weight at time of treatment rather than the actual weight of an adult cow.

Whilst there has been some debate as to which metrics are likely to be most appropriate for the UK situation, there is currently no clear evidence as to which metrics are optimal for recording AMU, and ultimately incentivising reductions in both AMU and AMR. As the veterinarian analysing dairy herd mastitis will employ both SCC and clinical mastitis cases to inform herd level mastitis control decisions, it would appear prudent to apply a combination of both dose and mass-based methodologies when analysing AMU on farms.

A detailed review evaluating metrics available for benchmarking AMU in the dairy industry is available from Mills *et al.,* (2018).

Motivating change

The motivations for the use of antimicrobials are complex for both veterinarian and farmer, and the decision to administer or prescribe can be influenced by a range of often competing intrinsic and extrinsic factors. Intrinsic factors exert a powerful influence on behaviour. Experience, confidence, attitude to risk and uncertainty all influence an individuals' tendency to administer or prescribe, and in human medicine, these factors have been found to be some of the biggest determinants of antimicrobial prescribing rate (De Sutter *et al.,* 2001). It would be unsurprising to find that the same was true in the farm animal context, where individual treatment decisions are often made by the farmer in the absence of direct veterinary supervision, and poor compliance with treatment protocols is common from a UK perspective (Sawant *et al.,* 2005). There are also a range of extrinsic factors, including the clinical presentation, patient characteristics, economics and withhold times. Add to this the tendency of antimicrobial users towards defensive prescribing; the "precautionary principle", encapsulated by the idea of administering antimicrobials "just in case", and the pressure towards inappropriate use becomes clear. In spite of this, there is clear evidence of motivation amongst dairy farmers to reduce AMU, and it has also been shown that farmers consider veterinary surgeons to be the most influential source of information in this regard (Jones *et al.,* 2015). It is important to acknowledge this complexity when designing any strategy to motivate change in AMU on farm and to recognise the need to equip veterinary surgeons with appropriate communication skills training (e.g. motivational interviewing) (Bard *et al.,* 2017; van Dijk et al., 2017)

Proactive, multi-disciplinary, collaborative approaches from veterinarians to improve animal health alongside targeted reductions of the use of highest priority critically important antimicrobials (HP-CIAs, which include 3rd and 4th generation cephalosporins, fluoroquinolones and colistin) have been shown to be effective, without significant effect on animal health outcomes (Tisdall *et al.,* 2016; Turner *et al.,* 2018). When farmers are drawn in as partners in the process and the competing factors which influence motivation are addressed, revisions in AMU policy as part of a proactive approach to herd health management becomes routine, and real behavioural change can occur. Farmer training on compliance and responsible use (such as the avoidance of HP-CIAs) is important, but information alone is insufficient to produce lasting behavioural change. The importance of intentional, one-to-one conversations with veterinary surgeons who are modelling best-practice, alongside the powerful influence of changing social norms and farmer role models should not be underestimated.

Herd Health

A summary of the key areas of dairy cow herd health that can lead to AMU reduction follows. A summary of key interventions for each area is provided in Box 2 and the potential impact in Figure 3.

Box 2 A summary of the key interventions to reduce inappropriate AMU on dairy farms using a herd health approach

The following list summarises some key steps in dairy herd health that are likely to reduce inappropriate AMU on dairy farms

- Udder health
    - Reduction in clinical mastitis incidence by implementing, for example, the AHDB dairy mastitis control plan
    - Cease use of injectable antimicrobial mastitis therapy as an adjunct to intra-mammary therapy and use NSAIDs instead
    - Implement selective dry cow therapy to reduce AMU and reduce Gram negative mastitis cases post-calving
    - Consider if on farm culture could be appropriate (e.g. low levels of Gram positive mastitis, and only if considering not treating Gram negative cases, which may not be economically worthwhile)
- Lameness
    - Eliminate the use of antibiotic footbaths
    - Identify lameness prevalence and predominant lesion(s)
    - Ensure early detection and treatment
    - Treat claw horn disease with NSAIDs and block, not antimicrobials
    - Implement effective prevention strategies (e.g. improve cubicle comfort, improve hygiene)
- Reproductive health
    - Monitor calving health, disease incidence, energy balance and levels of hypocalcaemia in order to effectively implement control strategies if above target levels.
    - Optimise transition cow nutrition, housing and management
    - Eliminate use of highest priority critically important antimicrobials (HP-CIAs) e.g. *Ceftiofur*
- Youngstock
    - Monitor and ensure adequate passive transfer/colostrum intake
    - Optimise environmental conditions (e.g. bedding hygiene, ventilation) and nutrition
    - Avoid the use of antimicrobials in the treatment of calf diarrhoea, in the absence of clinical signs consistent with septicaemia and culture and sensitivity testing
    - Consider respiratory disease vaccination if appropriate
    - Eliminate the use of in-milk antimicrobials for prophylaxis/metaphylaxis
- Infectious disease
    - Ascertain current disease status and implement appropriate biosecurity
    - Join or align with national initiatives (i.e. BVD eradication) where appropriate
    - Use vaccination to help control endemic disease when required (BVD, respiratory disease etc)

Udder health

Mastitis remains one of the greatest challenges to the UK dairy industry (Bradley 2002), and can significantly affect AMU; being responsible for up to 68% of AMU when measured by dose based methodology (Kuipers *et al.,* 2016). 4 out of the 6 RUMA dairy sector targets relate directly to mastitis therapy (Table 1), and by reducing both clinical mastitis and antimicrobial dry cow therapy a significant reduction in dairy farm AMU can be achieved (Kromker and Leimbach 2017).

One method of mastitis reduction with a strong evidence base is the implementation of the AHDB Dairy Mastitis Control Plan (DMCP: www.dairy.ahdb.org.uk/technical-services/mastitis-control-plan), with plan users being shown to achieve a 20 percent reduction in clinical mastitis incidence compared with control farms (Green *et al.,* 2007). Recent data suggests a 40 percent decrease in lactating cow intra-mammary AMU achieved via use of the DMCP (Bradley *et al.,* 2017, Breen *et al.,* 2017) (Box 3). Generally unnecessary additional treatments such as the use of parenteral antimicrobials have no beneficial effects on the outcomes of mild/moderate clinical mastitis (Wenz *et al.,* 2005), and the use of systemic antimicrobials can contribute to high AMU (mg/PCU) on dairy farms (Hyde *et al.,* 2017). In contrast, the use of non-steroidal anti-inflammatory medication (NSAIDs) have clear benefits in the treatment of clinical mastitis and should be encouraged (Leslie and Petersson-Wolfe 2012). Gram negative mastitis may cure spontaneously without the use of antimicrobials, and as a result, interest in the use of on-farm culture systems to target treatment is increasing (Lago *et al.,* 2011). Culture of mild clinical cases prior to antimicrobial treatment allows determination of bacterial cause avoiding unnecessary treatment. Caution is urged however, as due to decreased cure rates associated with delaying treatment of gram positive cases, this may not be cost effective for all UK farms (Down *et al.,* 2017). The blanket use of antimicrobial dry cow therapy (DCT) regardless of infection status is challenging to justify, and selective DCT using recent somatic cell count and clinical mastitis data (for example having a somatic cell count <200,000 cells/ml and no clinical mastitis within the last 3 individual monthly recordings (Bradley *et al.,* 2010)) can dramatically reduce AMU when measuring DCDvet. In addition, the use of selective DCT has been found to decrease prevalence of *E.coli* clinical mastitis cases post-calving (Bradley *et al.,* 2010) compared with antimicrobial DCT, resulting in a potential reduction in disease incidence alongside a reduction in AMU.

With a primary focus on the reduction of clinical mastitis incidence through the implementation of the DMCP, the reduction in generally unnecessary treatments such as parenteral therapy of mild/moderate cases, and adoption of selective DCT, it should be possible to dramatically reduce mastitis related AMU. It is worth noting reductions in intramammary usage primarily impacts dose or course based measures (rather than mass) as intra-mammary preparations typically have lower amounts of antimicrobial compared to systemic treatments. The role of the farm animal veterinarian must extend far beyond the treatment of individual cases of mastitis, and epidemiological data analysis skills in determining mastitis origin at herd level are likely to be extremely important in implementing effective mastitis control measures (Green et al., 2007).

Box 3. Example reductions in AMU through implementation of the AHDB Dairy Mastitis Control Plan

The implementation of the AHDB Dairy Mastitis Control Plan on a 600 cow dairy farm has been described as a case report (Breen et al., 2017), highlighting a reduction of clinical mastitis cases from a rate of 60-70 cases per 100 cows/year to less than 20 cases per 100 cows/year. Following analysis of herd level clinical mastitis and somatic cell count data, a focus on dry cow cubicle management as well as drying off technique resulted in dramatic reductions in both clinical and subclinical mastitis. This was paired with a reduction in AMU from 40mg/PCU and 14 DDDvet to 26mg/PCU and 7 DDDvet over a 3-year period, highlighting the positive impact that herd level interventions can have on both animal health and welfare whilst simultaneously reducing AMU.

Lameness

Lameness is a common presentation in dairy cattle and significant cause of financial loss and poor welfare. The most common causes of lameness are conditions of the foot, and these can be divided into claw horn lesions (sole haemorrhage/sole ulcer and white line disease) and soft tissue infections (interdigital phlegmon and digital dermatitis) (Archer *et al.,* 2010). Investigations of lameness at a herd level should aim to establish prevalence (for example by mobility scoring) and the predominant lesion types present on the farm by examining the feet of lame cows and analysing foot trimming records.

A discussion of the causes of claw horn lesions is beyond the scope of this article, and has been undertaken elsewhere (Mahendran and Bell, 2015). However, it is clear bacterial infection is not thought to play a role in the pathogenesis (Newsome *et al.,* 2016). It should not be necessary to treat claw horn lesions with antimicrobials and the best outcomes for the treatment of claw horn disease are achieved with the application of a foot block and the administration of a NSAID (Thomas *et al.,* 2015). When detection and treatment are delayed, cure rates decline (Thomas *et al.,* 2016), and regular mobility scoring has been described as an effective way of identifying early cases (Groenevelt *et al.,* 2014). As well as better outcomes for the cows, early and effective treatment should prevent cases progressing to deep digital sepsis and other complications where antimicrobials would be required. Lame cows should not be given injectable antimicrobials as an alternative to examination of the foot. Prevention of the lesions should focus on improving lying comfort, reducing standing times, and reducing potential trauma (inappropriately sharp turns and high stocking rates), and regular foot trimming to quickly treat cows that do become lame.

Soft tissue lameness is more likely to be bacterial in origin with interdigital phlegmon (foul) caused by *Fusobacterium necrophorum* and other bacteria and digital dermatitis thought to be caused by *Treponema* species (Maxwell *et al.,* 2015). Clearly in these cases antimicrobial treatment may be justified, although only topical treatment is required for most digital dermatitis lesions (Laven and Logue 2006). Cure rates remain low with common topical and systemic treatments and improved antimicrobial or non-antimicrobial treatment protocols are required and may be developed (Evans *et al.,* 2016). Prevention should focus on improving environmental hygiene and in particular underfoot conditions. Regular use of a disinfectant foot bath is an essential measure in the control of digital dermatitis with evidence to support the use of both formalin and copper sulphate products (Bell *et* *al.,* 2014). Care needs to be taken with either product, formalin is a carcinogen and alongside concerns of environmental accumulation there is evidence that heavy metals such as copper may select for AMR (Hobman & Crossman, 2018). Anecdotally, some herds have used antibiotic footbaths to control digital dermatitis. This practice is associated with extremely high levels of AMU, with farms using antibiotic footbaths being far more likely to be "high users" overall (Hyde *et al.,* 2017) and is no longer considered acceptable or necessary (Bell et al.,2017). Where the prevalence of acute digital dermatitis is high and/or disinfectant footbaths would cause too much discomfort to affected cows then targeted topical treatment (for example the application of oxytetracycline spray) of individual animals should be carried out, resulting in a significantly decreased level of AMU compared with herd level antibiotic footbathing.

Reproduction

Postpartum reproductive disease is relatively common in dairy cows, and the combination of reduced fertility, increased risk of culling, and increased AMU associated with these conditions makes their control and prevention extremely important (Gilbert 2016). The treatment of postpartum diseases such as metritis have historically involved the use of ceftiofur, however the use of HP-CIAs essential for human medicine largely on the basis of zero milk withdrawal is extremely difficult to defend. Many alternatives to HP-CIAs exist, and these should be considered wherever possible, particularly in light of recent farm assurance changes such as the Red Tractor antibiotic standards. Practitioners should be aware that the swapping of HP-CIAs to non-critical alternatives may result in an increase in overall AMU as measured by mass based methodologies, due to the relatively low dosing requirements of HP-CIAs (i.e. ceftiofur dosage: 1mg/kg, amoxicillin: 8mg/kg). Also to be considered are bulk tank residue failures if farmers' are not adequately informed of milk withdrawal requirements of HP-CIA alternatives, as well as the significant risks posed by the feeding of antimicrobial waste milk to calves as a route of disposal (Ricci *et al.,* 2017). Treatment of bacterial reproductive disease such as metritis with antimicrobials can be justified, however cases of retained fetal membranes should not need antimicrobial treatment in the absence of pyrexia (Drillich *et al.,* 2006). Whilst the treatment of clinical endometritis with intrauterine cephapirin has been shown in several studies to improve reproductive outcomes (Hyde & Brennan, 2017), the use of antimicrobial treatments for reasons other than cow health may be challenging to justify. Alternatives to antimicrobials such as prostaglandin treatments are widely used, although their efficacy in improving reproductive outcomes have been called into question (Haimerl *et al.,* 2013). It is far more effective to prevent diseases such as endometritis than rely on treatment options with limited evidence of efficacy.

The prevention of postpartum reproductive disease focusses on maintaining dry matter intake over the dry period, reducing negative energy balance and improving hygiene (Gilbert 2016), as well as minimising social group changes . A diagnostic approach to transition cow disease should focus on housing, management and nutrition. Key aspects are ensuring adequate feed space, ration composition and stocking density to maximise feed intake as well as control of hypocalcaemia and negative energy balance, all of which are areas practitioners can regularly monitor. A minimum feed space of 76cm per cow has been recommended for transition cows (Cook and Nordlund 2004), with a minimum required area per cow of 1.25m^2/1,000 litres/year (Green *et al.,* 2007) in loose housing. Cows should be assessed for body condition, lameness and infectious disease. Consideration can be given to the use of preventive treatments, such as a monensin (although it is worth noting monensin is also an antibiotic) or immune restoratives (Ruiz *et al.,* 2017), although recent studies suggest the potential for immune restorative products such as pegbovigrastim to have significant detriment to cow health (Zinicola *et al.,* 2018).

Both pre-partum energy balance monitoring with non-esterified fatty acid (NEFA) testing, and post-partum with beta-hydroxybutyrate (BHB) testing as a herd level strategy to identify both individual and herd level issues is of value (Ospina *et al.,* 2013). For example, early identification of ketotic cows via BHB testing and subsequent treatment with propylene glycol might prevent downstream complications of ketosis such as metritis and left-displacement of the abomasum (LDAs).

Furthermore, the regular monitoring of these metabolites at a herd level can be invaluable in determining where attention best be focused to prevent post-partum reproductive disease.

Youngstock

Neonatal calf diarrhoea and bovine respiratory disease (BRD) are common causes of morbidity and mortality in calves, and both are frequently treated with antimicrobials. Whilst calf AMU often has a relatively minor effect on overall herd AMU figures, these diseases represent a significant cost both in terms of economics and welfare, and remain a great opportunity for AMU reduction relative to calves. Treatment decisions are complicated by mixed viral, bacterial and protozoal aetiologies, and patterns of clinical signs which lack specificity for each cause. In addition, a wide range of risk factors relating to the housing environment and husbandry practices are at play. The combination of uncertainty surrounding a specific diagnosis, the relatively low cost and practical simplicity of antimicrobial therapy, and an aversion to risk, potentially all contribute to defensive prescribing in these cases.

The use of calf-side diagnostics can help predominant pathogen identification in cases of calf diarrhoea, though mixed infections are commonly present. Control should focus on maximising calf immunity through effective passive transfer of colostral immunity and reducing the pathogen challenge by improving environmental hygiene (Lorenz *et al.,* 2011). Therapy should focus on fluid rehydration by oral or intravenous routes, dependant on the degree of shock (Meganck *et al.,* 2014). NSAIDs are also appropriate, where adequate renal perfusion is maintained. Antimicrobial therapy of neonatal calf diarrhoea with oral boluses or parenteral injections are not needed, with the exception of severely sick animals, for example those affected with septicaemia associated with *E. coli* in the first few days of life (Constable 2004).

Control of BRD should again focus on achieving adequate passive transfer as well as improving environmental conditions and nutrition (for example improved ventilation, increased frequency of bedding and adequate energy intake) (Gorden and Plummer 2010). In closed herds identifying the causative primary pathogens may be of value to inform preventive strategies. Sampling of acute cases of respiratory disease using broncho-alveolar lavage (BAL), trans-tracheal washes and conjunctival/nasopharyngeal swabs are techniques underused in clinical practice to inform treatment decisions. Culture and sensitivity results from post-mortem submissions may have more limited value in informing treatment decisions because they often represent chronic cases and treatment failures rather than the primary agent, however post-mortem examination can be extremely valuable when cases are appropriately selected. Retrospective or ideally paired serology of cohorts undergoing the same management system can be useful to identify predominant pathogens, but has less value therapeutically. An extensive range of vaccines are available for the common causes of respiratory disease, although are unlikely to completely prevent disease in the presence of poor environmental conditions (Sherwin and Down 2018). Similarly, vaccination of dams to provide immunity to calves for the causative agents of diarrhoea will not be effective if colostrum and environmental management is inadequate.

Prophylactic use of antimicrobials should be avoided, with a clear emphasis placed on preventing disease. The use of tetracyclines to medicate milk powder as a control strategy for BRD does not represent responsible AMU (VMD, 2013), particularly when effective control strategies, including vaccination are available. The potential for co-selection for resistance to cephalosporins in cattle is well recognised and should increase concern regarding the unnecessary and overuse of tetracyclines (Kanwar *et al.,* 2014). The routine monitoring of calf serum total proteins and colostrum quality will enable the early detection and subsequent investigation of issues within the colostrum management process, and bacteriological analysis of colostrum may also be of interest if hygiene failures are suspected. There is great potential for the veterinarian to have significant impact on calf health by improving management factors such as colostrum management, which will lead to measurable improvements in calf health and consequently reductions in AMU.

Infectious disease

Infectious disease control has been a significant part of veterinary surgeon led herd health planning over many years. The drivers for infectious disease control include reducing disease (production, economic and welfare impacts) and increasing stock value (trade). Key single agent infectious diseases important in dairy herds include BVD, Bovine herpes virus (BHV), Leptospirosis, Johnes Disease and Bovine Tuberculosis (bTB). BVD exacerbates calf disease through immunosuppression (Lanyon *et al.,* 2014), and BHV can cause pneumonia (IBR) and abortions (Graham 2013), and whilst both BVD and BHV are viral infections, it is likely that AMU will increase in the face of disease. Johne's Disease is bacterial in origin but considered untreatable, again increased AMU seems likely due to the increased risk of other diseases (Tiwari *et al.,* 2006). Bovine TB has the potential to indirectly increase AMU through restrictions on livestock sales, resulting in overstocking of calves, or restocking through purchases increasing infectious disease risk.

A number of disease control and eradication strategies and schemes are available, and it is plausible that good control of single agent infectious diseases are not only good for health and productivity but are also likely to lead to reductions in AMU. Regular bulk tank milk serological screening and the adoption of appropriate biosecurity and/or vaccination strategies are commonly advocated for BVD, IBR and Leptospirosis, although all approaches have their limitations. BVD eradication is supported by legislation in Scotland and industry led schemes in England (BVD Free) and Wales (Gwaredu BVD). Johne's disease control requires control plan compliance over a sustained period of time, with advice available from the National Action Group on Johne's (actionjohnesuk.org). Bovine TB control is achieved through statutory controls, and accreditation schemes (such as CHeCS) also exist and again biosecurity is essential in control.

Retailers and milk buyers

Milk price banding has been used to pay for milk constituents for many years, and to incentivise somatic cell count control since 1994. The milk price received and contractual relationship now extends much more widely to cover AMU and herd health through aligned retailer contracts, which create a direct relationship between retailer and supplier. These aligned contracts give the retailer direct influence in the supply chain, allowing the retailer an opportunity to address issues such as health, welfare and medicine residues, with the aim of building consumer trust. Contracts require dairy farms to meet minimum standards and higher standards can be incentivised. Two methods of AMU data collection exist – reporting directly by farmers, or reporting of antimicrobial sales by the veterinary practice. Whichever collection method is used, benchmarking identifies AMU by type and class.

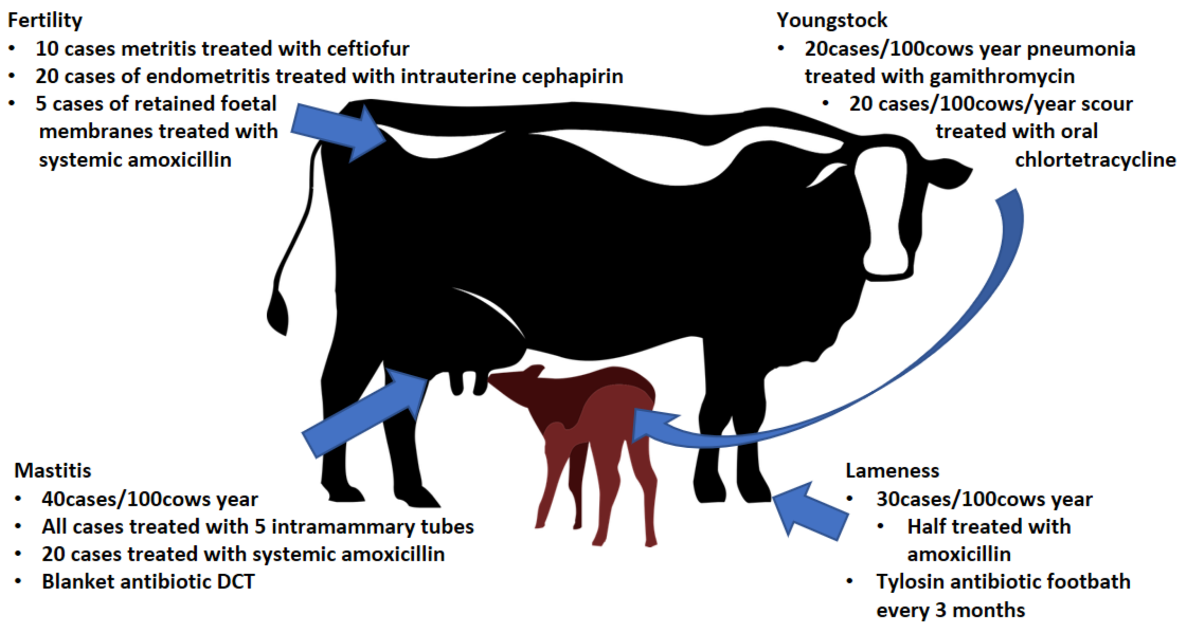
AMU reporting can be used to influence antimicrobial selection, with retailers restricting access to highest priority critically important antimicrobials, and this approach has been adopted from June 2018 by the Red Tractor Assurance Scheme. Treatment decision making is influenced through the encouragement of selective dry cow therapy, which requires somatic cell count recording and control. Farms with relatively high use of therapeutic antimicrobials can be identified as benefit is likely to be seen from both improved disease control as well as implementing rational treatment protocols if they do not yet exist. Benefits from an AMU reduction plan should be accrued by the retailer (less reputation risk), the processor (less residue risk), the farmer (less cost), the cow (less disease) and the veterinarian (herd health opportunities). Aligned contracts encourage farmer engagement through benchmarking and incentives (potential for price or volume bonuses from high performance) and risk (contracts may be lost from underperformance). While retailer contracts are driving change and AMU reduction, this change should be beneficial to all, and is simply another step towards increased preventive health.

Summary

The responsible use of antimicrobials on dairy farms is an important issue. By monitoring AMU and applying the principles of herd health to reducing disease associated with high AMU, significant decreases in AMU can be achieved. Reductions in AMU achieved by reducing disease are likely to be sustainable as well as good for animal welfare, farm profitability and production, whilst limiting the dissemination of antimicrobials into the environment, not to mention an excellent opportunity for veterinarians interested in providing a herd health consultancy service to their farm clients.

Veterinarians have a great role to play in the training of farmers, and are clearly gatekeepers in AMU prescription with an obligation to be in control of what is being prescribed to farms. Benchmarking at practice level is an easy and effective method of identifying high usage farms and allows effective AMU reductions to be rapidly achieved through targeted herd health interventions. Freely downloadable tools are available both to measure and benchmark AMU on farms, and should feature as a routine component of a herd health review, enabling veterinarians to engage with high use farms, and reduce AMU by reducing disease incidence through proactive herd health interventions.

Figures



Fertility
- 10 cases metritis treated with ceftiofur
- 20 cases of endometritis treated with intrauterine cephapirin
- 5 cases of retained foetal membranes treated with systemic amoxicillin

Youngstock
- 20cases/100cows year pneumonia treated with gamithromycin
  - 20 cases/100cows/year scour treated with oral chlortetracycline

Mastitis
- 40cases/100cows year
- All cases treated with 5 intramammary tubes
- 20 cases treated with systemic amoxicillin
- Blanket antibiotic DCT

Lameness
- 30cases/100cows year
  - Half treated with amoxicillin
- Tylosin antibiotic footbath every 3 months

Figure 1 A diagram illustrating high antimicrobial use on an example dairy farm

1. Input the number of adult dairy cows on the farm

	Number
Dairy cow	100
Slaughtered Cow	
Slaughtered Heifer	
Slaughtered Bullocks and Bulls	
Slaughtered Calves and Young Cattle	
Total PCU (Kg)	**42500**

2. Input the antimicrobial products used within the last year

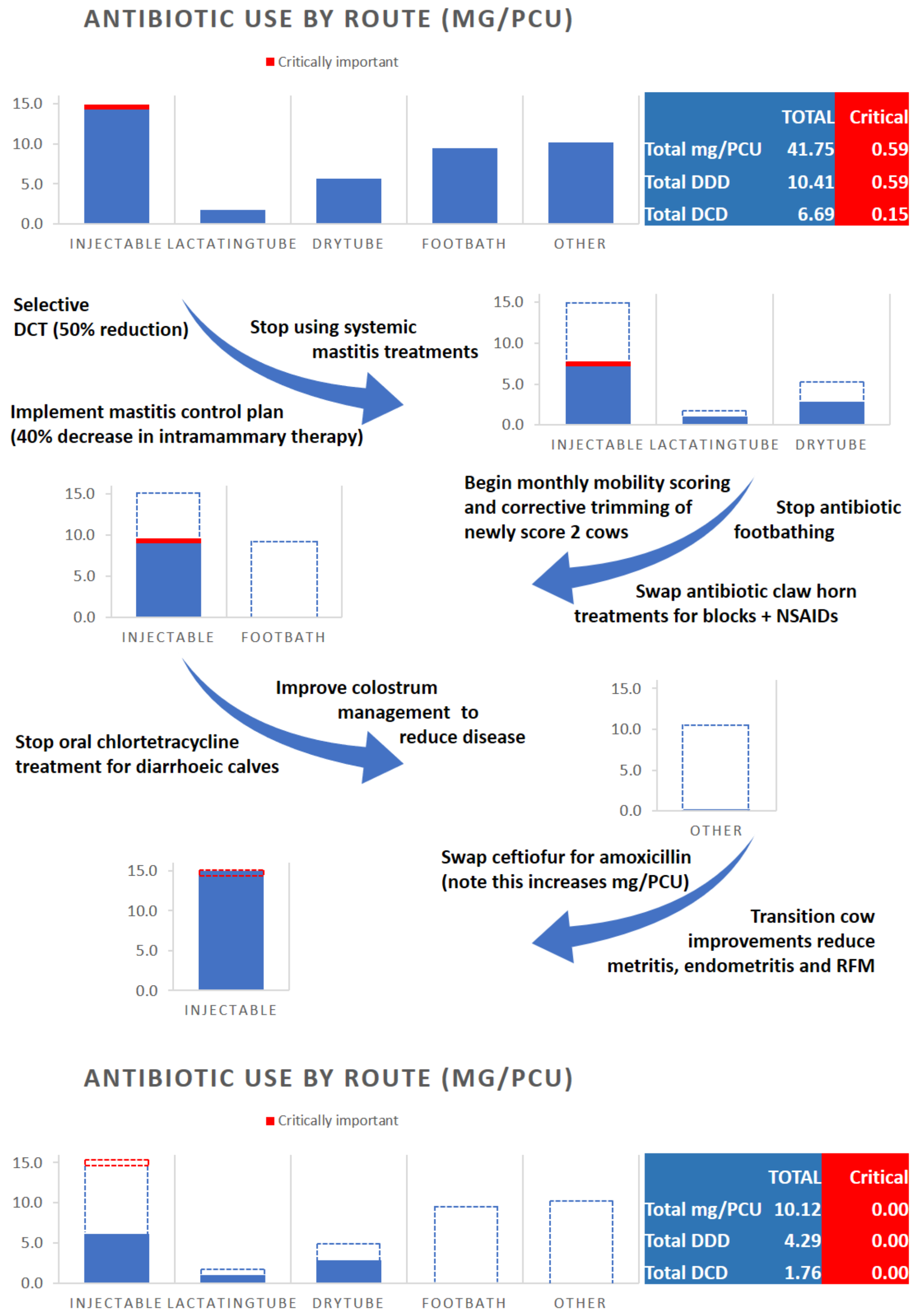
	TOTAL	Critical
Total mg/PCU in herd	41.75	0.59
Total DDD	10.41	0.59
Total DCD	6.69	0.15

Route	Product	Amount used	Units	mg/PCU	Critically important?
Injectable	Betamox 150mg/ml Suspension for Injection	4000.00	ml	14.12	
Lactatingtube	Tetra-Delta Intramammary Suspension	200.00	Tubes	1.72	
Drytube	Orbenin Extra Dry Cow 600 mg Intramammary :	400.00	Tubes	5.65	
Footbath	Tylan Soluble Powder for Oral Solution Footba	400.00	grams	9.41	
Injectable	Cevaxel RTU 50 mg/ml	500.00	ml	0.59	CRITICAL
Other	Metricure 500 mg Intrauterine suspension	20.00	Units	0.24	
Injectable	Draxxin 100 mg/ml solution for injection for ca	60.00	ml	0.14	
Other	Chloromed 150mg/g Oral Powder for Calves	2800.00	grams	9.88	

3. Analyse antimicrobial usage by different metrics, and identify where usage is highest

4. Using the benchmarking tool, benchmark farms within practice/group

Figure 2 An illustrated guide to using the AHDB/University of Nottingham antimicrobial use calculator (available to download for free from www.dairy.ahdb.org.uk/technical-information/animal-health-welfare/amu-calculator) and Benchmarking tool (available to download for free from www.dairy.ahdb.org.uk/resources-library/technical-information/health-welfare/amu-benchmarking-tool) to assess AMU on the example farm (figure 1), and benchmark against other farms



	TOTAL	Critical
Total mg/PCU	41.75	0.59
Total DDD	10.41	0.59
Total DCD	6.69	0.15

Selective DCT (50% reduction)

Stop using systemic mastitis treatments

Implement mastitis control plan (40% decrease in intramammary therapy)

Begin monthly mobility scoring and corrective trimming of newly score 2 cows

Stop antibiotic footbathing

Swap antibiotic claw horn treatments for blocks + NSAIDs

Improve colostrum management to reduce disease

Stop oral chlortetracycline treatment for diarrhoeic calves

Swap ceftiofur for amoxicillin (note this increases mg/PCU)

Transition cow improvements reduce metritis, endometritis and RFM

	TOTAL	Critical
Total mg/PCU	10.12	0.00
Total DDD	4.29	0.00
Total DCD	1.76	0.00

Figure 3 A diagram illustrating the scale of antimicrobial use reduction that could be achieved in the example herd (Figure 1) by implementing the advice in the article

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