

An analysis use patterns of antimicrobials and risk factors for their use on New Zealand farms

M BRYAN*, E KNUPFER, S FRUEAN
VetSouth Ltd, Winton, Southland New Zealand

*markb@vetsouth.co.nz

Abstract

Antimicrobial resistance (AMR) has been described as one of the greatest global threats to mankind (1). Although New Zealand has a relatively low level of antimicrobial use (AMU) compared to other countries (2), the New Zealand Veterinary Association (NZVA) has still recognised its role in the mitigation of risk around AMR, and in 2015 released its aspirational statement that 'by 2030, NZ Inc will not need antimicrobials for the maintenance of health and welfare in animals' (3).

To achieve this requires a far greater understanding of both antimicrobial (AM) use and resistance. The industry is currently engaged in developing a programme of work under the joint oversight of both the Ministry for Primary Industries (MPI) and the Ministry of Health, and improved surveillance of AMR and AMU amongst livestock will be an important element of this.

This paper describes the preliminary findings of a current pilot study developed to capture and analyse comprehensive AMU data from veterinary clinics, with the goal of developing a methodology for ongoing surveillance and understanding.

Keywords: antimicrobial, resistance, PCU, use, surveillance

Introduction

Agricultural antimicrobial use (AMU) has been linked to the development of antimicrobial resistance (AMR) which could potentially pass between animals and humans (4,5).

The potential development of AMR is a complex function involving the volume of antimicrobials used; the types of antimicrobial actives used; the mechanism of administration; the target species and many other factors. Direct transfer of AMR between animals and humans is also complex, and may occur in either direction (6,7). Indirect (for example, food-borne) AMR transfer is also a significant potential risk.

Although New Zealand has been identified as the third lowest user of antimicrobials in the world for agriculture (2), there is a lack of understanding around use patterns and risk factors that increase or decrease use. To achieve the NZVA's aspirational goal around AMU, a better understanding of the use patterns of antimicrobials in New Zealand agriculture, and a more rigorous surveillance framework is needed to help progress this goal.

Recent work has suggested that just under half of antimicrobials used in dairy farming for example, were used in dry cow antimicrobial therapy (DCAT) (8). The use of

dry cow therapy has been associated with increasing the risk of resistant pathogens on dairy farms (9,10). With the help of these data, the NZVA has proposed that DCAT should be limited to only infected cows by 2020 (11). This could potentially reduce DCAT use by over half.

This study was designed as a pilot project to assess and explore AMU data across all production animal species in New Zealand. The project captures data from five key regions at a very detailed level of not only AMU but also risk factor data such as farm size, species, ownership structure.

Materials and methods

Data were collated from six key clinics from five key regions of New Zealand. These clinics all participated in a national animal health and welfare programme, and so had standardised data that were more readily accessible. AMU data was gathered for all farms serviced by these clinics during the period 1 June 2015 to 31 May 2016. Sales were used as a proxy for use. These data were gathered from a variety of veterinary business software.

In addition, denominator data was gathered for each animal category for each farm identified; and risk factor data (ownership structure, postcode, species) were also gathered.

The data were merged into a single database along with comprehensive data on all antimicrobials available for sale in New Zealand. For each antimicrobial sold the quantity of active ingredient in each unit dose sold was calculated. Antimicrobial usage was quantified by dividing the total mass of the active ingredient by the total biomass, also known as the population correction unit (PCU), to give the mass of active ingredient per PCU (mg ai/PCU), as described in Anonymous (12). Antimicrobials were classified as aminoglycoside, cephalosporin, fluoroquinolone, lincosamide, macrolide, penicillins, sulfonamides, tetracycline and trimethoprim. All data handling and statistical analysis was performed using Microsoft Office Access and Excel 2013 (Microsoft Corp, Redmond, Wa), SPSS (SPSS v22, IBM Analytics, New York, 2013, and STATA software version 14 (StataCorp, College Station, Texas).

Data will be analysed using categorical variables ('farm type', 'ownership structure', 'region') and by continuous variable ('farm biomass', 'farm size'). Complete univariate descriptive statistics including raw odds-ratios and likelihood ratio Chi-square (χ^2) analyses of categorical variables will be developed. The categorical outcomes will also be explored using multinomial logistic regression, and the continuous outcome variables will be examined using simple linear regression.

Predictor risk factor variables will be built into a univariate regression models using 'mg of drug/kg of farm weight' as an outcome. A multivariate model will be built if relevant using predictors identified where $p < 0.1$. The final model will be verified using maximum likelihood estimates, proper likelihood ratios, and Wald's tests.

Results

It must be stressed that at the time of writing the data have only recently been collated and a summary analysis performed. The numbers are likely to change once the final data verification and analysis is completed.

Demographics

From six clinics, 1463 dairy farm client records and 744 red meat (sheep, beef, deer or mixed) farm client records were obtained (total 2207 holdings). This comprised 1,413,881 red meat animals and 928,268 dairy animals (total 2.34m).

Of the dairy farms involved, the vast majority were owner-operator run (69.0%, $n = 1009$). The next most common group was sharemilkers, who made up 12.6% ($n = 185$).

Antimicrobial usage

The total biomass represented within the dataset was 511.3m kg, of which 74.4% (380.5m kg) was represented by dairy and the remainder by the red meat sector. A total of 16170 separate sales items were recorded on the database. Preliminary analysis has shown an overall use rate of 4.84mg ai/kg PCU. For the dairy farms only the figure was 6.5mg ai/kg PCU and for the red meat farms this was 4.4mg ai/kg PCU. This aligns with previous data (2, 8) which indicated that dairy farms in a small subset used a mean of 8.65mg ai/kg PCU, and livestock in New Zealand in general (including pigs and poultry), used a mean of 7.62 and 11.46mg ai/kg PCU over a period of 10 years leading up to 2012, respectively.

For dairy alone, the majority of AM used (by mg of active) was penicillins, which represented 64.9% of all AM use. This was followed by tetracyclines (16.0%) and then macrolides (7.7%). It is worth noting that fluoroquinolone, one of the antimicrobials that has been identified by the World Health Organisation (WHO) as a critically important antimicrobial (13) (CIA), represented only 0.009% of all antimicrobials used.

Discussion

This paper introduces some preliminary findings from a number of veterinary businesses across New Zealand and begins to identify some key areas for greater understanding with our current use of antimicrobials in livestock.

Further analysis of the data will reveal specific risk factors associated with key AM actives, or use patterns, and will allow the industry to better target messaging and develop appropriate interventions and/or change processes.

Surveillance of AMU has been developed overseas, most notably in the Netherlands and in Denmark. Both countries have had the benefit of an existing comprehensive national

animal database where disease and treatment was recorded mandatorily. New Zealand has no analogous existing database, nor regulatory requirement.

However, New Zealand does have stringent and largely effective regulation covering the prescribing and sales of AMs to farmers. AMs may only be prescribed by an appropriate veterinarian, and may only be sold by either an appropriate veterinarian or a registered trader. These data draw only from veterinary sales and not trader sales, but it is understood that the volume of AMs traded by registered traders is quite small and unlikely to have much of a bearing on these data.

Furthermore, rural veterinary businesses in New Zealand servicing production animals tend to be larger than their European counterparts. Thus, although the absence of a compulsory national database may be seen as an impediment to good AMU surveillance, the presence and willingness of a small but highly significant number of rural veterinary businesses make this method of data collation and analysis feasible.

Currently, MPI collates and publishes sales volumes (by weight) of all antimicrobials sold in New Zealand, on an annual basis periodically. This is a useful higher level analysis but is insufficiently granular to determine use patterns and risk factors. However, this pilot project demonstrates that there is considerable merit in developing a comprehensive AM sales surveillance using veterinary businesses.

Using only clinics who participate in a national programme has the potential to introduce bias to the data, and this is acknowledged. This goal should be to use the framework and database to capture data from as broad a range of clinics as possible to mitigate this risk.

Developing this programme further, extending the capture of data from a greater number of willing veterinary participants, and continuing the stringent application of a regulatory framework regarding the supply of AMs will allow the primary sector stakeholders to firstly develop appropriate pathways towards the NZVA's goal; and secondly, to continue to demonstrate to trading partners and other countries the low level of AM use involved in our agricultural sector.

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