# Integrating bacteriological milk examination into decision support for reduced use of antimicrobials

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## Abstract

With respect to the increasing emergence of antimicrobial resistance, the use of antibiotics in livestock production is an issue of growing concern. In an observational study in 249 dairy herds (6475 cow-years) in Austria, antimicrobial treatments, pathogen information and various risk factors were analysed. Standardised treatment data that were provided by 17 different veterinary practices showed very diverse patterns of antimicrobials used for treatment of mastitis and for drying-off. The pathogen information was harmonised across the six laboratories. Additionally different environmental- and management information related to udder health management was collected. Management tools incorporating pathogen information additionally to routine milk recording information and veterinarian diagnoses were elaborated. Technical interfaces to the central cattle database as well as the required data protection measures were developed and are presently implemented to routine.

This study showed that the pathogens isolated from mastitis milk were predominantly contagious on some farms and mainly environmental on others. These results support the need to develop tools which lead to a more evidence-based prudent use of antimicrobials when treating mastitis and drying off dairy cattle. Analyses across routinely-recorded production data, health data and antimicrobial use provide valuable information on disease-risks as well as the cow groups at risk. Failures in management and causes of diseases can be identified more easily and eliminated at an earlier stage. Assessing the infection status of the udder, by means of milk culture results, can assist the decision-making processes regarding more precise control and prevention measures to improve udder health. The more information is available, the more targeted a treatment can be. Standardisation and integration of data, therefore, play a crucial role in the prudent use of antimicrobials on dairy farms.

## Introduction

Animal health, animal welfare and food safety are of increasing concern to consumers. An important measure in the dairy industry is the improvement of udder health, which is influenced by different factors such as environmental factors and herd management,

genetics as well as targeted treatment of udder infections. In view of the rising occurrence of antibiotic resistance, prudent use of antimicrobials and pathogen-specific treatments are of high importance and can only be possible if various data sources are available and linked: farm specific environmental factors, animal specific information such as auxiliary traits including somatic cell count, and, most importantly, information on diagnoses with laboratory tests on pathogens as well as animal-specific treatment information with results from sensitivity tests of antimicrobials. In order to ensure efficient management and provide effective advice to dairy herd managers, it is important to combine this variety of different data sources and prepare simple but meaningful decision support tools for farmers and veterinarians. In the Central Cattle Database (German: *Rinderdatenverbund*, RDV) in Austria different datastreams such as farm specific information, bulk milk information, milk performance records, breeding records, genome data, as well as veterinary diagnoses, results of bacteriological milk cultures, and data on the administration and dispensing of veterinary drugs are recorded and can be accessed by the farmer and herd veterinarian online via computer or mobile phone. The precondition of integrating many different data sources into comprehensive databases and common tools is data standardisation. Within the ADDA (Advancement of Dairying in Austria) project, standardised protocols for bacteriological milk analyses and harmonised documentation of findings were developed with the respective laboratories. Within the "Electronic Herdbook" project, use of antimicrobial treatments with respect to animal and diagnoses was standardised within Austria based on the legal background in conjunction with the regulation on monitoring antimicrobial use in livestock. To develop a targeted dry off-strategy, the impact of farm-specific management and environmental factors was assessed. This paper describes the work done in regard to standardisation of pathogen information and antimicrobial treatments and gives an overview of further ongoing steps within the D4Dairy project to develop a decision support tool for a targeted dry off-strategy using existing health and production data to reduce the overall use of antibiotics.

## Material and methods

In an observational study *(*Firth *et al., 2017)* over a trial period of one year from October 2015 to September 2016, data on antimicrobial use on 249 dairy farms were collected as part of the ADDA (Advancement of Dairying in Austria) research project. The dataset comprised data from 7867 antimicrobial treatments, 6700 cows and standardised treatment data provided by 17 different veterinary practices. The antimicrobial treatments were analysed and information on various risk factors was recorded.

### *Standardisation of bacteriological investigations*

The aim was the harmonisation of bacteriological culture results and pathogen information across laboratories. A working group of researchers and representatives of the labs was formed. After analysing the current situation, harmonisation of the analyses in the labs from sample preparation, methods of testing and interpretation of results including quality assurance with continuous ring tests of participating labs was carried out. Another topic was standardisation of findings across laboratories. To enable the amalgamation of various data, technical and legal aspects of data communication between labs and the central database had to be developed as well.

### *Standardisation of antimicrobial treatment*

Austria has a nationwide "Health Monitoring in Cattle" programme (Egger-Danner *et al.,* 2012). Veterinarian diagnoses have been recorded centrally in the Central Cattle Database since 2006. This database was recently extended to include the harmonised

electronic documentation of animal- and diagnosis-specific use of antimicrobials. The data on antimicrobial use were standardised according to EMA and ESVAC guidelines. To allow for comparison between farms, TD365 metrics based on antimicrobial consumption treatment days over 365 production days were calculated per farm (Figure 1), according to the European Medicines Agency units of Defined Daily Doses (DDDvet) and Defined Course Doses (DCDvet, for dry-off preparations) (EMA, 2015; EMA, 2016)

These metrics provide added value to the milk performance and herd health dataset and make individual herd-specific data comparable to metrics from other herds (benchmarking).

The set-up of the standardisation and integration of the data has taken the legal regulations into account. In this way it was possible to develop a mobile application for farmers where the legal documentation requirements can be complied with electronically.

Integrated tools for herd management were developed and integrated to the Central Cattle Database, where various relevant information is combined for to assist with decision making.

**Calculation of the number of treatment days over 365 production days per farm (*#TD365*):**

$$\#TD365 = \sum_{i=1}^{n} \frac{amount\ AS_i\ in\ period\ P\ (mg)}{DDDvet_i\ (mg/kg/day)\ x\ \#\ production\ days\ in\ period\ P\ (days) \times standardised\ weight\ (kg)}\ x\ 365$$

| | |
|---|---|
| *# TD365* | = number of treatment days per year that an animal is present on the farm |
| *amount $AS_i$* | = amount (in mg) of active substance i used in period P; i = 1, 2, …, n |
| *$DDDvet_i$* | = Defined Daily Dose of active substance i (in mg/kg/day); i = 1, 2, …, n (EMA 2016) |
| *# production days in period P* | = number of animals present daily during period P (in days) |
| *standardised weight* | = standard animal weight at treatment (in kg) |

**Correction #TD365 for dry cow treatment:**

*#TD365 dry cow treatment corrected = #TD365 dry cow treatment * (CI/365 * (100/100–PR))*

| | |
|---|---|
| *CI* | = calving interval of the herd (days) |
| *PR* | = percentage of cows replaced |

*Figure 1. Calculation of antimicrobial use.*

### *Evaluation of risk factors*

Based on different surveys conducted among veterinarians, farmers and consultants, herd specific management and risk factors for udder health have been identified for each farm (Firth *et al.,* 2019). Advanced statistical analyses will be applied to further in-depth studies of risk factors (Klimek *et al.,* 2018) within D4Dairy.

### *Targeted dry-off strategy*

Within the D4Dairy project, hypotheses based on targeted dry-off strategies are tested on pilot farms and data streams including risk factors will be combined to enable the development of targeted decision support tools.

## Results and discussion

Based on the data from the ADDA observational study, standardised procedures for bacteriological analyses were developed and harmonised processes, applicable to both Germany and Austria, were defined (LKV Nordrhein-Westfahlen, 2016; Codeset 8262 Befundschluessel). The standardised procedure is described in Baumgartner *et al.,* 2018.

To legally permit the amalgamation of various data technical, certain legal aspects of data communication between labs and the central database had to be clarified; which have since been implemented into routine applications within the Central Cattle Database (RDV).

Pathogens present and antimicrobials used across farms and veterinary practices showed very diverse patterns on the farms included in the ADDA project (Firth *et al.,* 2017, Schabauer *et al.,* 2018).

Integrated tools for herd management based on the Central Cattle Database have been developed and are now available for farms and veterinarians (Suntinger *et al.,* 2018; Suntinger *et al.,* 2019). Figure 2 shows an example of such a tool based on pathogen information. Figure 3 shows the benchmarking metrics provided for farmers to compare themselves to the other farms in terms of treatment days per year in total, with respect to udder health alone, treatments used for drying off, and for each disease complex, as well as the percentage of antimicrobial substances used which are considered the Highest Priority Critically Important Antimicrobials (HPCIA) for human medicine. Figure 4 displays the potential of the mobile application for practical use for the farmers. One example is that the medicinal withdrawal period for each individual cow is always available online.

Conclusion and outlook

To enable a more prudent use of antimicrobials with targeted treatment and dry-off strategies, it is essential that all relevant data can be linked and more in depth knowledge is available with respect to risk of infection, the causative pathogens and possible antimicrobial resistance. Drying-off is one of the major reasons for use of antimicrobials in dairycows, therefore measures to reduce the use of antimicrobials while ensuring udder health are vital. Within the D4Dairy project, research is being done on further data communication and data integration, analyses of risk factors for occurrence of mastitis. For developing a decision support tool for animal-based dry-off strategies, beside the existing standardised information, testing of hypothesis for dry-off strategies


*Figure 2. Example for displaying information on pathogen information from bacteriological milk sample implemented within the Central Cattle Database (RDV).*

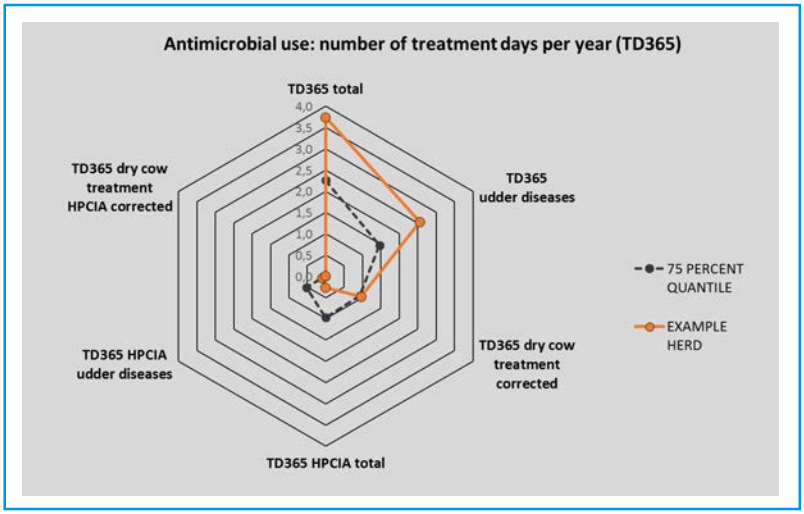


*Figure 3. Herd-specific antimicrobial use in comparison with other farms milk sample implemented within the Central Cattle Database (RDV)*

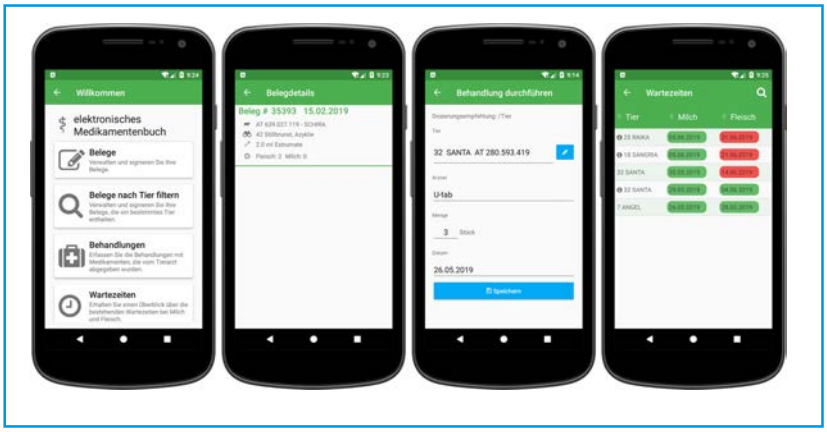


*Figure 4. Mobile documentation of antimicrobial use.*

and the harmonisation of antimicrobial resistance testing is a research focus within D4Dairy. Standardisation and integration of data continue to play a crucial role in supporting the prudent use of antimicrobials on dairy farms and is also essential to enable monitoring and comparisons.

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