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Antimicrobial drug use and risk factors associated with treatment incidence and mortality in Swiss veal calves reared under improved welfare conditions

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ABSTRACT

Ninety-one Swiss veal farms producing under a label with improved welfare standards were visited between August and December 2014 to investigate risk factors related to antimicrobial drug use and mortality. All herds consisted of own and purchased calves, with a median of 77.4% of purchased calves. The calves' mean age was 29 ± 15 days at purchasing and the fattening period lasted at average 120 ± 28 days. The mean carcass weight was 125 ± 12 kg. A mean of 58 ± 33 calves were fattened per farm and year, and purchased calves were bought from a mean of 20 ± 17 farms of origin. Antimicrobial drug treatment incidence was calculated with the defined daily dose methodology. The mean treatment incidence (TI_{ADD}) was 21 ± 15 daily doses per calf and year. The mean mortality risk was 4.1%, calves died at a mean age of 94 ± 50 days, and the main causes of death were bovine respiratory disease (BRD, 50%) and gastro-intestinal disease (33%). Two multivariable models were constructed, for antimicrobial drug treatment incidence (53 farms) and mortality (91 farms). No quarantine, shared air space for several groups of calves, and no clinical examination upon arrival at the farm were associated with increased antimicrobial treatment incidence. Maximum group size and weight differences >100 kg within a group were associated with increased mortality risk, while vaccination and beef breed were associated with decreased mortality risk. The majority of antimicrobial treatments (84.6%) were given as group treatments with oral powder fed through an automatic milk feeding system. Combination products containing chlortetracycline with tylosin and sulfadimidine or with spiramycin were used for 54.9%, and amoxicillin for 43.7% of the oral group treatments. The main indication for individual treatment was BRD (73%). The mean age at the time of treatment was 51 days, corresponding to an estimated weight of 80–100 kg. Individual treatments were mainly applied through injections (88.5%), and included administration of fluoroquinolones in 38.3%, penicillines (amoxicillin or benzylpenicillin) in 25.6%, macrolides in 13.1%, tetracyclines in 12.0%, 3th and 4th generation cephalosporines in 4.7%, and florfenicol in 3.9% of the cases.

The present study allowed for identifying risk factors for increased antimicrobial drug treatment and mortality. This is an important basis for future studies aiming at reducing treatment incidence and mortality in veal farms. Our results indicate that improvement is needed in the selection of drugs for the treatment of veal calves according to the principles of prudent use of antibiotics.

1. Introduction

Antimicrobial consumption and bacterial resistance are topics of numerous scientific studies and political discussions and attract the interest of the media as well as of the general public. In Europe, over the last twenty years, several countries started programs for monitoring antimicrobial resistance (Chantziaras et al., 2014). The importance of standardizing methods to quantify antimicrobial consumption in food producing animals in order to generate comparable data from different countries has been discussed (Pardon et al., 2012a), but it remains a challenge to obtain reliable data that can be compared among countries, even within Europe. In Switzerland, approximately two-thirds of the antimicrobial drugs sold for veterinary use are products designated for

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oral group treatments (Bundesamt für Lebensmittelsicherheit und Veterinärwesen, 2013), of which about half is given to veal calves.

In contrast to the main producer countries where the veal calf industry is highly integrated with large groups of calves being bought for intensive fattening (Pardon et al., 2012b), an alternative system exists in Switzerland. Dairy farmers raise their own calves for slaughter (with or without additional purchased calves) with whole milk. Usually, male calves and excess female calves are purchased at the age of 4 weeks, with a weight of approximately 75 kg. These calves are mostly housed in straw-bedded pens in groups of up to 40 calves and fed by automatic feeding systems with whole milk and milk powder. The purpose of this rearing system is to slaughter the calves before the age of 160 days, with a carcass weight of 140 kg and a rosy meat colour. In Switzerland, about 250,000 veal calves are slaughtered annually (Proviande, 2013), which corresponds to about 4% of the European production of veal calf meat (5.8 million calves) (Sans and de Fontguyon, 2009).

In Switzerland, animal welfare is a subject of importance for the general public. The welfare standards defined in the Swiss legislation are higher than those in most other European countries. Permanent access to water and ad libitum feeding of an appropriate roughage source is mandatory for veal calves and for dairy calves (Tierschutzverordnung, 2008). Even though veal calf meat is a premium product representing only 5.8% (3 kg) of the meat consumed per person and year in Switzerland (Proviande, 2013), veal meat production is often in the focus of public attention (Medienspiegel Kälbergipfel, 27. Juni, 2011; SRF, 2011, 2012a,b,c). Criticism relates mostly to animal welfare because the "white" veal meat colour expected by some of the consumers results from inappropriate feeding of the calves, mainly with milk without sufficient roughage, and subsequent iron deficiency (Räber et al., 2013). In order to satisfy consumers' expectations, different labels certifying a higher quality product and better animal welfare standards than the minimum requirements of the Swiss animal welfare legislation (Tierschutzgesetz, 2005) have been created. IP-SUISSE is one of these labels. It covered 16.4% of the Swiss production of veal calves in 2013. In a previous study (Lava et al., 2016) focusing on the production in IP-SUISSE certified farms, three veal calf farm types were identified, namely: (1) farms slaughtering only purchased calves, (2) farms slaughtering purchased and own calves, and (3) farms slaughtering only own calves. Research should primarily focus on farms from the second group since they represent the numerically biggest group of calves and have the highest antimicrobial use and mortality rate.

The present study aimed at quantifying and describing antimicrobial use and at identifying the major risk factors associated with antimicrobial drug use and mortality among IP-SUISSE certified veal farms rearing own and purchased calves in Switzerland.

2. Materials and methods

2.1. Study design and farms selection

A retrospective cross-sectional study was performed. The study population consisted of 107 IP-SUISSE veal farms where own and purchased calves were fattened. The standards of IP-SUISSE prescribe, among others, a straw-bedded area of $\geq$1.8 m^2/calf up to 200 kg, the feeding of at least 1000 l whole milk per calf, a minimum age of 4 weeks at the time of purchase, and a maximum of 40 calves per compartment in all-in/all-out systems or up to 15 calves per compartment for continuous stocking of calves (IP-SUISSE, 2013). From 2015 on, access to an outside pen and a total surface of $\geq$3.5 m^2 per calf is mandatory (Verordnung über die Direktzahlungen an die Landwirtschaft, 2014; IP-SUISSE, 2015). In a previous study, all 2169 IP-SUISSE farmers had been asked to participate in a short survey regarding the type of herd (fattening purchased calves, own calves, or both), the number of calves fattened per year, morbidity, mortality, and antimicrobial treatments (Lava et al., 2016). The farmers had been contacted electronically or by surface mail depending on the availability of an e-mail address. The survey was available on-line or the farmers could return the questionnaire per surface mail. In accordance with the results of this previous study, the target population of the present study was farms rearing purchased and own calves (56.9% of the farms, 66.7% of the calves produced under the IP-SUISSE label). Farmers who expressed interest for a farm visit and collection of data for the present study during the first survey were contacted by phone. Twenty or more calves had to be slaughtered per year for a farm to be included in the study. Of the 107 farmers fattening own and purchased calves who had expressed interest to participate in a further study, 13 farmers were no longer willing to take part in the study, 2 farmers had not purchased veal calves and one farmer had slaughtered less than 20 veal calves in the year 2013. A sample size of 90 farms had been calculated to detect a difference in treatment incidence of 6 daily doses of antimicrobial drug per calf and year for a risk factor present in 50% of the farms, assuming an average treatment incidence of 20, a standard deviation of 10, a power of 80% and a 5% significance level (Hintze, 2013).

2.2. Farm visits, questionnaire and documents

Between August and December 2014, 91 IP-SUISSE veal farms were visited once. The standardized visit protocol included both a questionnaire filled in with the farmers and observations on the farms. The questionnaire was developed based on existing literature (Svensson et al., 2003; Lundborg et al., 2005; Assié et al., 2009; Bähler et al., 2010, 2012; Brscic et al., 2012; Woolums et al., 2013b; Künzler et al., 2014; Beer et al., 2015; Lago et al., 2006) and was tested with 7 veterinarians and 5 farmers prior to the start of the study. The questionnaire consisted of 4 parts related to management (6 questions), housing (6 questions), nutrition (4 questions), and calf health (4 questions) (Table 1). The farmers were asked to provide a copy of the registered treatments with antimicrobial drugs (group and individual treatments) as well as a copy of all bills released by the veterinarian for the year 2013. Written permission to access the information provided by the Swiss national animal movement database (Tierverkehrsdatenbank, TVD) was provided by the herd managers.

2.3. Animal data

Individual calves' data such as birth date, breed, gender, farm of origin, date of purchase (if applicable), date of slaughtering or death were registered. Data on the weight upon admission of the calves were generally not available for all calves, thus the weight was not registered. In order to ensure good quality of the data, the information provided by the farmers was compared to that available from the TVD, and, if diverging, the farmers were contacted for further clarification. All data were entered in a relational Database (Access 2010, Microsoft®, Redmond, WA, USA).

2.4. Antimicrobial use data

The information regarding the amount of antimicrobial drugs used in each herd during the year 2013 was mostly extracted from the veterinary bills. To ensure the quality of the data, the information provided by the farmers in the treatment records was compared with that in the veterinarians' bills, and, if diverging, the veterinarians and/or the farmers were contacted for further clarification. The antimicrobial drug treatments were divided based on two criteria, namely (1) group vs. individual treatments, and (2)