Impact of the Suissano Health Programme on antimicrobial usage on 291 pig farms in Switzerland

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ABSTRACT

Background In 2015, in Switzerland the Suissano Health Programme was implemented in pig production to improve transparency for antimicrobial usage (AMU) and to reduce the usage of fluoroquinolones (FQ), macrolides and cephalosporins, representing highest priority critically important antimicrobials.

Methods In the presented cohort study, the impact of the Suissano programme on the AMU of 291 pig farms between 2016 and 2017 was investigated. AMU was calculated in total numbers of defined course doses (nDCDch) for all farms in the programme. For each single farm the nDCDch/animal/year was determined for four different age categories (suckling piglets, weaned piglets, fattening pigs, sows) as well as each antimicrobial substance separately. Trends between 2016 and 2017 were investigated for all farms as well as the 25 per cent with the highest usage of antimicrobials (high users) separately.

Results Total AMU measured in nDCDch declined by 23 per cent between 2016 and 2017, but statistically significant differences could not be observed when comparing the data sets of the individual farms. A significantly reduced usage of FQ could be demonstrated in suckling piglets (P=0.003), weaned piglets (P=0.006) and sows (P=0.008) in 2017 compared with 2016. For high users, a significant reduction of total AMU could be shown in suckling piglets (P=0.02), weaned piglets (P=0.0004) and fattening pigs (P=0.01).

Conclusion This study demonstrated a significant reduction in the usage of FQs in suckling piglets, weaned piglets and sows as well as total AMU in suckling piglets, weaned piglets and fattening pigs on high-usage farms.

INTRODUCTION

Resistance of pathogenic bacteria against antimicrobials endangers both human and veterinary health. The link between the use of antimicrobials and the development of antimicrobial resistance has been shown before.[1–5] The World Health Organization (WHO) has published an action plan to combat the development of antimicrobial resistance.[6] Of major interest are the 'Highest Priority Critically Important Antimicrobials (HPCIAs)', which, according to the WHO definition, are of particular importance for the treatment of certain diseases in humans.[7]

HPCIAs include third and fourth-generation cephalosporins, fluoroquinolones (FQ) and macrolides, and since 2017, polypeptides too (mainly represented by colistin in food-producing animals). Monitoring systems have been implemented in agricultural production in various countries to control the use of antimicrobials and often focus on the usage of HPCIAs.[2 8 9]

In Switzerland up until 2015, the nation-wide use of antimicrobials was monitored based only on pharmaceutical industry sales to veterinarians. Information was therefore limited, as the use in different animal species was not defined and these sales did not necessarily match with the prescriptions given by veterinarians. According to the latest European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) report, Switzerland is only ranked in the middle of the table in terms of sales of antimicrobials.[10]

Defined daily doses (DDD) were developed in human medicine for the analysis of trends in usage of various medicines. It has since also been adopted in veterinary medicine to monitor the use of antimicrobials.[11 12] The European Medicines Agency (EMA) has defined the units defined course dose for animals (DCDvet) and DDDvet in order to follow trends in antimicrobial use and published guidelines according to which DDD and DCD have to be defined.[13 14] Since DDD/DCDvet less accurately reflect the reality of prescription of antimicrobials at the national level, national units for DDD and DCD were subsequently defined in various countries following EMA guidelines and consequently DCDch and DDDch were also developed for Switzerland.[13–17]

In 2015, Swiss pig producers in cooperation with veterinary authorities, pig trading companies and retailers launched the Suissano programme.[9 18] The aim of the programme was to analyse the use of antimicrobials and to improve transparency and a considered usage of antimicrobials in participating farms,

primarily aiming at a lower use of HPCIAs. To this end, participating farms reported antimicrobial usage (AMU) based on veterinary prescriptions. For four age categories (suckling pigs, weaned piglets, fattening pigs and sows), the total amounts of active substances (AS) delivered annually by veterinarians were recorded. Based on these data and the numbers of animals housed on the farms, the number of DCDch (nDCDch)/animal/year was then calculated for each farm and age category. Subsequently, feedback was given to each farm including a comparison with the AMU levels of all other participating farms.

To reach the target of reducing the treatments with HPCIAs within the Suissano programme, a multiplying factor of 4 was implemented when calculating AMU for treatments with FQ, macrolides and cephalosporins on the participating farms. This aimed to encourage farmers to reduce the use of these antimicrobial classes.[18] The number of farms participating in the Suissano programme increased every year and by the end of 2020 it is expected that around 2200 farms, or over 50 per cent of all Swiss pig herds will be part of the programme (SUISAG; personal communication). For Suissano farms, membership in the Swiss pig health service is mandatory. This includes regular visits by veterinarians to the pig herds, documentation of the health status and the obligation to react immediately in case of health problems.

The present study aimed to investigate trends in AMU between 2016 and 2017 within the Suissano Health Programme.

MATERIALS AND METHODS

All farms included in this study were participants in the Suissano Health Programme in Switzerland and were thus obliged to report AMU based on veterinary prescriptions. In cooperation with herd veterinarians or veterinary consultants, the antimicrobials supplied to the farms were allocated to four age categories: suckling piglets, weaned piglets, fattening pigs and sows. In the years 2016 and 2017 a total of 875 respectively930 farms participated in the Suissano programme, including all types of pig-producing farms such as fattening farms and breeding farms as well as combined farrow-to-finish farms. To exclude any farm effects, the investigation of AMU in 2016 and 2017 was carried out on the same farms in both years. Farms that had not reported data covering the complete years 2016 and 2017 or farms on which animal stocks showed differences of more than 5 per cent between both years were excluded from the study. Numbers of animals were defined as the number of animals produced per year for suckling piglets, weaned piglets and fattening pigs. The number of sows was defined based on the animals housed on the farms.

The nDCDch used in 2016 and 2017 was calculated for each farm and each age group according to the following equation by using the quantity of veterinary medicinal products (VMP) prescribed annually by the veterinarian, the concentration of AS in the respective VMP, the number of animals on the farm, the DCDch defined for the respective AS according to the definition of Echtermann *et al.* and the standard weight of the age category according to the EMA standard weight definition $(4\,\text{kg}/12\,\text{kg}/50\,\text{kg}/220\,\text{kg})$[15]:

$$nDCDch = \frac{\text{amount VMP}\,(g) * \text{concentration of AS in VMP}\,(mg/g)}{DCDch\,(mg/kg) * number\ of\ animals * standard\ weight\,(kg)}$$

For VMPs containing two or three AS, each AS was evaluated individually as recommended by the EMA and different authors.[13 19 20]

The proportion of total AMU accounted for by the different classes of AS was calculated for the years 2016 and 2017 measured in nDCDch. Moreover, the proportions of farms using HPCIAs or VMPs containing two or three AS including one HPCIA were counted for each age category.

To determine the trends describing AMU at the farm level, the nDCDch/animal/year was calculated for each participating farm, age category and AS in the years 2016 and 2017. The data sets were examined for differences in terms of AMU between 2016 and 2017 in total as well as regarding the use of HPCIAs. The differences in total AMU between 2016 and 2017 were calculated for each farm and age category and correlations to farm size and type of production were investigated.

For each age category, a group of 25 per cent of farms with the highest AMU measured in nDCDch/animal/year in 2016 was defined as high users. The development of AMU between 2016 and 2017 was also investigated specifically for this group.

Statistical analysis

All data sets were prepared with Microsoft Excel V.16.30. Statistical analysis was carried out using IBM SPSS V.25.

The proportions of different antimicrobial classes in total AMU measured as the nDCDch/year for all animals of an age group were calculated and displayed as percentage. All data sets including the nDCDch/animal/year calculated for each farm were tested for normal distribution using the Shapiro-Wilk test. Data sets with non-equal distribution were further analysed for significant differences using the Mann-Whitney U test for independent variables. Results with P values lower than 0.05 were considered significant. Linear regression analyses were performed for each farm and age category to assess possible correlations between the differences in AMU between 2016 and 2017 and farm size as well as type of production. The residues were tested for normal distribution. Observations with Cook's distance values greater than 3 were defined as outliers and excluded from further analyses. Regression coefficients were calculated and P values lower than 0.05 were considered significant.

RESULTS

In total 291 farms provided complete AMU for both 2016 and 2017. Sixty-two (21 per cent) of the farms were breeding farms, housing suckling piglets, weaned piglets

Table 1 Sizes of 291 study farms: total number of animals, number of study farms housing the respective age category, and minimum (min), maximum (max) and median of the number of animals housed (sows) or produced (suckling piglets, weaned piglets, fattening pigs) on the farms in 2016. All farms were participants of the Suissano Health Programme

	Total number of animals	Farms (n)	Animals housed (n)		
			Median	Min	Max
Sows	12,580	161	63	8	310
Suckling piglets	366,751	150	2051	260	7987
Weaned piglets	317,045	151	1840	320	6795
Fattening pigs	191,314	218	697	4	5500

and sows. One hundred and twenty-nine farms (44 per cent) were fattening farms and 88 (30 per cent) were combined farrow-to-finish farms. Eleven (4 per cent) of the study farms only housed gestating sows and one farm housed weaned piglets and fattening pigs. Table 1 shows the number of animals per age category included in the study and the total number of farms housing pigs of the respective age category.

The total AMU calculated as the nDCDch decreased by 23 per cent between 2016 and 2017 (table 2). In suckling piglets, weaned piglets and fattening pigs a decrease of 27, 14 and 24 per cent respectively could be observed, when calculating the AMU separately for each age group. In sows the total AMU increased by 19 per cent between 2016 and 2017.

Penicillins were the most frequently used antimicrobial class in total as well as in each age category and each year. The proportion of penicillins of the total AMU increased in all age categories between 2016 and 2017. The total usage of penicillins decreased in suckling piglets and fattening pigs during the study period, while it was increased in weaners and sows.

The proportion of FQ in total AMU in suckling piglets decreased between 2016 and 2017. Other HPCIAs were not used to a significant extent in suckling piglets, and polypeptides (colistin) were used in 2017 in a proportion of roughly 1 per cent. In weaned piglets, the proportion of macrolides, polypeptides (colistin) and FQ in total AMU decreased between 2016 and 2017.

The proportions of macrolides in total AMU in fattening pigs and of FQ in total AMU in sows also both declined between 2016 and 2017 (table 2).

Comparing all age categories, the nDCDch of FQ, macrolides, cephalosporins and polypeptides (colistin) were reduced by 63, 45, 89 and 20 per cent, respectively, between 2016 and 2017. The proportion of farms using HPCIAs in 2016 and 2017 declined from 18 to 14 per cent in fattening pigs, from 36 to 25 per cent in sows, from 60 to 43 per cent in weaners and from 54 to 44 per cent in suckling piglets.

Regarding the use of VMPs containing two or three AS including one HPCIA, a reduction by 41 per cent from 35,854 DCDch (2016) to 21,345 DCDch (2017) in weaned piglets and by approximately 78 per cent (2016: 7960 DCDch; 2017: 1797 DCDch) in fattening pigs was

observed. Nevertheless, the number of farms reporting usage of such VMPs increased between 2016 and 2017 from 26 to 39 out of a total 151 in weaned piglets and from 11 to 20 out of 218 in fattening pigs.

When investigating the data sets with AMU calculated as nDCDch/animal/year for each separate farm, total AMU was not significantly reduced in any age group, but a significant decrease could be observed between 2016 and 2017 in high users in the age categories of suckling piglets (P=0.02), weaned piglets (P=0.0004) and fattening pigs (P=0.01) (figure 1). In sows the decrease was not significant (P=0.4; figure 1). No significant correlations could be demonstrated between the differences in AMU of 2016 and 2017 and farm size and type of production for any age group (table 3).

The consumption of FQ significantly decreased in suckling piglets (P=0.003), weaned piglets (P=0.006) and sows (P=0.008) (figure 2) between 2016 and 2017. In fattening pigs, the differences were not significant (P=0.2; figure 2). No significant reduction in the usage of other HPCIAs could be observed for any age category.

DISCUSSION

In the present study, significant changes in the use of antimicrobials on farms participating in the Suissano Health Programme were found between 2016 and 2017. While a reduction in total AMU was observed between 2016 and 2017 in suckling piglets, weaned piglets and fattening pigs, total AMU increased in sows. Additional investigations are necessary to evaluate the potential for further reduction of antimicrobial use in sows without impacting health. In sows the number of treatments with pyrimidines and sulfonamides increased to nearly the same extent as FQ treatments were reduced, therefore, it may be assumed that treatments with FQ have been replaced by pyrimidines and sulfonamides in sows. Such a change in treatment would make particular sense for the treatment of the postpartum dysgalactia syndrome in nursing sows.[21] The usage of older antimicrobials with a higher dose rate such as penicillins or pyrimidine and sulfonamide combinations instead of HPCIAs with a lower dosing could result in an increased nDCDch without changes in treatment frequency. This could also explain

Table 2 AMU of 291 Swiss pig farms during 2016 and 2017 measured as the number of DCDch (nDCDch) and difference between both years (△), displayed by age category and AS. All farms were participants of the Suissano Health Programme

| Antimicrobial class	Suckling piglets			Weaned piglets			Fattening pigs			Sows			All age categories		
	2016	2017	△	2016	2017	△	2016	2017	△	2016	2017	△	2016	2017	△
Aminoglycosides*	13,937 (3%)	7832 (3%)	−6105	4407 (3%)	2204 (2%)	−2203	3077 (5%)	1726 (3%)	−1351	1449 (10%)	736 (5%)	−713	22,870 (4%)	12,498 (3%)	−10,372
Amphenicoles*	0	1750	+1750	0	0	0	0	40	+40	23	77	+54	23	1867	+1844
Cephalosporins*	809	21	−788	38	19	−19	58	40	−18	67	32	−35	972	112	−860
Fluoroquinolones*	33,389 (8%)	11,498 (4%)	−21,891	6815 (5%)	3153 (3%)	−3662	180	446	+266	725 (5%)	313 (2%)	−412	41,109 (6%)	15,410 (3%)	−25,699
Lincosamides*	2288	2148	−140	26	48	+22	1	1	0	3	2	−1	2318	2199	−119
Macrolides*	433	0	−433	12,863 (10%)	7373 (6%)	−5490	1831 (3%)	885 (2%)	−946	47	83	+36	15,174 (2%)	8342 (2%)	−6833
Penicillins*	360,950 (85%)	273,701 (88%)	−87,249	51,264 (38%)	59,287 (51%)	+8023	45,240 (70%)	39,707 (81%)	−5533	10,672 (72%)	13,597 (77%)	+2925	468,126 (74%)	386,292 (79%)	−81,834
Pleuromutilins	33	0	−33	11	111	+100	5	5	0	1	0	+1	50	116	+66
Polypeptides*	1701	2816	+1115	25,143 (19%)	18,751 (16%)	−6392	568	320	−248	0	0	0	27,412 (4%)	21,887 (4%)	−5525
Pyrimidines*	1284	2764	+1480	1670	1787	+117	2530 (4%)	759 (2%)	−1771	807 (5%)	1295 (7%)	+488	6291	6605 (1%)	+314
Sulfonamides*	2034	4014	+1980	15,105 (11%)	9975 (9%)	−5130	6290 (10%)	2084 (4%)	−4206	866 (6%)	1304 (7%)	+438	24,295 (4%)	17,377 (4%)	−6918
Tetracyclines*	6128	3116	−3012	16,674 (12%)	12,878 (11%)	−3796	4867 (8%)	3108 (6%)	−1759	134 (1%)	107 (1%)	−27	27,803 (4%)	19,209 (4%)	−8594
Total†	422,986 (66%)	309,660 (63%)	−113,326	134,016 (21%)	115,586 (24%)	−18,430	64,647 (10%)	49,121 (10%)	−15,526	14,794 (2%)	17,546 (4%)	2752	636,443	491,913	−144,530

*Percentage of total usage of the respective age category in parenthesis. Proportions are only displayed when 2% or more.
†Percentage of total usage of all age categories in parenthesis.
AMU, antimicrobial usage; AS, active substance.
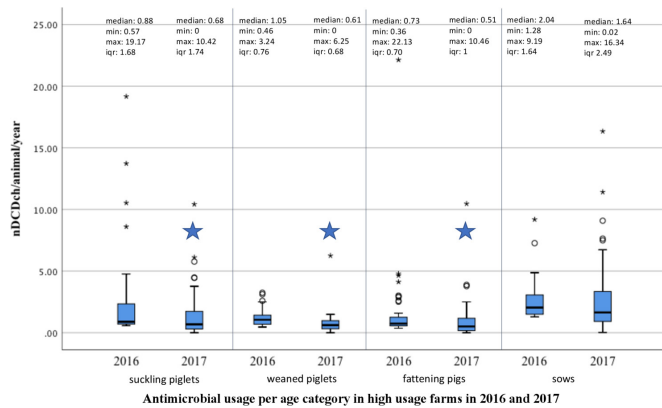
Figure 1 Distribution of antimicrobial usage (AMU) measured in number of DCDch/animal/year of 25% high users out of 291 Swiss pig farms in suckling piglets, weaned piglets, fattening pigs and sows in 2016 and 2017. Significant changes are marked with a star. All farms were participants of the Suissano Health Programme. nDCDch, number of defined course doses.
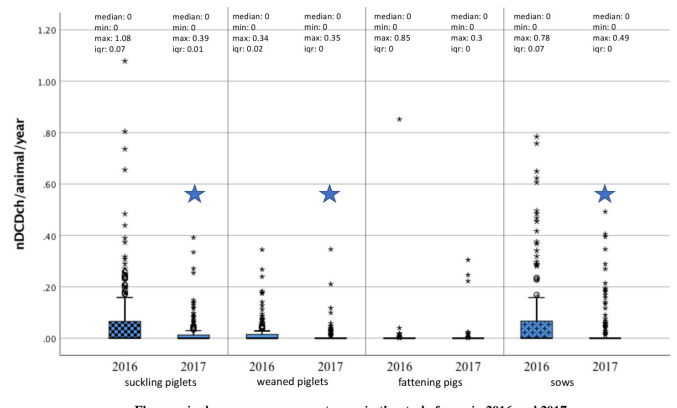
Figure 2 Distribution of fluoroquinolone usage measured in number of DCDch/animal/year of 291 Swiss pig farms in suckling piglets, weaned piglets, fattening pigs and sows in 2016 and 2017. Significant changes are marked with a star. All farms were participants of the Suissano Health Programme. nDCDch, number of defined course doses.

why a reduction of total AMU measured in nDCDch was not observed in this study.

The markedly decreased use of HPCIAs observed in the study farms may have been caused by their specific evaluation in the Suissano programme and by the amendment of the Veterinary Medicines Ordinance, which prohibited the supply of HPCIAs in large quantities to the farmers by veterinarians.[22] On the other hand, these adjustments came into force by 2016 and thus at the beginning of the study. Changes between 2016 and 2017 could therefore be accounted for also by the Suissano programme. Experience in Denmark has also shown that the use of antimicrobials can be steered by using multiplying factors for certain treatments.[23 24] The usage of polypeptides was reduced by 90 per cent after a multiplying factor of 10 was introduced. In Denmark, the 'yellow card' system has also shown that the identification of high-usage farms and the threat of sanctions for high users has a clear effect on the nationwide consumption of antimicrobials.

Between 2016 and 2017, the aim of the Suissano programme was not to identify high-usage farms but to provide information concerning the AMU on each farm compared with all participating farms. The reduction achieved under these settings shows that certain targets concerning AMU can be achieved by 'nudging'. The latter describes methods of influencing people's behaviour without resorting to prohibitions and regulations or changing economic incentives.[25 26] Inappropriate prescribing of antimicrobials was shown to be reduced by nudging after encouraging judicious use in human medicine.[27] Malik *et al* and Visschers *et al* showed in their work that awareness of AMU and resistance problems varies among farmers.[28 29] The Suissano programme may have improved awareness of the risks of an increased usage of HPCIAs and high usage of antimicrobials in general on the participating pig farms. Coyne *et al* suggested that the veterinarian is the key factor for AMU and guides the choice of suitable preparations for use by farmers.[30] The

Table 3 Correlations between farm type and size and difference in AMU in 2016 and 2017 for 291 Swiss pig farms. Number of farms housing the respective age category (n), median, minimum (min) and maximum (max) of differences in AMU measured in nDCDch/animal/year between 2016 and 2017 for four age categories (sows, fattening pigs, suckling piglets and weaned piglets) and linear regression coefficients (rco) and P values for correlations between differences in AMU and farm size as well as farm type. All farms were participants of the Suissano Health Programme

Age category		Sows	Fattening pigs	Suckling piglets	Weaned piglets
n		161	218	150	151
Difference 2016–2017 (nDCDch/animal/year)	Median	0.131	0	0.0235	0.0122
	Min	−7.15	−5.82	−2.92	−3.01
	Max	4.71	18.36	13.06	18.13
Farm type	rco	−0.124	0.156	−0.033	0.318
	P value	0.5	0.4	0.9	0.4
Farm size	rco	−0.032	−0.013	0.018	0.003
	P value	0.1	0.3	0.2	0.8

AMU, antimicrobial usage; nDCDch, number of defined course doses.

transparency concerning AMU on Suissano farms may also have helped veterinarians to encourage farmers to reduce AMU.

The significant decrease in AMU of high users in three of four age categories observed in this study is an indication of the positive effect of allowing farmers to compare their AMUs with those of other farms. Overall, the consumption of HPCIAs found in the farms participating in this study was low compared with other investigations of AMU in pigs in Switzerland.[31] Since participation in the Suissano programme was voluntary for the study farms and only farms with proper recordings of AMU in 2016 and 2017 were selected, a bias towards more motivated farmers in terms of AMU cannot be excluded. The observations made in this study may therefore not apply for the national pig production in Switzerland.

Although the usage of HPCIAs was generally reduced on the study farms, the number of farms using HPCIAs declined but remained within a considerable range. To keep these antimicrobial classes available for treatment in pig production in the future and to prevent further legal interventions or prohibitions, prudent usage of these antimicrobials is essential.

In principle, the reduction of AMU is desirable but it should not be carried out thoughtlessly and not to the detriment of animal health. It is important to consider the AMU and the levels of biosecurity and animal health to determine the benchmarks for pig farms, since any improvement of animal health will help in reducing AMU. For Suissano herds, the mandatory membership in the pig health service requires regular herd visits but a quantitative assessment of animal health in the herds has not yet been implemented. Systems for recording and measuring associations between these aspects have been investigated before.[32–34] For the further development of the Suissano programme, it is essential that AMU data are linked with a quantitative assessment of animal health and farm management.

The calculation of the treatment frequency from the quantity of antimicrobials prescribed is only approximate using standard weights and dosages. A more precise calculation can be undertaken using 'used daily doses' (UDD), which directly describes the proportion of treatments of a population of animals on a farm. However, the calculation of the treatment frequency by UDDs requires a higher quality of data, which is often difficult to achieve in practice when analysing non-electronically recorded treatment data on study farms.[19 35–37] Since 2018, an electronic treatment journal has been developed for the calculation of the AMU on pig farms in Switzerland. This innovation will allow the therapeutic frequency to be calculated in future studies based on UDDs on the farms, as proposed by other authors.[35]

CONCLUSION

The present study showed significant changes in antimicrobial consumption between 2016 and 2017 in pig herds participating in the Suissano Health Programme. Without defining any benchmark or penalties but introducing a factor 4 for HPCIAs, the usage of FQs was reduced in suckling piglets, weaned piglets and sows. Total AMU was demonstrated to be significantly reduced in suckling piglets, weaned piglets and fattening pigs on high-usage farms.

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