

Article

Characteristics of drug use on sheep farms in Ontario, Canada

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Abstract – This study examined characteristics of the use of drugs, especially antimicrobials, on Ontario sheep farms. Forty-nine sheep farms participated in a 12-month prospective study. Producers documented treatment events during the study period and drug use data from the records were summarized. The most frequently used drugs of the 15 drug categories used by producers belonged to the following categories: antimicrobial (40.7%, $n = 2710$), vitamin/mineral (12.0%), and biological (11.1%). Short-acting penicillin (27.2%, $n = 1103$), long-acting oxytetracycline (22.9%), and long-acting penicillin (21.9%) were the most frequently used antimicrobials. The drugs that were used most frequently on sheep farms were antimicrobials, of which 93% of treatments were extra-label. Extensive extra-label drug use may be the result of the limited number of drugs that are approved in Canada for use in sheep.

Résumé – **Caractéristiques de l'usage de médicaments dans les élevages de moutons en Ontario, au Canada.**

Cette étude a examiné les caractéristiques de l'usage de médicaments, particulièrement les antimicrobiens, dans les fermes ovines de l'Ontario. Quarante-neuf troupeaux ovins ont participé à une étude rétrospective de 12 mois. Les producteurs ont documenté les traitements durant la période de l'étude et les données d'usage de médicaments tirées des dossiers ont été résumées. Les médicaments les plus fréquemment administrés parmi les 15 catégories de médicaments utilisés par les producteurs appartenaient aux catégories suivantes : antimicrobiens (40,7 %, $n = 2710$), vitamines et minéraux (12,0 %) et biologiques (11,1 %). La pénicilline à action brève (27,2 %, $n = 1103$), l'oxytétracycline à action longue (22,9 %) et la pénicilline à action longue (21,9 %) étaient les antimicrobiens les plus fréquemment utilisés. Les médicaments qui étaient le plus fréquemment utilisés dans les fermes ovines étaient des antimicrobiens, dont 93 % des traitements étaient en dérogation des directives de l'étiquette. L'importante utilisation de médicaments en dérogation des directives de l'étiquette peut être le résultat du nombre limité de médicaments qui sont approuvés au Canada pour administration chez les moutons.

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Introduction

Knowledge of drug use practices in food producing animals is important to animal welfare, the livestock industry, food safety, and human health. When using veterinary drugs,

one should consider the well-being of the animal as well as the production of safe food to protect human health. Furthermore, awareness of drugs used in a livestock industry can help that industry ensure that drugs are being used in a prudent manner.

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Research has provided information on antimicrobial use (AMU) in livestock species including cattle and swine, but there is little information on drug use practices for sheep in Canada (1,2). In Canada, sheep are considered a minor species, because they are food-producing animals that do not have a large economic footprint; they are not often targeted for drug development and approval. Additionally, the market for drug use in sheep is small, resulting in limited financial commitments from pharmaceutical companies. With sparse clinical data generated in North America supporting drug use in sheep, it is difficult to license drugs for use in this species (3). Veterinarians and sheep producers therefore have a limited selection of licensed drugs. It is thought that much of the drug use in sheep is extra-label drug use (ELDU), meaning use in a manner not in accordance with instructions on its label, package insert, or product monograph (4).

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One Canadian study that began in 2001 described antimicrobial use in the Alberta sheep industry. It was found that injectable antimicrobials were used on 94.3% of farms, whereas in-feed, in-water, and oral antimicrobials were used in low amounts (5). Injectable penicillin and tetracycline were reportedly used most commonly by participating producers. Limited information regarding ELDU of antimicrobials can be extracted from this study. Of the 6 injectable antimicrobials reported, 2 were not approved for use in sheep (5). Unfortunately, further information that captures ELDU, including class of sheep, dose, and reasons for administering drugs was not available.

The research performed in Alberta provides some insight into AMU in sheep, but the researchers collected data by means of a retrospective questionnaire, focusing predominantly on the use of injectable antimicrobials. Until now, a gap in knowledge existed regarding the use of all drug categories, such as anticoncials and endectocides, and health products such as hormones and injectable vitamins and minerals. To further the understanding of drug use practices in the sheep industry (including health product use), a prospective drug use study was conducted. The objective of this study was to describe drug use on 49 Ontario sheep farms during a 12-month period, by category of drug, with emphasis on AMU and ELDU.

Materials and methods

Study design

Sheep producers whose primary commodity is meat (as opposed to fiber or dairy), were recruited to participate in the study by promotion of the research program at Ontario sheep district meetings, recruitment through articles in the *Ontario Sheep News*, a magazine produced for the Ontario sheep industry, and through the Ontario breeders' lists. Initially, 51 producers across Ontario agreed to volunteer their sheep farms to participate. However, 2 farms dropped out before completion of the study period, leaving a total of 49 meat-producing sheep farms, which included 1 lamb feedlot.

The study period for each farm was a minimum of 12 mo from the date of the initial visit. The data collection began with an initial visit in 2006/2007 and was completed with a final visit in 2007/2008. During the study period, each farm's record-keeping was monitored by a follow-up visit and by 2 to 3 telephone calls.

At the initial visit, a questionnaire was administered to the producer, capturing information about farm demographics, animal management, and AMU during the previous 12 mo. Producers were provided with health product treatment (HPT) forms, purchased health product and medicated feed inventory forms, and monthly sheep inventory forms, to be completed by producers over the course of the study period. Producers recorded all treatments involving sheep on-farm, including drugs (such as antimicrobials) and health products (for example, injectable vitamins/minerals). At the final visit, records were collected and the same questionnaire was administered to gather information representing the study period. Questionnaire data from the final visit were investigated for potential risk factors for AMU and ELDU as part of a separate research objective.

Table 1. Frequency of drug category use by number of treatment events on 49 sheep farms ($n = 2710$)

Drug category	Treatment events (%)
Antimicrobial	40.70
Vitamin/mineral	12.03
Biological	11.07
Endectocide	10.74
Anticoccidial	6.57
Anthelmintic ^a	5.39
Anti-inflammatory ^a	4.32
Hormone	2.62
Gastrointestinal aid	2.25
Antiseptic agent	1.55
Acetonemia (ketosis) preparation	1.29
Fluid replacement therapy	0.55
External parasiticide ^a	0.48
Topical product (non-antimicrobial)	0.30
Anesthetic/analgesic/sedative/tranquilizer ^a	0.15

^a No drug product reportedly used within drug category licensed for use in sheep in Canada.

Data management and analysis

Data were entered into EpiData for data management (EpiData, version 3; The EpiData Association, Odense, Denmark) (6). Electronic records were created to capture the information from the collected records, inventories, and questionnaires.

Data from the HPT records were exported from EpiData to Stata v.9 (StataCorp, College Station, Texas, USA) (7), for data analysis. Treatment events from the HPT records were summarized where each row of the record (that recorded the class of sheep, number of sheep, reason and disease description, drug product used, dose, duration, frequency and route of administration, and whose decision it was to administer the drug) represented 1 treatment event, regardless of the number of sheep treated or the duration of treatment. Each drug and health product used was put into 1 of 15 categories. For simplicity, the hormone and injectable vitamin/mineral health products were referred to as "drug" products. For reason of drug use, producers chose from "treat sick animal," "prevent/control disease," "reproductive management," "growth promotion," or "other reason." Producers were free to record, in their own words, the disease and/or condition for which the drug was used.

For ELDU, drug products were dichotomized as to whether or not they were licensed for use in sheep in Canada. Antimicrobial use was further described to capture how antimicrobials were used in an extra-label manner. Three categories, including 2 ELDU categories, of AMU were generated: 1) use of a licensed antimicrobial in accordance with its label (no ELDU); 2) use of an antimicrobial not licensed for use in sheep (including active ingredients and trade names); and 3) use of a licensed antimicrobial in an extra-label manner for at least 1 reason. These reasons included: use for a class of sheep or disease condition not indicated on the label, and route of administration or dosage differing from label instructions. Dosage included the dose, frequency, and duration of AMU, whereby it was considered extra-label if the dose differed from the label dose by > 1 mL for that animal; the drug was administered more/less frequently than required by the label; or the duration was different by ≥ 1 d than indicated on the label.

Table 2. Common diseases/conditions treated and drug products used, by frequently used drug categories, excluding antimicrobial drugs

Drug category (<i>n</i>)	Drug product (%)	Disease/condition (%)
Vitamin/mineral (326)	Vitamin E/selenium (58.28) Vitamins A & D (15.03)	Nutritional musculodystrophy (51.84)
Biological (300)	Clostridial vaccine (54.00) CLA/clostridial vaccine (39.00)	Clostridial disease (60.00)
Endectocide (291)	Ivermectin (99.31) Moxidectin ^a (0.61)	Gastrointestinal parasitism (96.91)
Anticoccidial (178)	Lasalocid (58.99) Amprolium ^a (22.47)	Coccidiosis (89.89)
Anthelmintic (146)	Fenbendazole ^a (57.53) Albendazole ^a (42.47)	Gastrointestinal parasitism (92.47)

^a Drug product not licensed for use in sheep in Canada.

Table 3. Common drug categories and active ingredients used, stratified by lamb and adult sheep

	Drug category (<i>n</i>)	Active ingredient (% within drug category)
Lamb	Antimicrobial (480)	Long-acting oxytetracycline (21.25)
		Long-acting penicillin (21.25)
		Short-acting penicillin (21.25)
	Vitamin/mineral (270)	Vitamin E/selenium (66.67) Vitamins A & D (17.04)
Biological (158)	Clostridial vaccine (66.46)	
	CLA/clostridial vaccine (27.22)	
Anticoccidial (144)	Lasalocid (56.25)	
	Amprolium (27.78)	
	Decoquinat (10.42)	
Adult sheep	Antimicrobial (624)	Short-acting penicillin (31.73)
		Long-acting oxytetracycline (24.04)
		Long-acting penicillin (22.44)
Endectocide (213)	Ivermectin (99.53)	
Biological (148)	CLA/clostridial vaccine (51.35)	
	Clostridial vaccine (41.22)	
Hormone (70)	eCG (34.29)	
	Oxytocin (32.86)	
	Progestagen (17.14)	

For each of the non-licensed antimicrobial, the ways in which they were used most frequently were summarized. For the licensed antimicrobials, the proportion of treatment events resulting in ELDU from trade name, indication, class of sheep, route and dosage were summarized to characterize the pattern of ELDU. Furthermore, the decision to use an antimicrobial, as recorded on the HPT record, was investigated in order to determine who was making the decision resulting in ELDU.

Results

Overall drug use

There were 2715 treatment events on HPT records from 49 farms, with ≥ 1 sheep being treated at each treatment event. The number of treatment events per farm ranged from 1 to 203 with a mean of 55.4 [standard deviation (*s*) = 49.43]. Flock size, determined as the average number of ewes present on farm during the initial and final visits (and thus does not include the feedlot), varied from farm to farm [median 137; interquartile range (IQR): 68 to 252]. The number of lambs marketed by

Table 4. Frequency of antimicrobials reportedly used over 1103 treatment events on 49 sheep farms

Antimicrobial agent	Number of farms	Percent of treatment events
Short-acting penicillin	30	27.2
Long-acting oxytetracycline ^a	28	22.85
Long-acting penicillin	29	21.94
Trimethoprim-sulfadoxine ^a	19	12.15
Tilmicosin	11	3.26
Danofloxacin ^a	1	2.63
Short-acting oxytetracycline	7	1.81
Chlortetracycline (in feed)	6	1.81
Neomycin	5	1.72
Florfenicol ^a	6	1.54
Special Formula ^{a,b}	6	1.54
Ceftiofur	2	0.45
Tetracycline (in water)	2	0.27
Tulathromycin ^a	1	0.27
Polymyxin b ^a	1	0.18
Oxytetracycline (mineral)	1	0.09
Spectinomycin ^a	1	0.09
Sulfamethazine	1	0.09
Trimethoprim-sulfamethoxazole ^a	1	0.09

^a Not licensed for use in sheep in Canada.

^b Special Formula (Pfizer Animal Health) includes novobiocin, short-acting penicillin, polymyxin B, and streptomycin.

participating producers during the study period totalled 31 059; approximately 23% of Ontario lambs sent to market in 2007.

The number of sheep treated was available for 2679 treatment events, and totalled 151 334. Treatment events involved treating a single sheep 49.16% of the time; the range was 1 to 15 139 sheep. Larger numbers of sheep treated during a single event were often due to group treatments or in the case of the 15 139 sheep, continuous use of drugs administered in the feed.

There were 15 categories of veterinary drugs on the HPT records (Table 1). The greatest proportion of drug use was to treat a sick animal (49.17% of treatments) or aimed solely at disease prevention or control (42.73%) (< 2% of events reported using a drug for these reasons in combination with another reason, such as reproductive management). The most commonly used drug category to solely treat a sick animal was antimicrobials (67.84%; *n* = 1330); however, if the treatment was to solely prevent or control disease, the most commonly used drug class was biologicals (vaccine) (24.91%; *n* = 1160), followed by endectocide (20.43%) and injectable vitamin/mineral use (17.07%).

Table 5. Percentage of use resulting in ELDU of frequently reported antimicrobials licensed for sheep

Reason for ELDU	SA ^a penicillin (%)	LA ^b penicillin (%)	Tilmicosin (%)	SA oxytetracycline (%)
Trade name	1.00	25.62	0.00	15.00
Indication	80.47	22.78	75.00	70.59
Sheep class	0.00	0.00	88.89	0.00
Route	14.14	6.67	11.11	0.00
Dosage	56.57	65.17	8.33	85.00
Total ELDU ^c	91.67	82.23	97.22	95.00

^a Short-acting.^b Long-acting.^c Extra-label drug use.

Table 2 highlights the ways in which frequently reported drug categories (antimicrobials excluded) were used for all sheep production classes, including the most commonly used drugs within each of these drug categories. Extra-label drug use was common as demonstrated in Tables 1 and 2. Not considering AMU, 29% ($n = 882$) of treatment events in lambs and 28% ($n = 756$) in adult sheep used a non-licensed drug.

Antimicrobials were the most frequently used drug category for lambs (35%) and adult sheep (45%). Following AMU, lambs were treated most often with injectable vitamin/minerals, 19.82%; biologicals, 11.60% and; anticoccidial drugs, 10.57% ($n = 1362$); adult sheep were treated most often with endectocides, 15.43%; biologicals, 10.72%; and hormones 5.07% ($n = 1380$). The most commonly used products within the aforementioned drug categories are presented in Table 3.

Antimicrobial use

Twenty-four diseases/conditions were recorded as being treated with 1 of the 19 antimicrobial products (Table 4) reportedly used during the study period ($n = 1103$ treatment events). The most commonly recorded were: systemic signs (where no body systems were defined, such as depressed, fever, off-feed), 21.60%; respiratory disease, 14.52%; mastitis/udder condition, 13.25%; post-lambing event in which the ewe was treated, 12.16%; and lameness, 8.80% ($n = 1102$). Fifty-one percent of antimicrobial treatment events were for ewes, followed by market lamb, 18.91%, nursing lamb, 16.68%, replacement lamb, 8.21% and rams, 4.82% ($n = 1121$).

Over the course of 1099 treatment events that documented number of treated animals, antimicrobials were used on a total of 29 279 lambs and adult sheep. Most antimicrobial use was for treating a single sheep, but this ranged from 1 to 1300 sheep, and mainly to treat sick animals versus to control or prevent disease. Long-acting oxytetracycline was used on the greatest proportion of sheep, 29.07%; followed by neomycin, 26.34%; chlortetracycline in the feed, 22.42%; tetracycline in the feed or water, 9.05%; and long-acting penicillin, 4.11%.

ELDU of antimicrobials

Of the 1103 antimicrobial treatment events, 456 used an antimicrobial agent not licensed for use in sheep (for example, trimethoprim-sulfadoxine). An additional 68 treatment events involved using unapproved products; the antimicrobial agent was approved for use in sheep for some commercial products

but the product used did not list sheep on the label [long-acting penicillin as Propen LA (Vétoquinol Canada, Lavaltrie, Quebec)]. Altogether, this type of ELDU totals 48% of antimicrobial treatment events. Of the remaining 579 treatment events using a licensed antimicrobial, 88% were extra-label for at least 1 reason (indication, dosage). Thus, overall ELDU of antimicrobials was 93% ($n = 1103$).

Non-licensed antimicrobials that were most often used included long-acting oxytetracycline, 22.85% and trimethoprim-sulfadoxine, 12.15% ($n = 1103$). Long-acting oxytetracycline was used to treat 20 disease conditions; most often for respiratory disease, 20.87%; lameness, 19.29%; systemic signs, 14.57%; and eye conditions, 14.57% ($n = 254$). Trimethoprim-sulfadoxine was used to treat 13 disease conditions predominantly systemic signs, 30.60%; post-lambing in ewes, 19.40%; respiratory disease, 18.66%; and mastitis/udder condition, 14.93% ($n = 134$).

The specific type of ELDU found in this study for the licensed antimicrobials, short- and long-acting penicillin, tilmicosin, and short-acting oxytetracycline, is summarized in Table 5. Total use (100%) of the licensed antimicrobials neomycin, ceftiofur, oxytetracycline (mixed in the mineral), sulfamethazine, and tetracycline, was ELDU. The reasons were a combination of indications, class of sheep and dosage not indicated on the labels, specifically: neomycin — combination of indication and dosage; ceftiofur — 100% for indication, class of sheep and dosage; oxytetracycline (mineral) — 100% for indication and class of sheep; sulfamethazine — 100% for dosage; and tetracycline — 100% for indication and dosage.

Producers made most treatment event decisions (95%, $n = 1103$) regarding AMU. Ninety-three percent of their decisions ($n = 1043$) resulted in ELDU, of which 47% of producer-determined treatments used a non-licensed antimicrobial, and 87% of the licensed antimicrobial use was extra-label ($n = 557$). Antimicrobial use that was decided upon by veterinarians comprised similar levels of ELDU; 97% ($n = 59$) were extra-label, with the majority being use of a non-licensed antimicrobial (66.67%).

Discussion

Limitations of results

Bias may have arisen in the present study due to the study design. Participation in the study was on a volunteer basis, which is prone to selection bias. Although not calculable in this study, there may be differences in drug use between sheep

producers who volunteered and those who did not. A considerable commitment was required by participating sheep producers in keeping records during the study period. It is likely that drug use data from the HPT records were underreported due to producers' wavering enthusiasm during the 12-month study. However, the data were representative for Ontario sheep farms as study farms were geographically ranged across Ontario and further farm characteristics (flock size) compared to provincial and national standards.

Describing drug use and AMU by the number of treatment events is limited as it does not account for the number of sheep treated or the duration of the treatment event. This is illustrated by the continuous in-feed administration of drug to 15 139 sheep during 1 farm's study period. Methods for calculating antimicrobial exposure rates have been described (2) and were adapted to include rates of ELDU for the sheep drug use data in a separate research objective.

For all categories of drug use combined and antimicrobial use alone, the greatest percentage of treatment events was for treatment of a single sick sheep. This is an important finding as it confirms anecdotal information that most drug use in the sheep industry is to target those animals that are sick, as opposed to preventing or controlling disease in a group of animals as might occur in a beef feedlot to prevent respiratory disease on arrival. A limitation however, is that whether or not the animal was truly sick could not be validated, nor was validation of diagnosis possible.

Commonly reported drug categories were often used for diseases/conditions indicated on the drug products' labels. Injectable vitamin E and selenium combinations were used to prevent and control nutritional musculodystrophy which affects newborn lambs in Canada as a result of dietary deficiency. It is a common practice for producers to inject newborn lambs with this vitamin and mineral combination (6). There are currently 5 vitamin E and selenium combination drug products available for use in Canadian sheep that are all labelled for prevention and/or treatment of nutritional musculodystrophy (7). Also, common practice was to vaccinate lambs and adult sheep to prevent a variety of clostridial diseases and/or caseous lymphadenitis using 1 of 3 licensed vaccines.

In order to maintain productivity, sheep producers need to be able to control gastrointestinal parasites in their flocks. Parasiticides including endectocides (such as, Ivermectin) and anthelmintics (fenbendazole, for example) are effective in the treatment of these infections. During the study period, producers used endectocide products (parasiticides that act on ectoparasites and endoparasites) nearly twice as many times as anthelmintic products (parasiticides that act only on helminth infections). This may be explained by the fact that no anthelmintic products were licensed for use in sheep in Canada during data collection and hence producers and veterinarians chose to use the single licensed endectocide drug (ivermectin) to manage gastrointestinal parasites.

Various anticoccidial products are available for the prevention and treatment of coccidiosis in livestock species. Until recently, however, few options existed for preventing and treating coccidiosis in sheep. Lasalocid (Bovatec; Alpharma Animal Health,

Bridgewater, New Jersey, USA) was approved for use in lambs in Canada during the study period; this was the anticoccidial product used in the greatest proportion of treatment events. Use of non-licensed anticoccidials on participating farms may be for a number of reasons, including preference or unawareness of the approval of lasalocid.

The ranking of AMU differs when ordering by the number of treatment events compared to the number of sheep treated with each antimicrobial. Long-acting oxytetracycline ranked second in number of treatment events, but was used to treat the greatest number of sheep. This is likely because some producers used this drug to control disease in more than a single animal (such as for control of abortion or lameness in a group). Neomycin, chlortetracycline, and tetracycline were each used in < 2% of treatment events but they were used on the second, third, and fourth greatest number of sheep, respectively. Although many producers did not use these antimicrobials at all or often, when they were used these drugs were administered to groups of sheep in the feed or water, often for preventative reasons. Other antimicrobials such as injectable short-acting penicillin and trimethoprim-sulfadoxine were used often and by many producers; however, they were each used on relatively few sheep (1.25% and 0.59%, respectively). Administration by injection is likely favorable only when targeting single sick sheep because of the time and economics involved.

A study performed in Alberta reported penicillins, tetracyclines, and trimethoprim-sulfa combinations to be used most commonly by producers (5). Although the study was unable to differentiate long-acting from short-acting penicillin and tetracycline, results are comparable to those in the present study in which the top 4 ranked antimicrobials (by number of treatment events) included short- and long-acting penicillin, long-acting oxytetracycline, and trimethoprim-sulfadoxine. Furthermore, the most frequently treated age group reported in the Alberta study were adult sheep (57.1%), once again comparable to the 56% of adult sheep treated with an antimicrobial in the present study. Finally, common health problems requiring AMU were consistent with the present study, including mastitis, respiratory problems, post-lambing ewes, and lameness (5). In addition to documenting injectable AMU on Ontario sheep farms, the present study adds to the information reported in the Alberta study by documenting use of antimicrobials administered in other ways.

When administering antimicrobials not licensed for use in sheep or using the antimicrobial in a manner not described on the label, information regarding the indication (for example, respiratory disease), dosage, and the withdrawal times for meat and/or milk is extrapolated from labelled instructions and may not be appropriate. Extra-label use of antimicrobials may compromise safety and efficacy of treatment and production of foods. Uncertain withdrawal times increase the risk for residues, and misuse may increase the risk of AMR (8,9). Nonetheless, producers and veterinarians must consider animal welfare; limited availability of licensed antimicrobials for use in sheep does not justify not treating sick animals or not using antimicrobials in a manner to promote a healthy flock.

The non-licensed antimicrobials long-acting oxytetracycline and trimethoprim-sulfadoxine were frequently used to treat all 5 of the most commonly treated diseases illustrating that there was a need for treatment but producers sought the use of antimicrobials licensed for other species. A number of antimicrobials are approved for use in sheep for respiratory disease and mastitis/udder conditions while few, if any, antimicrobial products are licensed for use in sheep for systemic signs, ewe post-lambing, and lameness. One wonders why producers used non-licensed products as opposed to the approved antimicrobials for respiratory disease and mastitis/udder condition. For example, veterinary-prescribed ceftiofur and tilmicosin are approved for respiratory disease in lambs. Long-acting oxytetracycline can be purchased over-the-counter (OTC) at livestock medicine outlets without a veterinary prescription, but is not licensed for sheep. Perhaps ease of use or economics are driving factors for use of OTC non-licensed antimicrobials, when approved products are available.

Extra-label use of licensed antimicrobials is predominantly due to changes in dosage and use to treat conditions not listed on the label. In the case of tilmicosin, which is only labelled for treatment of lambs with pneumonia, the majority of use was for treatment of mastitis in ewes. Although deemed to be an effective treatment option, regulated tests on safety and efficacy for use in this manner have yet to be conducted in Canada. Short-acting penicillin is identified as an antimicrobial used most frequently in an extra-label manner to treat diseases, likely because labels for short-acting penicillin often only indicate treatment of bacterial pneumonia and wound infections.

Producers play a major role in AMU in sheep flocks and a large percentage of producer-based use is extra-label. It is possible that veterinarians prescribed specific AMU protocols prior to the start of the study period but producers recorded the treatments as decided by producer, since the producer initiated specific individual animal treatments during the study period. In the United States, ELDU by producers is illegal; it is only permitted by veterinarians in a valid-veterinarian-client-patient-relationship and requires sufficient documentation. Canadian regulations are moving in this direction. The Canadian Sheep Federation's Food Safe Farm Practices Program (10), which may become mandatory for sheep farms in some provinces, requires that all ELDU be by veterinarian prescription. Ultimately it is

understood that most AMU decisions are made by producers who are oftentimes using OTC and prescription-only antimicrobials in an extra-label manner. Future studies, including producer focus groups, would be beneficial to investigate factors that drive producers' choices and decisions regarding these antimicrobial practices.

Prior to this study, the only documentation of drug use practices on Canadian sheep farms was performed in Alberta, and involved predominantly injectable antimicrobial use information by means of a retrospective questionnaire. The present study adds to the information reported in the Alberta study by documenting prospectively collected drug and health product use data from 15 drug categories. Furthermore, ELDU of products within these drug categories was reported to address anecdotal information that much of the drug use in sheep in Canada is extra-label.

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