International Journal of Food, Agriculture and Veterinary Sciences ISSN: 2277-209X (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jfav.htm
2014 Vol. 4 (2) May-August, pp. 87-96/Osei Sekyere
Research Article

TYPES AND SELLING PRACTICES OF ANTIBIOTICS IN VETERINARY SHOPS IN ASHANTI REGION, GHANA

***Osei Sekyere John[1, 2]**
[1]*Department of Pharmaceutics, Faculty of Pharmacy and Pharmaceutical Sciences, KNUST Kumasi, Ghana*
[2]*Department of Pharmacy, University of KwaZulu-Natal, Durban 4000, South Africa*
**Author for Correspondence*

ABSTRACT
Veterinary (vet) shops are major sources of information on livestock diseases and vet drugs for livestock farmers. They are the sole points for purchasing vet antibiotics in Ghana. However, there are limited reports of their activities and its role in antibiotic resistance development or containment in Ghana. Hence, twenty five vet shops were visited to observe the antibiotics they sell and their practices. Results showed that 100% of respondents at these shops were literate though not all had a formal training in veterinary medicine. 81% of the shops scored below three on a 5-point graded scale measuring knowledge in antibiotic resistance, antibiotic residues and their relatedness to the withdrawal periods albeit their familiarity with the terms; 80% of the vet shops knew about withdrawal period and antibiotic residues from the product labels. 83.33% of these shops recommended products to customers; however, 60% of these recommendations were based on farmers' descriptions of the disease symptoms and not on objective evidence. Services provided by vet shops to farmers included diagnoses (58.33%), counselling (83.33%), credit (16.67%) and farm visit (83.33%). The antibiotics sold included members of all the major classes: tetracyclines (48.55%), sulphonamides (27.33%), amino glycosides (22.46%), macrolides (18.12%), fluoroquinolones (10.87%), trimethoprim (9.42%), penicillins (7.97%), phenicols (3.62%), cationic peptides (3.62%) and probiotics (0.67%). Less than 5% of farmers bought antibiotics with prescription from these shops and off-label use was advised. Farmers largely over depend on vet shops for antibiotic informationalbeit the largely substandard veterinary qualifications of the attendants which could further antibiotic abuse. This strong existing tie provides a platform that can be utilised to contain the abuse of antibiotics and the subsequent spread of antibiotic resistance through better training of attendants and the establishment of regulations to govern the sales of antibiotics.

Keywords: *Veterinary shops, antibiotics resistance, antibiotic residues, withdrawal period, Kumasi*

INTRODUCTION
Livestock farmers in Ghana and other African countries obtain their antibiotics and other animal health services from government and private veterinary (vet) shops. The veterinary shops are the main agencies that wholesale and retail veterinary antibiotics through a marketing chain that extends from manufacturers to farmers. Vet shops happen to be major agents in the dissemination of information about antibiotics and in the promotion of new and various antibiotics to farmers (Machila *et al.,* 2003; Bett*et al.,* 2004; Addah*et al.,* 2009; Kagira and Kanyan, 2010).Veterinary shop attendants come from all levels of the educational ladder with varying backgrounds in animal health training (Bett*et al.,* 2004).

Due to the inadequate number of veterinarians and extension officers who visit and educate farmers, the latter fall on the veterinary shops for knowledge on antibiotics and animal health (Machila *et al.,* 2003; Bett*et al.,* 2004; Addah*et al.,* 2009; Kagira and Kanyan, 2010). In a study among livestock farmers in Kumasi, Poynter (2001) found that 39% of livestock farmers used government veterinary services. It is therefore our hypothesis that these veterinary shops may play a role in antibiotic residues and the development of antibiotic resistance in livestock.

Two of the major concerns of the WHO (2011) is off-label use (using antibiotics differently from that stated on the legends) and non-prescription antibiotic use; factors implicated in antibiotic resistance. In order to nip these practices in the bud, veterinary shops are inevitable. This is due to the fact that they

provide information on the dosage, withdrawal period, routes of administration, expiry dates, storage conditions and on new antibiotics (Bett*et al.,* 2004; Kagira and Kanyan, 2010).

Moreover, important causes of antibiotic resistance in clinical medicine are the consumption of antibiotic residues in meat and the transfer of resistant bacterial strains from meat and meat products to consumers (Borgen *et al.,* 2000; Lee *et al.,* 2000). These have led the WHO (2011) to recommend a clear distinction between the antibiotics used in clinical medicine and that of veterinary medicine. As a result of the larger amounts of antibiotics used in veterinary medicine vis-à-vis that of clinical medicine, bacteria in livestock quickly develop resistance which can be transferred through the food chain (WHO, 2011). Unfortunately, the antibiotics used in livestock production encompass all antibiotics used in clinical medicine or belong to the same class. Because antibiotics of the same class have similar mechanisms of action, bacteria that develop resistance to an antibiotic within any class naturally become resistant to other members within the class—a phenomenon called co-resistance (WHO, 2011). These bacteria can transfer their resistance genes to other bacteria belonging to a different family or genus—a situation known as cross-resistance—thus spreading resistance to several antibiotics among a wider sphere of bacteria. Through these means, a single bacterium can express resistance to several antibiotics—multidrugresistance. Multidrug resistance is the end or apogee of antibiotic use, abuse and misuse. Thesephenomena are common in livestock farms (Silbergeld *et al.,* 2008; Chee-Sanford *et al.,* 2009).

There is currently limiteddata on veterinary shops, antibiotics sold and the services they provide to farmers who patronize their antibiotics in Ghana. Hence, this study focused on the types of antibiotics sold in the various veterinary shops in the Ashanti region, Ghana, and the advisory services they provide to their customers to evaluate their role in the abuse and misuse of antibiotics among livestock farmers. The containment of antibiotic resistance through rational or prudent antibiotic use can only be advanced through policies that incorporate and regulate the activities of veterinarians and veterinary shops (WHO, 2011).

MATERIALS AND METHODS

Study Area

The study was conducted in Kumasi, the capital city of Ashanti Region and the second largest city in Ghana, Atwima Nwabiagya and Ejisu Juaben districts where most of the veterinary shops in the Ashanti region are located. Two of the veterinary shops were situated in Abuakwa in the Atwima Nwabiagya district and one was in Ejisu in the Ejisu-Juaben district (all within the Ashanti region of Ghana). The veterinary shop at Ejisu and one of the two in Abuakwa were located at the district veterinary office and they were managed by the veterinarian and other veterinary assistants. Most of the vet shops in Kumasi were located in the centre of town (‘Adum’ and ‘Kagyatia’) at close proximities to each other. Ashanti region was chosen due to close proximity from the university and the relatively higher number of vet shops in this region.

Sampling

There are a total of 29 veterinary outlets in the Ashanti region alone, which covers a total land surface area of 24 389 km^2, and an estimated 97 veterinary shops or outlets in Ghana as a whole; the relatively higher number of veterinary shops in the Ashanti region (29/97) also made it optimal for the study. There was no official data on the number and locations of the shops in Ghana and the Ashanti region so the number and locations of vet shops in the Ashanti region were manually obtained by the principal investigator. The shops included wholesalers, retailers, wholesalers/distributors, retail outlets of manufacturers, private and government outlets. However, some shops were not cooperative or always available for the study and were left out. This reduced the size to twenty five shops, which is 86.21% and 25.77% of vet shops in the Ashanti region and Ghana respectively.

Categorization of Staff

The staffs were categorized into two based on their training: professionals and non-professionals. The professionals included attendants with a certificate, diploma or degree in veterinary science/medicine

from an accredited institution and the non professionals included all those without any such training irrespective of source or level of education.

The attendants were further categorised into three (low, moderate and high performance) based on their performance as assessed from their practices, interviews and the information gathered from the key informants in veterinary medicine.

Shop attendants were graded on a scale of 1 to 5 based on their knowledge of antibiotics. These included their understanding of the benefits of using antibiotics, antibiotics banned in livestock production, reasons for banning certain antibiotics in livestock farming, where and how they obtained such information and how to use antibiotics. Each question was given a grade of one. Consequently, respondents who answered each question correctly obtained grade 5.

Data Collection

An elaborate structured questionnaire was used to collect data from vet shops. In all, a total of 25 interviews were conducted between July and November, 2012 to cover both dry and wet seasons. Though the shops had other staff, only those directly engaged in the sales of the antibiotics were interviewed and observed. The views and practices of the attendant on duty were taken as the representative of that shop.

The questionnaires were structured into two phases. The first phase had close-ended questions to capture the interviews with the attendants on duty at the time of the visit and the second phase had sections to document the observed practices of the attendant during diagnoses, prescription and dispensing. These practices were juxtaposed with the answers given and evaluated with the responses obtained from the key informants. These were used to assess the attendants and categorise them into three performance levels: high, moderate, low.

The questionnaire was designed to collect data on manufacturers and distributors, educational level of the attendant and their knowledge in antibiotics, source and level of veterinary science training, types and brands of antibiotics sold, their dosage forms and routes of administration, reason for use, the information on the labels and the types of services provided to farmers. The questionnaires were pre-tested on a pilot basis with veterinarians and selected shops in Kumasi before starting the field work.

Questionnaire administration was done by the principal investigator and one field assistant in the local language, *Twi*and in English. Visits were made to shops thrice at different times of the day and at different seasons to know of changes in their practices per season. A minimum of two hours were spent to observe the interactions between attendants and farmers, their basis for antibiotic choice, dispensing ability, diagnosis of disease based on farmers' descriptions, their understanding of livestock diseases and other questions addressed in the questionnaires.

None of the shops kept data on reports of antibiotic reactions, resistance or poisoning so this data could not be obtained.

Interviews with Key Informants

Interviews were conducted with ten key informants in the livestock industry. They included veterinarians from the districts and at the regional offices as well as leading researchers in veterinary medicine and animal sciences from a local university, Kwame Nkrumah University of Science and Technology. The interviews focused on getting their views on antibiotics sales by veterinary shops and their roles in antibiotic abuse and misuse, antibiotic residues and antibiotic resistance, withdrawal period of antibiotics. Their views on symptoms of the various diseases affecting livestock, means of diagnoses, appropriate therapy and other questions addressed in the questionnaires were sought and documented. The information gathered was used as a yardstick to measure the performance of the shop attendants.

Analysis

The questionnaires, observations and interviews were structured into subthemes that guided the analysis. Quantitative data from questionnaires were entered into Microsoft Office Excel© software (Microsoft Corporation, version 2010, USA). Qualitative data and descriptive answers were computed in verbatim text in Microsoft Office Word© 2010 as already advised (Padgett, 2012, Bourgeault, 2010) and manually analysed.

Ethical Clearance and Informed Consent

The Faculty of Pharmacy, Kwame Nkrumah University of Science and Technology, approved the study. An informed consent form which explained the purpose of the study was sent to the managers of the vet shops for approval before the interviews commenced. A verbal consent was also obtained from the interviewees prior to beginning the interviews per recommended methods (Padgett, 2012, Bourgeault, 2010).

RESULTS

Characteristics of Vet Shop Attendants

Educational Background of Shop Attendants

All the veterinary shops attended had attendants with at least secondary education (Table 1) and were thus able to read the product labels and manuals and explain them to the farmers and buyers.

Table 1: Educational level of shop attendants

Educational level	Number of shops (n=13)	Percentage (%)
No education	0	0
Basic (grade 1-9)	0	0
Secondary (grade 10-12)	4	30.77
Tertiary (>grade 12)	9	62.93

Source of Veterinary Drugs Training and Comparative Performance

Not all the private veterinary shops had veterinarians (professionals). There were retail outlets in the offices of all the district (government) veterinary offices visited and the attendants in these offices had at least a diploma in veterinary science/medicine (Table 2); they sold antibiotics to farmers from these outlets with comparatively better performance (Table). Not all the attendants at private vet outlets had in-depth knowledge about the pharmacological basis of the medicines except what they knew from experience, the product labels or seminars (Table 2). Private shops with veterinarians were basically distributors of large veterinary drugs manufacturers and owned by the veterinarians themselves. These veterinarians served as managers or supervisors and hardly attended to the farmers except where the attendants had problems or they needed to diagnose complicated diseases.

Of the thirteen respondents (n=13) graded in antibiotics knowledge, 7.69% (1/13) got grade 5, none got 4, 7.69% got grade 3, most (69.23%) had grade 2 and 15.38% got grade 1.

Table 2: Source of training in veterinary drugs

Source of veterinary training	Number of shops (n=13)	Low performance level	Moderate performance level	High performance level
Fomal[1]	6 (46.15%)	0	3	3
Informal[2]	7 (53.85%)	4	3	0

NB: 1, this includes tertiary veterinary colleges; 2, this includes those who learnt from friends, on the job or from seminars organised by manufacturers and distributors to retailers to introduce new drugs

Training in Livestock Health/Diseases

66.66% (8 out of 12) of shops interviewed confirmed that they (the attendants) had training in livestock health as against 33.33% who had no training at all. Such knowledge is necessary to aid these attendants to determine the diseases affecting the animals judging from the symptoms described by the farmers.

Services Provided to Farmer

Veterinary Shops (attendants)—Farmers Interactions

90.90% of respondents (n=11/13) discussed benefits of antibiotics with farmers; 9.09% did not. 83.33% of respondents (n=12/13) recommended particular products to farmers; 16.67% did not.

Basis for Recommending Products to Farmers

Table 3 depicts the answers given by various shops when asked about their basis for recommending specific products to farmers. 60% depended on the farmers' descriptions of the disease symptoms without further objective evidence.

Table 3: Basis shop attendants use for recommending antibiotics to farmers

Basis or premise for recommendation	Number of shops (n=10)	percentage
Faeces	1	10%
Behaviour of animal	2	20%
Coughs/sneezing	1	10%
Farmers' description	6	60%
Animal/farm history	1	10%
Post-mortem	2	20%
Diagnosis	1	10%
Experience	1	10%

Types of Services Provided to Farmers

The vet shops provided a lot of services to customers. These included farm visits (83.33% i.e. 10/12) to aid farmers improve upon their practices, observing animals to provide diagnosis (58.33% i.e. 7/12) of their diseases, providing medicines to farmers on credit (16.67% i.e. 2/12) and giving counsel (83.33% i.e.10/12) to farmers on several issues of which they have no knowledge. Provision of credit was rare due to faithfulness of customers.

Information Provided by Manufacturers and Distributors

91.67% of veterinary shops (n=12) reported that manufacturers/distributors provided information on their products though only eight outlets gave the breakdown shown in Table 4. Some manufacturers did so by organising seminars for distributors and retailers whiles others did not. Such seminars were organised to introduce new products into the market. Many shops however depended on the product labels and legends to know about the product.

Table 4: Antibiotic information provided by manufacturers and distributors

Information	Number of shops (n=8)	Percentage
Use	6	75%
Indication	6	75%
Side effects	2	25%
Composition	3	37.5%
Dosage	4	50%
Contra-indications	1	12.5%
Expiry dates	1	12.5%
Storage	1	12.5%
Safety	1	12.5%

Manufacturers and Distributors of Antibiotics to Veterinary Shops

The main manufacturers of veterinary medicine in Ghana were Maridav, Dannex and Dex-iberica. These manufacturers began as distributors and still distribute imported products; they also produced a limited number of products on a relatively smaller scale. From the survey conducted, it was realised that all products of a manufacturer were distributed by sole agents. The distributors were Maridav, Ashvet, Dexvet, Multivet, Gokals, Reiss & Co., AsuoAfram Chemists Ltd., Dannex, Vetrico Ltd., Chemico, Medivet, Frankatons and Amen ventures.

Knowledge on Antibiotic Resistance

Knowledge about Withdrawal Period, Antibiotic Resistance and Residues

Eight out of twelve shops/respondents (66.66%), when asked, said they had knowledge on antibiotic resistance and antibiotic residues. All respondents (100%) said they had knowledge about withdrawal period. One out of five (20%) respondents knew about antibiotic resistance, antibiotic residues and withdrawal period from experience whiles 80% knew about this from the product labels.

Respondents view of How to Prevent Antibiotic Resistance and Residues

Table 5 depicts the views of the various veterinary shops on how to prevent antibiotic residues and resistance. Only one respondent felt that it could not be prevented in practice. The other respondents, however, mentioned several interventions like education, strict adherence to the withdrawal period, changing antibiotics and rational use.

Table 5: Veterinary shops' response to how to prevent antibiotic resistance and residues

Means of prevention	Number of respondents (n=8)	Percentage
Education	2	25%
Correct dosage	2	25%
By changing product	1	12.5%
Rational use	2	25%
Strict adherence to withdrawal periods	2	25%
Difficult to do so in practice	1	12.5%

Protective Items to Use during Antibiotic Use

81.81% of respondents (n=11) believed that protection during antibiotic handling was important, 9.01% thought it was not necessary and another 9.01% believed that it was not always necessary. The protective items viewed by shop attendants as necessary during antibiotic handling were clothing (63.63% i.e. 7/11), goggles (18.18% i.e. 2/11), boots (54.55% i.e. 6/11), gloves (63.64% i.e. 7/11), nose masks (27.27% i.e. 3/11) and face masks (9.01% i.e. 1/11).

Reportage of Health Problems or Reactions from Antibiotic Use to Shops

50% of responding shops (n=12) confirmed incidences of farmers reporting health problems due to antibiotic use. The other half had no such record. The actual health problems were however, not always stated. The shops did not have a data of such reports.

Types of Antibiotics Sold

A total of 138 antibiotic brands were realised from all the veterinary shops encompassing nine antibiotic classes and probiotics (table 6): Penicillins (7.97%), fluoroquinolones (10.87%), tetracyclines (48.55%), macrolides (18.12%), sulphonamides (29.71%), aminoglycosides (22.46%), cationic peptides (3.62%), Phenicols (3.62%), Pyrimidines (Trimethoprim) (9.42%) and Probiotics (0.72%). These antibiotic classes, except probiotics, were all prominent in clinical medicine. The tetracyclines were the most prominent and common class on the Vet markets. Following the tetracyclines were the sulphonamides, the aminoglycosides, macrolides, fluoroquinolones, trimethoprim and penicillins in descending order (table

6). The other classes were in relatively smaller percentages.72.07% of all the antibiotics sold was for treatment and the rest were for both treatment and prevention or prevention (probiotics).

Table 6: Types of antibiotics and probiotics sold in Vet shops

Active ingredients		Number of brands (n=138)	Percentages
1.	**Sulphaquinoxaline (sodium)**	7	5.07%
2.	**Oxytetracycline**	52	37.68%
3.	**Tetracycline**	2	1.45%
4.	**Doxycycline**	11	7.97%
5.	**Colistin**	5	3.62%
6.	**Procaine (benzyl) penicillin**	8	5.80%
7.	**Dihydrostreptomycin**	14	10.15%
8.	**Furaltadone**	2	1.45%
9.	**Tylosin**	14	10.15%
10.	**Neomycin**	14	10.15%
11.	**Sulphadimerazine**	1	0.72%
12.	**Enrofloxacin**	10	7.25%
13.	**Sulphadimidine**	17	12.32%
14.	**Trimethoprim**	13	9.42%
15.	**Erythromycin**	9	6.52%
16.	**Chloramphenicol**	4	2.90%
17.	**Sulphamethazine**	3	2.17%
18.	**Sulphadiazine (sodium)**	6	4.35%
19.	**Mixture of herbs**	5	3.62%
20.	**Toltrazuril**	1	0.72%
21.	**Norfloxacin**	4	2.90%
22.	**Ampicillin**	2	1.45%
23.	**Sulphamethoxypyridiazine**	2	1.45%
24.	**Tiamulin**	2	1.45%
25.	**Gentamycin**	3	2.17%
26.	**Sulphanilamide**	1	0.72%
27.	**Sulphathiazole**	2	1.45%
28.	**Amoxicillin**	1	0.72%
29.	**Chlortetracycline**	2	1.45 %
30.	***Saccharomyces cerevisiae***	1	0.72%
31.	**Sulphadoxine**	1	0.72%
32.	**Flumequine**	1	0.72%
33.	**Thiamphenicol**	1	0.72%
34.	**Sulphadiarine**	1	0.72%

DISCUSSION

The educational level of the shop attendants exceeds those reported in Kenya (Bett*et al.*, 2004) where few attendants (15/28) had no more than a secondary education; nevertheless, literary ability is not commensurate with comprehensibility, especially as the terms used on the labels are technical and can be best understood by persons with a veterinary background. For instance, though 66.66% of the responding shops claimed to have a training in vet drugs, 80% of them learnt about antibiotics resistance, withdrawal periods and antibiotic residues from product labels whiles 20% learnt it from experience; a clear indictment of the shop attendants thorough veterinary training. All these parameters are connected. An

abuse of antibiotics or non-adherence to the withdrawal periods lead to increased concentrations of antibiotics in the flesh of the animals. These antibiotic residues affect antibiotic resistance when they are exposed to the microbial flora of consumers (Borgen *et al.*, 2000; Lee *et al.*, 2000). Furthermore, less than half the attendants scored more than 3 in the antibiotics grade test conducted to test their knowledge on antibiotics in general; their abysmal performance belies their professed knowledge in antibiotic resistance, residues and withdrawal period.

The proportion of attendants with training in veterinary drugs is not commensurate with those with training in livestock health (66.66%), quickly suggesting that knowledge in one does not automatically endows one with knowledge in the other; in effect, they are two different disciplines. It can be realised from this data that attendants can learn about the drugs without in-depth knowledge of the diseases they are intended to cure, a further indictment of the holistic knowledge base of the attendants in veterinary medicine. The vet shops can be described more as business centres tilted towards the merchandise of veterinary drugs. It is worth noting that diagnosis and recommendation of antibiotics to farmers is dependent on understanding of livestock diseases and pharmacology. On the whole, vet shops with professionals, and consequently those in the districts veterinarian's offices, provided better services to the farmers than private shops with non professional attendants.

Consequently, the higher educational level of the shop attendants and their training in animal health and veterinary drugs is not supported by their understanding in antibiotic knowledge as demanded by the questionnaires and grading test and indicts their professionalism in helping tackle antibiotic resistance. These conclusions are not far removed from that arrived at by Bett and colleagues (2004) in a similar study in Kenya.

Nevertheless, their views on how to prevent antibiotic resistance and residues—education, strict adherence to withdrawal periods, rational use and correct dosage—are commendable. That these views are forcefully communicated to the farmers and strictly adhered to is a subject for further research as they can aid control the development and spread of antibiotic resistance on livestock farms.

It is encouraging to note that 81.81% of the respondents believed that farmers must protect themselves during their handling of antibiotics. However, this study did not seek the reasons behind their answers to ascertain their understanding of protection in limiting the development and spread of antibiotic resistance. Their views of the standard protective items to use during antibiotic handling, if adhered to by the farmers can greatly reduce the transfer of antibiotics and resistant bacteria from animals to farmers. Few of them advocated for nose, face and eye protection; areas which can also potentially harbour resistant bacterial strains and antibiotic powders.

The lower educational level of many Ghanaian farmers and the inadequate number of readily-available veterinarians makes them depend on vet shops (Addah*et al.*, 2009) though such was not entirely the case in Kenya (Kagira and Kanyan, 2010). The factors affecting the decision of the farmers included ignorance of the best medicines to buy, uncertainty of the disease affecting the animals, the price of the desired drug, the presence of alternate or substitute drugs at competitive prices, the absence of the desired drug and convincing recommendations from the shop attendants. Any of these factors can dissuade a farmer from his decision (40% of farmers were undecided—n=13—23% do not know what to buy when they get to the veterinary shop), giving the shop attendant an advantage to push his recommendations. Consequently, the advisory services carried out by most (90.90%) shops were to enable them recommend specific products (83.33% of the shops) to the farmers than to educate them entirely on antibiotics especially when 98% of farmers reporting at the shops had no prescriptions. It is therefore not surprising, though concerning to note, that only a handful of the attendants based their recommendations on objective evidence (Table 3). Such premises opened the way for guesses and trial-and-error, a condition that can further antibiotic abuse and misuse. The desire for profit making by the shops is therefore an important factor influencing their recommendations.

Education, counselling and farm visits to offer diagnosis and other technical advice are good practices except that the poor professional understanding demonstrated by the shops and their bases for diagnoses and prescriptions (Table 3) casts a shadow of doubt on the quality of these services. Among the shortfalls

observed in the shops were the absence of data on reported antibiotic reactions which could have been investigated and the absence of appropriate measuring equipment to accurately measure correct doses. Off-label use, a major cause of antibiotic resistance, has been fostered by this unfortunate condition as the doses are approximated.

As vet shops are the main source of antibiotics for farmers (Machila*et al.*, 2003), they show the spectrum of antibiotics that are circulating on Ghanaian livestock farms. The types and classes of antibiotic sold in the vet shops commensurate that reported from other parts of the world (Page and Gautier, 2012; Wageh*et al.*, 2013). The stability of solid dosage forms makes them preferred by manufacturers and they were the commonest in the shops (57.25% i.e. 79/138). These dosage forms are used more in poultry than in other livestock, the reason being the easy administration via their water and feed. Because the other livestock in Ghana are not mostly housed, fed or given water from a common source, adding the drugs through their water or feed is uncommon.

Unlike the solid dosage forms, not all the liquid drugs were administered orally. Injections were commonly indicated for cattle, sheep, goats, pigs and horses and administered per animal instead of per house as in poultry. By extension, oral solid and liquid dosage forms had a higher patronage due to the larger number of poultry birds (both sick and healthy) that must be served at a time through feed or water; increasing the risk of antibiotic residues and resistance among poultry.

The lower proportion (27.93%) of antibiotics for prevention (including probiotics), reflects the low interest of farmers in prevention and the unpopular nature of probiotics; the reasons are basically low finances and lack of promotion of probiotics. Growth promoters are thankfully uncommon albeit there are a few nutritional supplements with antibiotics. Though they could be serving as growth promoters, there is no such indication on the labels. The practice of halving the stated dose for prevention purposes selects for resistant bacterial phenotypes. Consequently, the WHO (2011) advises against the use of lower antibiotic doses for prophylaxis and the exclusion of antibiotics used in clinical medicine from veterinary medicine.

All the antibiotic classes represented on vet shop shelves are also important clinically. The tetracyclines are the most patronized of all the antibiotics, hence the numerous brands; bearing in mind that each brand is from one manufacturer and distributor (Table 6). The percentage of fluoroquinolones, though lower, is concerning as they are currently the main antibacterial agents used in Ghanaian clinical medicine. The aminoglycosides, trimethoprim and macrolides would better be reserved to safeguard their efficacy. Using all the antibiotics classes simultaneously is not advisable as it depletes our current antibiotic arsenals should there be resistance to all, leaving us with not reserve to fall upon.

Whereas the vet shops studied (an estimated 25.77% of veterinary shops in Ghana) cannot be said to be fully representative of the whole country, it nevertheless gives an indication of their conditions and practices which could inform remedial interventions to better address the challenges of antibiotic abuse and resistance development in livestock.

Conclusion

There are too many loopholes in the flow of veterinary antibiotics on the Ghanaian market. Most of the antibiotics (more than 96%) were bought without prescriptions and objective diagnosis. Coupled with farmers' ignorance, shop attendants based on these to make major decisions with ulterior profiteering motives. Regulations that check the types of antibiotics sold and the persons licensed to sell them in the vet shops are non-existent. The professional veterinary and dispensing deficiencies observed in the attendants furthered off-label use, increasing the risk of antibiotic abuse and misuse with their attendant results. Farmers' reliance on vet shops, however, necessitates stricter licensing regulations for veterinary shop attendants. It would be prudent to establish a discipline in veterinary pharmacy to train vet shop attendants in addition to a strong regulating body with surveillance teams to regulate the types of antibiotics sold in Vet shops.

Competing Interests

The author has no competing interests and the sponsors had no role or whatsoever in the preparation of the manuscript, data collection and analysis and decision to publish.

ACKNOWLEDGMENTS
This research was partially funded by the ADMER project (STATENS SERUM INSTITUT). We thank the veterinary shops visited for their cooperation and participation. The veterinarians of the districts visited and the regional veterinarian for their inputs towards this research and Prof. D. B. Okai for his assistance with questionnaires and information on pig science. We also thank the anonymous reviewers for their helpful comments.

REFERENCES
Addah W, Baah J, Tia S and Okine E (2009). Knowledge and practices of smallholder farmers and herdsmen in the use of acaricides and gastrointestinal anthelminthes in Ghana.*Livestock Research for Rural Development***21**(198). Available: http://www.lrrd.org/Irrd21/11/adda21198.htm [Accessed 19 Aebruary 2014].
Bett B, Machila N, Gathura PB, McDermott JJ and Eisler MC (2004). Characterisation of shops selling veterinary medicines in a tsetse infested area of Kenya. *Preventive Veterinary Medicine* **63**(1-2) 29-38
Borgen K, Simonsen GS, Sundsfjord A, Wasteson Y, Olsvik O and Kruse H (2000). Continuing high prevalence of Van-A type vancomycin resistant enterococci on Norwegian poultry farms three years after avoparcin was banned. *Journal of Applied Microbiology* **89** 478-485.
Bourgeault I, Dingwall R and de Vries R (2010).*Sage Handbook on Qualitative Health Research* (London: Sage Publications).
Chee-Sanford JC, Koike S, Mackie RI, Krapac IG, Lin Y, Maxwell S, Yannarell CA and Aminov RI (2009). Fate and Transport of Antibiotic Residues and Antibiotic Resistance Genes following Land Application of Manure Waste.*Journal of Environmental Quality* **38** 1086-1108.
Kagira JM and Kanyan PWN (2010). Questionnaire survey on urban and peri-urban livestock farming practices and disease control in Kisumu municipality, Kenya. *Journal of South African Veterinary Ass*ociation **81**(2) 82-86.
Lee E, Li ZH, Vakulenko S and Mobashery S (2000). A light inactivated antibiotic. *Journal of Medicinal Chemistry* **43** 128-132.
Machila N, Wanyangu SW, McDermot J, Welburn SC, Maudlin I and Eisler MC (2003). Cattle owners' perceptions of African bovine trypanosomiasis and its control in Busia and Kwale Districts of Kenya.*Acta Tropica***86**(1) 25-34.
Padgett D (2010).*Qualitative and Mixed Methods in Public Health* (Thousand Oaks, USA: Sage Publications).
Page SW and Gautier P (2012). Use of antimicrobial agents in livestock.*Revue scientifiqueet technique (International Office of Epizootics)* **31**(1) 145-188.
Poynter G (2001). Findings into a survey of urban livestock in Kumasi Ghana.MSc. Thesis, University of Edinburgh, UK.
Silbergeld EK, Graham J and Price BL (2008). Industrial Food Animal Production, Antimicrobial Resistance, and Human Health.*Annual Review of Public Health* **29** 151-69.
Wageh SD, Elsaid AE, Mohammed TE-A, Yoshinori I, Shouta N and Mayumi I (2013). Antibiotic residues in food: the African scenario. *Japanese Journal of Veterinary Research***61**(Supplement) S13-S22.
WHO (2011). Tackling antibiotic resistance from a food safety perspective in Europe.WHO regional office for Europe, Copenhagen, Denmark 1-88.