THE UNIVERSITY of EDINBURGH

Edinburgh Research Explorer

Characterising and comparing drug-dispensing practices at animal health outlets in the Rift Valley, Kenya: an exploratory analysis (part II)

Citation for published version:
Higham, LE, Ongeri, W, Asena, K & Thrusfield, MV 2016, 'Characterising and comparing drug-dispensing practices at animal health outlets in the Rift Valley, Kenya: an exploratory analysis (part II)', *Tropical Animal Health and Production*, vol. 48, pp. 1633–1643. https://doi.org/10.1007/s11250-016-1137-z

Digital Object Identifier (DOI):
10.1007/s11250-016-1137-z

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Tropical Animal Health and Production

General rights
Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

OPEN ACCESS

Download date: 12. Oct. 2024

Characterising and comparing drug dispensing practices at animal health outlets in the Rift Valley, Kenya: An exploratory analysis (Part II)

L.E. Higham[1,2], W. Ongeri[3], K. Asena[3] and M.V.Thrusfield[4]

[1]FAI (Food Animal Initiative), The Field Station, Wytham, Oxford, UK

[2] Division of Infection and Pathway Medicine, Deanery of Biomedical Sciences, College of Medicine and Veterinary Medicine, Chancellor's Building, 49 Little France Crescent, Edinburgh, EH16 4SB

[3]Sidai Africa Ltd, Nairobi, Kenya

[4]Veterinary Clinical Sciences, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, EH25 9RG UK

Corresponding author: Laura E. Higham, FAI (Food Animal Initiative), The Field Station, Wytham, Oxford OX2 4UG UK laura.higham@faifarms.com

Abstract

A mixed-methods study was conducted in the Rift Valley of Kenya to characterise drug dispensing practices amongst staff at animal health outlets, and to explore perceptions of veterinary medicines amongst pastoralists and farmers. Forty structured questionnaires were administered to staff at animal health outlets, including franchise outlets of 'Sidai Africa Ltd', and two focus group discussions were facilitated to explore the perceptions of local animal health services by a Maasai pastoralist group and a dairy farmer cooperative. Differences were detected in the characteristics of Sidai outlets, agrovets, pharmacies and dukas. A greater proportion of Sidai outlet staff selected drugs based on principles of responsible drug use than staff at other types of outlet, and technical qualifications and training were associated with responsible drug use. Across all outlet types, staff

knowledge and training gaps were identified, including in the correct administration of medicines. The majority of drug sales are accompanied by verbal advice to farmers. Members of the Maasai pastoralist group were concerned about accidental self-medication, withdrawal periods, drug residues and the misuse of drugs due to a lack of quality information and advice. The dairy farmer group raised similar concerns, reporting under-dosing as a common mistake amongst farmers. This study concludes that current knowledge, attitudes and practices of many service providers and livestock owners in the sale, purchase and use of veterinary medicines present risks of drug misuse and therefore the emergence of antimicrobial resistance. There is a clear demand from livestock keepers for accessible, affordable and quality animal health services and products in Kenya, and animal health practitioners have the potential to provide increased support to livestock-based livelihoods, and act as stewards of our existing portfolio of animal and human medicines.

Keywords

Livestock; health; veterinary medicine; drug dispensing practices; pastoralist; drug resistance.

1. Introduction

The threat of antimicrobial resistance (AMR) is increasing at an alarming pace (Sosa *et al.* 2010). The risks and impacts of AMR emergence are considered to be greater in developing countries, considering the high burden of infectious disease, poverty, poor sanitation, malnutrition, unregulated drug supply chains and constraints to health service provision (Sosa *et al.* 2010). In light of these concerns, and the implications of the coexistence of people and livestock in many low-income settings, further investigations are required to unravel the potential risk factors for AMR emergence resulting from drug use in animals in developing countries.

Veterinary surgeons, animal-health assistants, community animal-health workers, shops known as 'agrovets' (mixed agricultural suppliers) and 'dukas' (general stores), market vendors, ethnoveterinary practitioners and natural healers currently provide animal health services and products to farmers in Kenya (Heffernan and Misturelli, 2002; Young *et al.*, 2003). These practitioners all play an important role in the provision of veterinary services, but with variable levels of availability, accessibility, affordability, acceptability, quality (Campbell *et al.*, 2013; Leyland *et al.* 2014) and legal status (National Council for Law Reporting, 2012). In the absence of enforced regulation over veterinary drug prescriptions in Kenya (Grassvitz *et al.,* 2004), animal keepers are able to purchase drugs without a prescription. Ninety-eight percent of Maasai herders seek modern medicines provided by local dispensaries (Kiringe, 2006), and participatory studies have shown that accessible and affordable animal health services are a priority for pastoralists as a means of protecting their livestock assets (Catley, 2002). The application of professional judgement is a key feature of quality veterinary services (OIE, 2014b), impacting on animal health, welfare and productivity, the cost effectiveness of the drug purchase, and the risk of emergence of drug resistance (Grace, 2003). However, current practices amongst the diverse network of animal health service providers in reaching a diagnosis, guiding the selection of drugs and deciding upon a suitable route and dosing regimen have not been fully characterized in Kenya.

Building upon previous work by Bett *et al.* (2004), this study characterises animal health outlets in terms of their sales of animal health products, and the knowledge, attitudes and practices of staff in dispensing veterinary drugs. Understanding prescribing patterns is considered crucial to identifying areas for potential intervention to improve use (Bosu and Ofori-Adjei, 1997); therefore this study also explores customer expectations and interactions between animal health outlet staff and customers. The animal health outlets include regional headquarters and outlets of 'Sidai Africa Ltd', a social enterprise consisting of a franchised network of livestock service centres across Kenya,

providing animal health products and professional technical advice to farmers and pastoralists. A description of the facilities, services and workforces associated with the animal health outlets is presented elsewhere (Higham *et al*., 2016).

2. Materials and methods

2.1 The study area

A mixed-methods study (Bardosh *et al.*, 2013) was conducted in 23 towns and villages in seven counties of the Rift Valley of Kenya, between latitudes 1.60°S and 0.88°N and longitudes 34.81°E and 36.33°E. The study area was selected to represent a variety of agro-ecological zones from the semi-arid grasslands in Narok and Nakuru counties with prevailing Maasai pastoral systems involving mixed herds of cattle, sheep and goats, to Kericho and Bemot counties with mixed smallholder systems in high-potential areas around the tea plantations, and the medium-potential counties of Uasin Gishu, Butere and Nandi, which support smallholder farming and dairy cattle systems. See Figure 1.

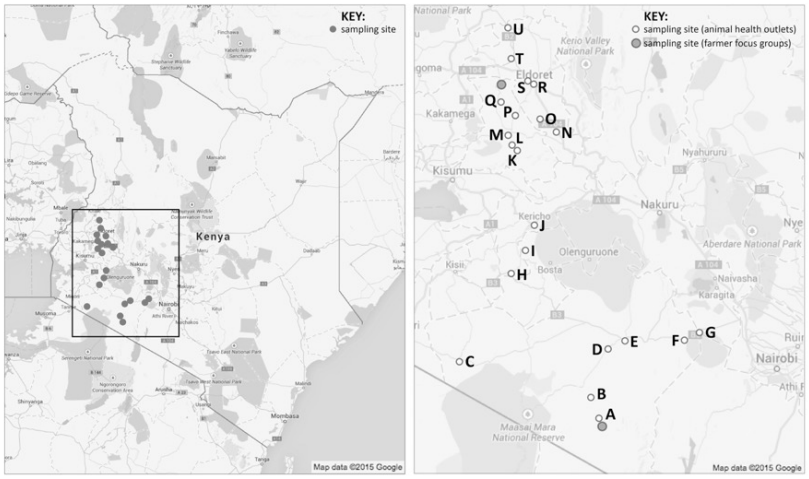

Figure 1: Maps of the study area in the Rift Valley of Kenya. The map on the right highlights the 21 towns and villages sampled for the animal health outlet survey, labelled A to U, and the two sites of the farmer focus group discussions. (Google maps, 2015)

2.2 Survey of animal health outlets

2.2.1 Criteria, sampling method and classification of animal health outlets

'Animal health outlets' were the units that were sampled. For the purpose of this study, animal-health outlets were defined as fixed premises (permanent shops) selling veterinary medicines; however many of the outlets offered clinical veterinary services, either on the premises of the outlet, or remotely at livestock holdings. Market vendors were therefore excluded from the scope of this study. Additional criteria for selection included (a.) premises being open at the time of the interviewers' visit, and (b.) presence of an available staff member who was willing to anonymously participate in the study with managerial consent.

The animal-health outlets were systematically sampled in the absence of a sampling frame. Selection of sampling sites was based on the presence of a Sidai outlet in the locale, facilitating the sampling of approximately equal numbers of Sidai outlets (n=16) and agrovets (n=18) in corresponding areas. 'Other' outlets, consisting of pharmacies and dukas selling veterinary medicines (n=6), were also sampled when available and identifiable. Pharmacies and dukas were evaluated as a single group, termed 'other' outlets, because of their small number. Within each sampling site, up to four animal health outlets were sampled in order to achieve the target quota of 40 animal health outlets.

2.2.2 Survey administration

Interviews were conducted at 40 animal health outlets over a two-week period in 2015. The interviews were administered as a structured questionnaire in Swahili in-person by the second and third authors. An inventory was also taken at each animal health outlet of visible drugs available on the shelves and injectable products, where permission was given to access the store.

2.2.3 Questionnaire design

The questionnaire included variables relating to outlet type and workforce, the sales of animal health products, and knowledge, attitudes and practices ('KAP') (WHO, 2008) of staff in dispensing drugs. Variables relating to the outlet type and workforce were designated as explanatory variables to determine their effect on the quality and capacity of the animal health outlet (OIE, 2014b). Variables relating to drug dispensing practices were selected as response variables, to represent indicators of

Table 1: The variables included in the questionnaire administered to animal health outlet staff in the Rift Valley of Kenya. The type of variable is ticked where the confidence interval overlap technique was used; all other variables were subject to descriptive statistics.

Variables: The Outlet and workforce	Variable type(s)		Comments
	Explanatory	Response	
Location			Nearest town and county
Type of outlet	✓		Sidai outlet, agrovet, other (pharmacy or duka)
Presence of technically-trained personnel in the workforce	✓		Technically-trained personnel are defined as vets, animal health workers, AI technicians or pharmacists
Role(s) of respondent	✓		Categorised as technically-trained or not
Guidance or training received by respondent on dispensing drugs	✓		Including training courses and access to books and materials
Variables: Knowledge, attitudes and practices			
Customer purchasing behaviour			Requests for advice on drug type; requests for a specific products
Provision of advice on drug choice		✓	To customers by the respondent
Awareness and basic knowledge of drug resistance		✓	Basic knowledge defined as respondent reference to the reduced therapeutic effect of drugs
Most frequently sold drugs and their use		✓	Respondent advice on application and dosing; deemed correct when within a 10% margin of error of the data sheet recommendation.
Reasons for which antibiotics are most frequently sold		✓	Treatment, prevention or growth promotion
Ranking of factors considered in drug selection for a customer			Factors include clinical signs in the animal, customer preference, route of administration; ranked in terms of importance.
Provision and nature of advice on the sale of a drug		✓	Basic level of advice defined as respondent's provision of drug dosage information to customers

the quality and capacity of the animal health outlet (See Table 1). Knowledge, attitudes and practices consistent with responsible drug use were indicated by (a.) the provision of advice to *all* customers on which drug to buy, (b.) a basic awareness of drug resistance, defined by a reference to the reduced therapeutic effect of a drug, (c.) the correct dosing of drugs within a 10% margin of error, (d.) the sale of antibiotics for treatment (not disease prevention or growth promotion) of animals, (e.) clinical signs or diagnostic test results selected as the most important factor in drug choice, and (f.) sufficient information, defined by dose rate as a minimum, imparted to customers with each drug purchase. Other variables were designated for descriptive analysis only. In the delivery of the questionnaire, a

variety of closed and open questions were employed (Bryman, 2015). The questionnaire was piloted on three respondents on 26th January in Narok and was revised to ensure clarity and feasibility.

2.2.4 Analysis

The data were transferred to a Microsoft® Excel® for Mac 2011 (Microsoft Corporation) database. For quantitative analysis, the response variables were calculated as proportions of Sidai and agrovet outlets, exploring the four explanatory variables, shown in Table 1. Confidence intervals of these proportions were calculated and plotted to allow the observation of overlap, with non-overlapping confidence intervals indicating a significant difference between the proportions, at a 95% level of significance (Schenker and Gentleman, 2001; Payton *et al.*, 2003). 'Other' outlets were excluded from statistical analyses due to the small sample size (n=6) obtained for these outlets. A descriptive analysis was performed on other variables.

2.3 Farmer focus group discussions

Focus group discussions were conducted with 12 male pastoralists in Embiti, a pastoral village 4km from the town of Naikarra, and with 15 male and five female dairy farmer members of the Kabiemit Cooperative Society in Kabiemit, a town in Nandi County. These farmers supplied milk to a national dairy processing company. Two-hour discussions in the local languages were guided using semi-structured interviews (Bryman, 2015).

3. Results

3.1 Sales of animal health products

The respondents were asked to specify the three best-selling veterinary medicines, and the composition of all best-selling drugs selected by respondents by region is shown in Table 2. The inventory revealed that, across all animal health outlet types and in all regions, the outlets stocked an average of ten acaricide products, 19 anthelmintic products, one trypanocide or East Coast fever

treatment, eight antibiotic products and seven 'other' products. The most frequently stocked acaricide products were amitraz and cypermethrin-based products. Albendazole and levamisole with or without oxyclosanide were the predominant anthelmintic agents stocked. Buparvaquone and diminazene were sold for East Coast fever and trypanosomiasis, and oxytetracycline and trimethoprim-sulphonamides were the most prevalent antibiotics stocked. Within the 'other' category, products included milking salve, electrolytes, calcium, kaolin, vitamins, glucocorticoids and oxytocin. There was an absence of analgesic products such as non-steroidal anti-inflammatories, and one outlet stocked the local anaesthetic, lignocaine. The respondents were asked to provide the current profit margin of their three best-selling veterinary medicines. The mean profit margins of the most commonly sold drugs were 23%, 22% and 19% at Sidai outlets, agrovets and other outlets, respectively.

Table 2: The composition of the best-selling veterinary medicines in animal health outlets in the Rift Valley of Kenya, by type, as selected by outlet staff.

Most commonly sold drugs	Percentage of best selling drug by type, and by region			
	South Rift	Mid Rift Valley	North Rift	All regions
Dewormers	52%	27%	49%	47%
Acaricides	28%	53%	28%	31%
Antibiotics	16%	13%	15%	15%
Trypanocides and ECF treatment	2%	0%	8%	4%
Other	3%	7%	0%	3%
	100%	100%	100%	100%

3.2 Drug dispensation

3.2.1 Drug choice

The respondents were asked to rank, in order of importance, the factors from a list that they consider when choosing a drug for a customer. The results are displayed in Figures 2-4 for the three different types of animal health outlet. Eighty-five percent of the respondents stated that customers 'sometimes' ask for a specific branded veterinary product, with the remaining 15% claiming that customers 'always' request a specific product. Thirty percent of the interviewees stated that customers 'always' ask for advice on the choice of drug for their animal, with the remaining 70%

claiming that customers only 'sometimes' request advice. The respondents were asked what products were requested by customers that they did not routinely stock. The results can be found in Table 3.

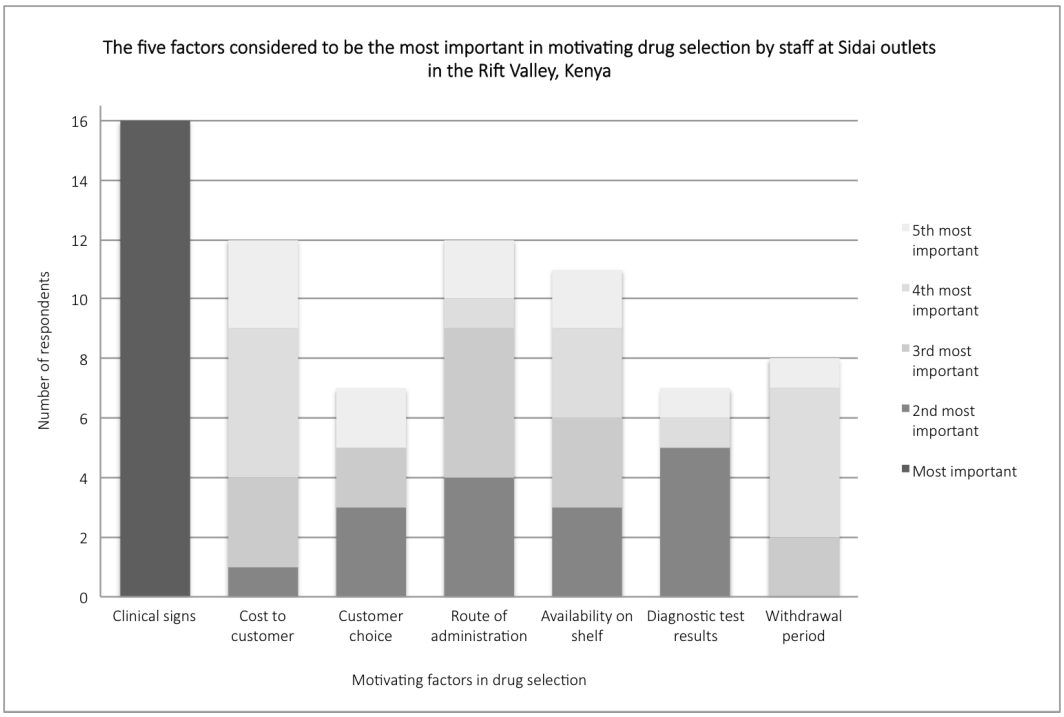

Figure 2: The five most important factors considered by Sidai outlet staff in the Rift Valley, Kenya, when selecting a veterinary drug for a customer. (y-axis indicates the number of respondents selecting the choice.)

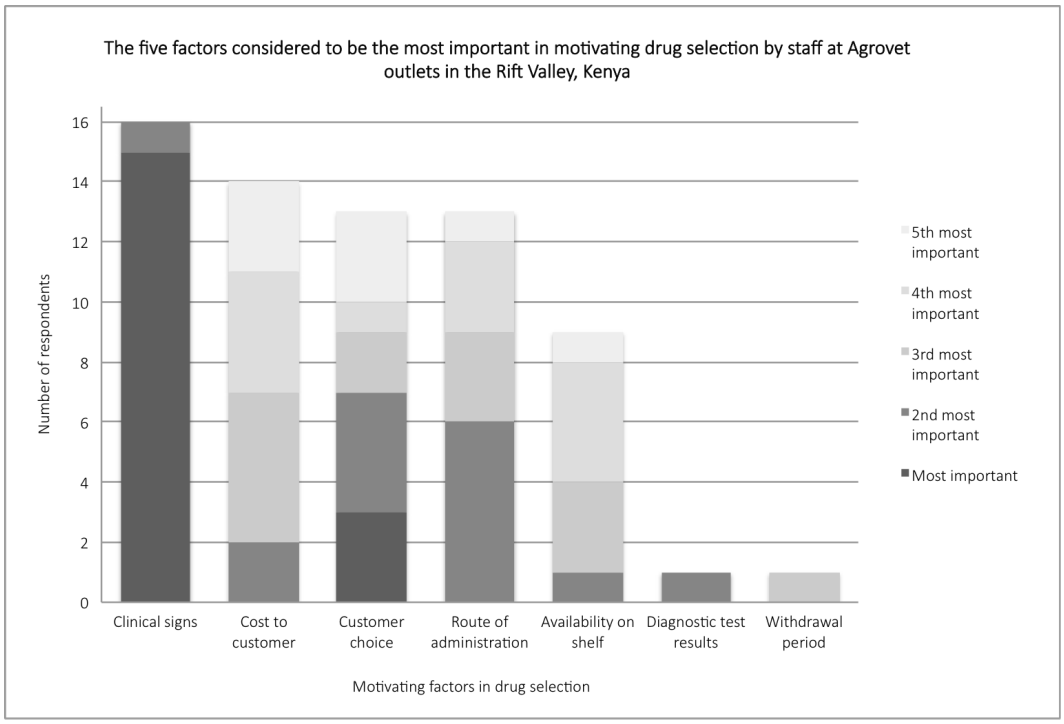

Figure 3: The five most important factors considered by agrovet staff in the Rift Valley, Kenya, when selecting a veterinary drug for a customer. (y-axis indicates the number of respondents selecting the choice.)

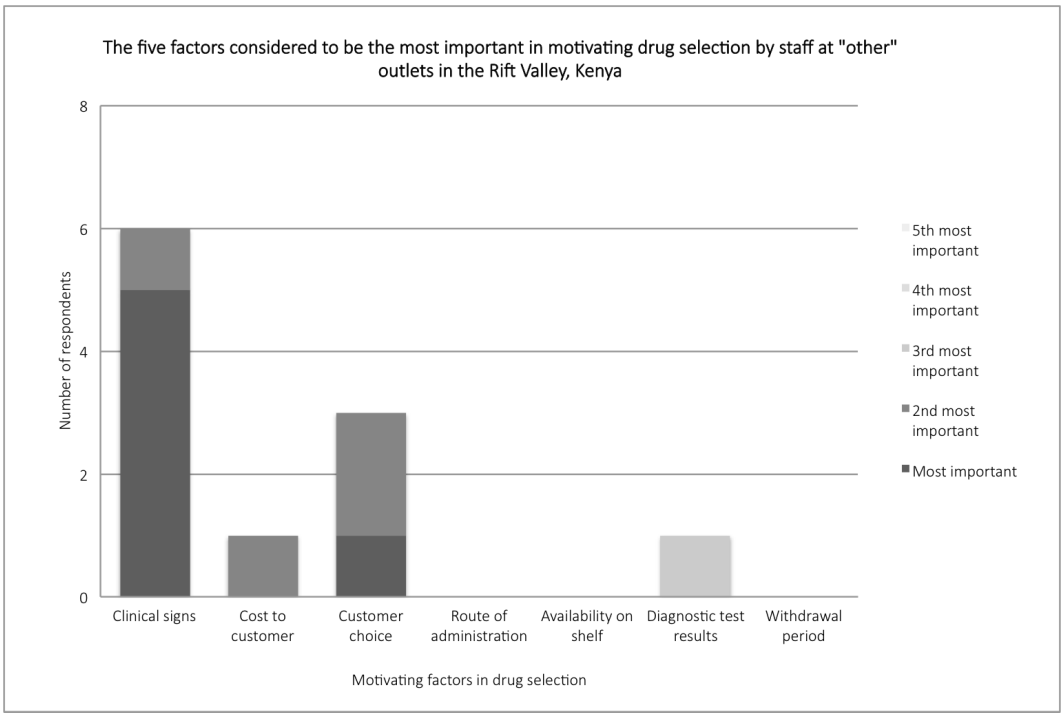

Figure 4: The five most important factors considered by pharmacy and duka staff in the Rift Valley, Kenya, when selecting a veterinary drug for a customer. (y-axis indicates the number of respondents selecting the choice.)

Table 3: The most commonly cited products requested by customers and not stocked by animal health outlets in the Rift Valley, Kenya.

Product requested but not stocked	Number of respondents referencing the product
Vaccines	18
Feeds (specific types)	7
Agrochemicals and fertilisers	5
Equipment	3
Dewormers	2
Artificial insemination	1
Minerals	1
Seeds	1
Hormones	1
Injectable products	1

3.2.2 Provision of advice on drug use

Eighty-five percent of respondents provide the minimum basic information on dose rate to their customers. All respondents provide the advice verbally, with 75% claiming that verbal advice was their primary means of providing the information. Fifteen out of forty respondents 'sometimes' provide written information, and six out of the 40 respondents supply both verbal and written

information with every drug sale. Illiteracy of some customers was cited as a reason for providing verbal information only.

3.2.3 Responsible drug use

Results are shown in Figures 5 - 8.

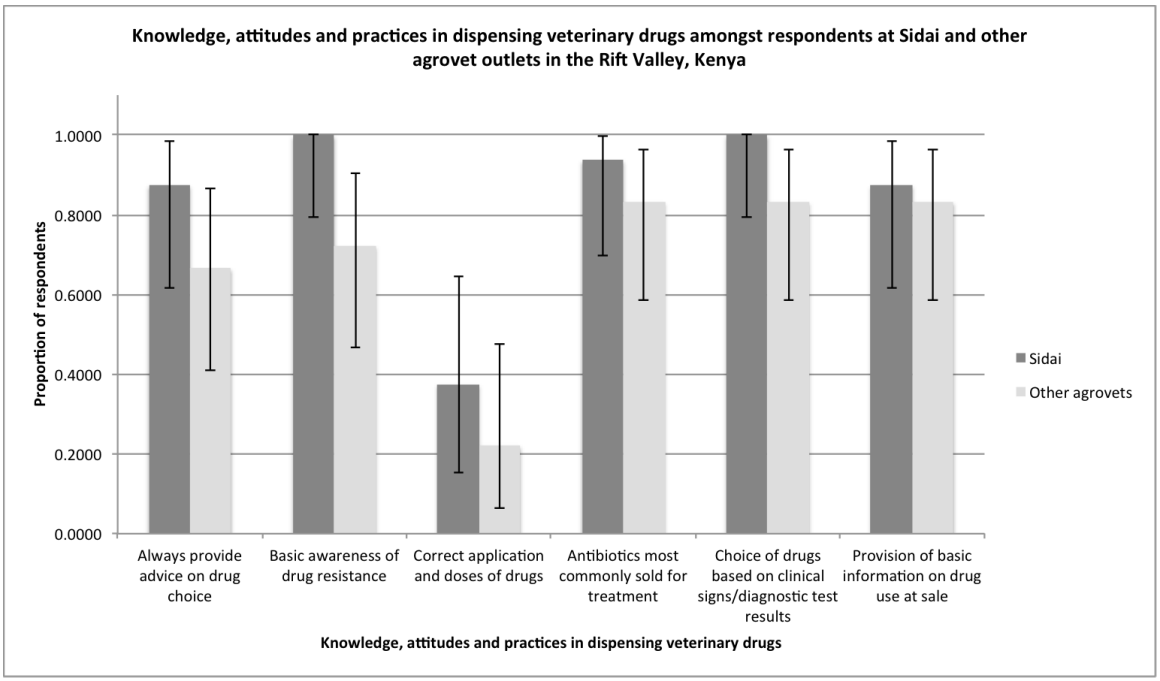

Figure 5: Proportions with 95% confidence intervals of respondents from Sidai outlets and agrovets with knowledge, attitudes and practices consistent with responsible veterinary drug use, in the Rift Valley, Kenya.

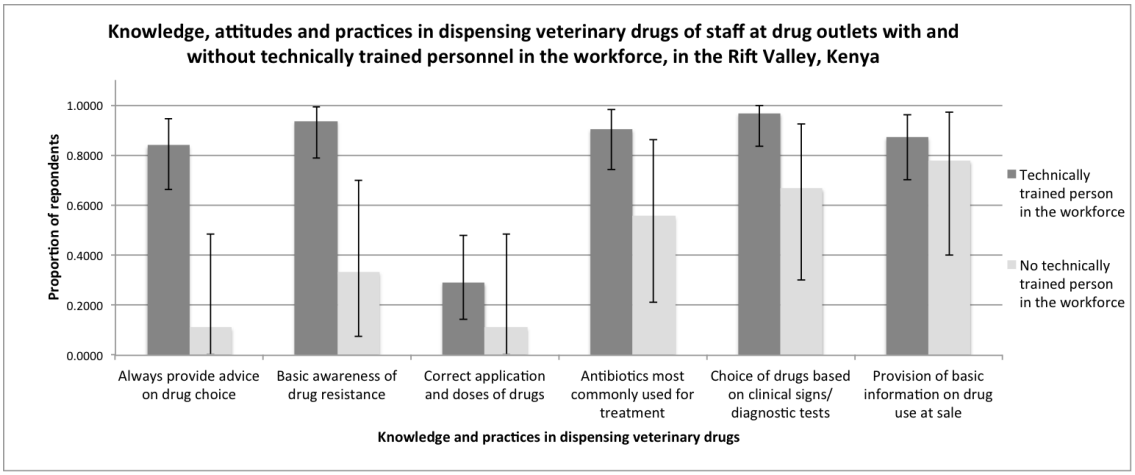

Figure 6: Proportions with 95% confidence intervals of respondents from animal health outlets with and without technically trained personnel in the workforce, with knowledge, attitudes and practices consistent with responsible veterinary drug use in the Rift Valley, Kenya.

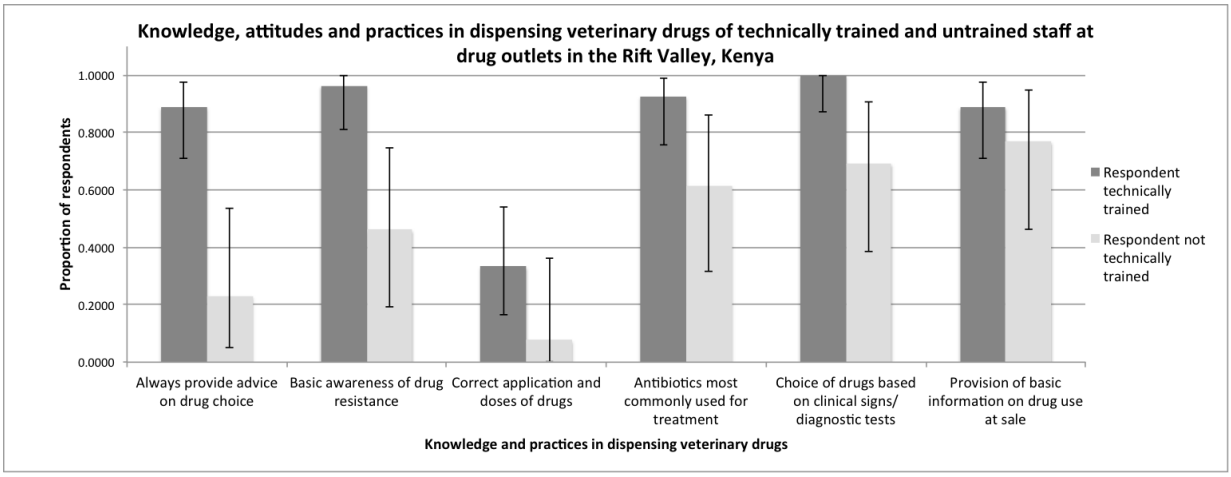

Figure 7: Proportions with 95% confidence intervals of technically trained and non-trained staff with knowledge, attitudes and practices consistent with responsible veterinary drug use at animal health outlets in the Rift Valley, Kenya.

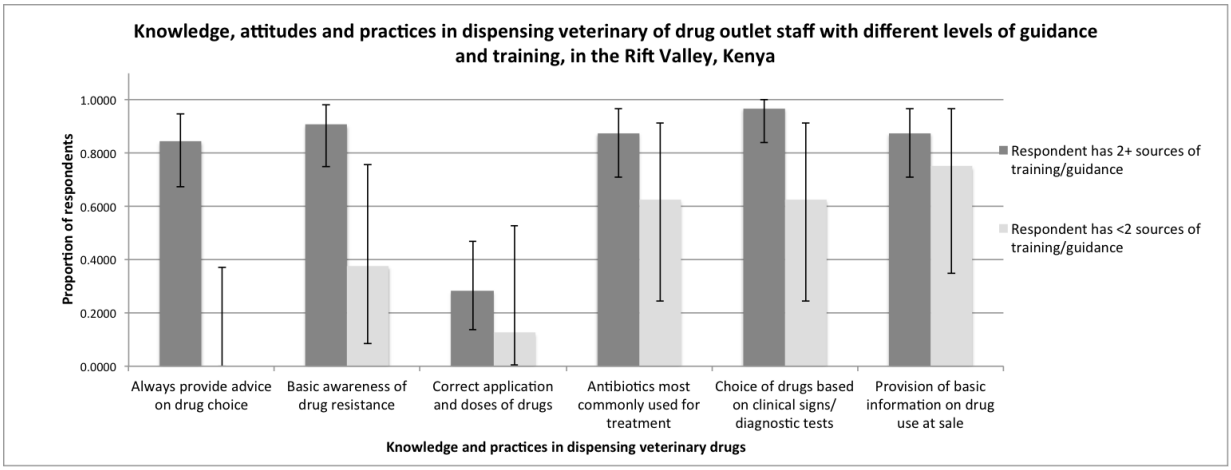

Figure 8: Proportions with 95% confidence intervals of staff with different levels of training and guidance with knowledge, attitudes and practices consistent with responsible veterinary drug use at animal health outlets in the Rift Valley, Kenya.

3.3 Farmer focus group discussions

3.3.1 Maasai pastoralist discussion group

The Maasai pastoralist group listed the most important features of a quality animal health service as (a.) provision of quality drugs, and the group discussed the prevalence of sub-standard drugs; (b.) affordability of drugs, although the group agreed that they would prefer to pay a higher price for more quality products; (c.) fast response to disease outbreaks; and (d.) ability of the staff to communicate in Maasai and to provide credit for drugs and services. The negative effects of veterinary medicines were discussed, and the group highlighted their concerns for accidental self-

medication, such as with sprays; meat and milk withdrawal periods which were neither fully understood by the group nor communicated effectively by animal health workers; and accidental misuse of medicines due to a lack of understanding of dose rates, quality information and advice. However the group reported that the local Sidai franchisee always provides advice on drug treatments, and agrovet staff sometimes provides advice. The group was aware of the risks of drug resistance.

3.3.2 Dairy cooperative focus group

The dairy cooperative group listed the most important features of a quality animal health service as (a.) efficiency of animal health workers in responding to problems; (b.) competence of staff; (c.) continuity of care, with follow-up of cases; (d.) affordability of drugs and services; (e.) provision of training; and (f.) availability of products. The farmers reported that Sidai staff provide advice regarding drug dosages, risks, expiry dates, storage and withdrawal periods. The farmers reported that under-dosing is a common mistake leading to poor efficacy due to farmers failing to follow instructions, and inaccurate weight estimations. Weigh bands were requested by the farmers. The group was aware of the problem of drug resistance, and they reported that the acaricide, cypermethrin, was failing to work due to frequent use.

4. Discussion

The drug inventories compiled at each animal health outlet revealed that most outlets stock a large number of products, including many different brands with the same active ingredients. For example, of the 113 anthelmintic products recorded across the study area, 39% were albendazole-based products and 32% were levamisole-based products. Of the 82 antibiotic products recorded, 45% were oxytetracycline-based products. As observed by Higham *et al.* (2016), farmers tend to have strong preferences for specific brands and products, and may lack knowledge of active ingredients. It appears that drug stockists cater for the demands of farmers by stocking a wide range of brands, but

often a narrow range of medicines. Apisarnthanarak *et al.* (2008) demonstrated links between 'favourite' antibiotics prescribed at drug stores in Thailand and patterns of resistance. The current study in Kenya indicates that farmers may be also less able to follow rotational or strategic drug programmes, which are recommended for routine preventive treatments such as anthelmintics (Sargison, 2011), due to the limited range of medicines on offer. The numerous brands may also generate confusion when customers face a large selection of the same drugs. The dairy farmer focus group perceived a wide product range as an important feature of a good animal health service, and the farmers agreed that the local Sidai outlet had a better range of products to suit their needs. These results suggest that drug outlets should refine their product range to reduce the range of brands offered, but stock a wider variety of medicines, provide advice on selection and effective deployment of rotational or strategic treatments.

There was little difference between the drug types stocked by the different outlet types, with all outlets stocking most drug types, including injectable products. One drug category that was not available from any of the sampled animal health outlets was analgesic pain medications such as non-steroidal anti-inflammatory drugs (NSAIDs). Glucocorticoid drugs were stocked in 14 outlets, indicated primarily for allergic conditions, and local anaesthetic lignocaine was stocked in only one outlet. This raises concerns for animal welfare during painful conditions or surgical procedures. The supply of NSAIDs by pharmaceutical companies and distributors, with training on use, would represent an important welfare intervention, and may also improve treatment response and recovery times.

There were marginal differences between the types of best-selling products between regions. In the south and north Rift regions, the majority of the best-selling products named by respondents were anthelmintics (52% and 49%, respectively). In the mid Rift valley, 53% of the named best-selling

drugs were acaricides and 27% were anthelmintics. Trypanocides and East Coast fever treatments, however, constituted 8% of the best selling drugs in the north Rift, and 2% and 0% in the south and mid Rift regions, respectively. This pattern reflects the geographical range of the tsetse fly vector of *Trypanosoma*, (Kadarmideen *et al.*, 2006), and thus the distribution of trypanosomiasis. The most commonly sold antibiotic is oxytetracycline, and together with the drug inventory, these findings are consistent with those of Sarmah *et al.* (2006) who state that tetracyclines, sulphonamides and trimethoprim account for 78% of antibiotic use in food producing animals in Kenya. Sarmah *et al.* (2006) indicate that the soluble tetracyclines and sulphonamides for poultry found ubiquitously in outlets in Kenya, may be used by farmers for growth promotion.

One hundred percent of Sidai outlet respondents selected 'clinical signs in the animal' as the most important factor for consideration when selecting a drug for a customer, with diagnostic test results selected as the second most important factor by 31% of respondents. Other important factors included route of administration, drug availability and customer choice. Eighty-three percent of agrovet respondents selected clinical signs as the most important factor in drug selection, with the remaining one respondent selecting customer choice. Other important factors to agrovet staff were route of administration, cost to the customer and availability of the drug. Similarly, five out of six 'other' outlet respondents selected clinical signs as the most important factor, and one selected customer choice. The empirical selection of drugs clearly prevails, with limited availability of diagnostic testing in the region. Results suggest that Sidai outlet staff are more likely to select drugs for customers based on principles of responsible drug use, and are less likely to be influenced by customer preferences. In the current absence of affordable and accessible diagnostic testing services and products in the region, there is a need to provide animal health outlet staff with training on the empirical selection of medicines for conditions of different types.

Fifteen percent of respondents stated that customers 'always' ask for a specific, branded product, and 85% reported that customers 'sometimes' ask for a specific product. Thirty percent of respondents stated that customers 'always' ask for advice on the selection of a drug, and 70% reported that customers 'sometimes' ask for advice. Overall, these results reinforce the finding from Higham *et al.* (2016) that farmers often have preferences for certain products, and a considerable number of customers visit animal health outlets for a specific product without seeking advice from the vendor. The removal of service providers from the decision-making process is a concern for animal health and prospects of emerging drug resistance, and there is a need to establish the position of animal health outlet staff as trusted advisors in the community. Of the 40 responses regarding the products that were frequently requested by customers but not stocked at the outlet, 18 related to vaccines. This suggests that there is a demand for vaccines, but as discussed in Higham *et al.* (2016), cold chain constraints limit the ability of animal health outlets to stock vaccines. There is a need to increase the availability of affordable refrigeration and to address the problems of unreliable power supply, for example using solar cells. Such an intervention would increase vaccine coverage for preventable infectious diseases, and provide an additional source of revenue for animal health outlets.

Eighty-five percent of respondents provide the minimum level of information on dose rate to their customers at the point-of-sale. Seventy-five percent primarily provide verbal advice, with some of these respondents claiming that the provision of written prescriptions is restricted by the literacy levels of their customers. Members of the Maasai pastoralist group were concerned about accidental self-medication, withdrawal periods, drug residues and the misuse of drugs due to a lack of quality information and advice. The dairy farmer group raised similar concerns, reporting under-dosing as a common mistake amongst farmers because of a failure to follow instructions and inaccurate body weight estimations. This is consistent with a study by Machila *et al.* (2008), who found that cattle farmers in Kenya consistently underestimated the weights of their cattle. The dairy farmer group also

referred to the emergence of drug resistance to the acaricide, cypermethrin. These findings suggest that improvements are required in communicating instructions on drug use to customers, taking into consideration different literacy levels. It is suggested that pictorial guidance notes should accompany drugs at the point of sale, and tools could be developed for the more accurate and consistent administration of medicines.

A number of knowledge, attitudes and practices were selected as indicators of responsible drug use. There was a difference between the proportions of respondents demonstrating responsible drug use between Sidai outlet staff and agrovet staff. A greater proportion of Sidai outlet staff 'always' provide advice on drug choice to customers, have a basic awareness of drug resistance and give the correct application and dosage of the three most commonly sold drugs. A greater proportion of Sidai staff also stated that they mainly sell antibiotics for treatment (as opposed to prevention or growth promotion), base their choice of drugs for a customer on clinical signs or diagnostic test results, and provide the minimum level of information on use of drugs at the point of sale. However, significant differences in these proportions between Sidai outlet and agrovet respondents, based on the confidence interval overlap technique, were not observed.

A greater proportion of respondents from outlets with technically trained personnel in the workforce 'always' provide advice to customers on drug choice and have a basic awareness of drug resistance, than respondents from outlets without technically trained personnel, with a significant difference observed using the confidence interval overlap technique. This may be due to the likelihood that the respondents in these outlets were, themselves, technically trained, and due to the support and training provided by trained personnel to their colleagues. In addition, a greater proportion of technically trained respondents 'always' provide advice to customers on drug choice, and have a basic level of awareness of drug resistance, than non-technically trained respondents, with a significant difference

observed between the proportions using the confidence interval overlap technique. This highlights the importance of training for animal health outlet staff, in terms of their responsible use of drugs. A greater proportion of respondents with two or more sources of training or guidance 'always' provide advice to customers on their choice of drugs, than respondents with less than two sources of training or guidance, with a significant difference observed between the proportions. It is clear that the presence of a technically trained staff member in the workforce, and the training and qualifications of personnel are significantly associated with responsible drug use by staff members, with the non-overlapping confidence intervals indicating a significant difference between the proportions, at a 95% level of significance.

Sosa *et al.* (2010) report that about one half of antibiotic prescriptions are inaccurate. In the current study, only 25% of all respondents provided the correct dosage of all three of the most commonly sold drugs at their outlet, within a 10% margin of error of the data sheet recommended dose, in mg/kg. A large proportion of respondents provide advice on the dosage of drugs at the point of sale, suggesting that, although advice is usually given to customers, the dose rates advised by outlet staff are often incorrect. A large proportion of respondents understand that antibiotics should primarily be used for treatment and have a basic awareness of drug resistance, both of which are important factors in mitigating overuse of drugs. These findings are consistent with those of Sarmah *et al.* (2006), who found that antibiotics are not officially used for growth promotion in Kenya but suggest that soluble trimethoprim-potentiated sulphonamides may be used for these purposes by farmers. Overall, the current study provides evidence of a basic understanding of some key principles in responsible drug use amongst animal-health outlet staff, but a number of key constraints and gaps in knowledge exist. Priority should be given to highlighting the importance of communicating accurate drug dose rates amongst veterinary drug vendors.

This study identifies a number of opportunities and constraints within the private animal health system in the Rift Valley of Kenya. The opportunities lie within the extensive and diverse network of animal health outlets in operation in the region, with a demand from livestock keepers for accessible, affordable and quality services and products. However, current knowledge, attitudes and practices of service providers and livestock owners in the sale, purchase and use of veterinary medicines present risks of drug misuse and therefore the emergence of antimicrobial resistance. There is a role for structures such as the Sidai franchise network in addressing these issues by maintaining a quality, trained workforce and providing farmer training, and for other stakeholders, including pharmaceutical companies, in providing locally-applicable tools and resources to promote correct and responsible use of veterinary products in low-income settings.

5. Acknowledgements

This research was kindly funded the Fund for Sankalpa. The authors would like to thank Ruth Layton, Christie Peacock, Rezin Ochieng Odede and Ruth Clements for providing their support and help in this project. The authors also extend their deep gratitude to the many animal health outlet staff, farmers and pastoralists who willingly gave their time and shared their views during data collection.

6. Ethical statement

Ethical approval was sought from the contributing organisations and from local institutions for conducting this study. This study was conducted alongside the NGO Sidai Africa Ltd, and interviews and focus group sessions were conducted with consenting Sidai staff and customers, and staff members at neighbouring shops.

7. Conflict of interest statement

There are no conflicts of interest to declare.

8. References

Apisarnthanarak, A., Tunpornchai, J., Tanawitt, M. and Mundy, L.M., 2008. Non-judicious dispensing of antibiotics by drug stores in Pratumthani, Thailand. Infection Control and Hospital Epidemiology, 29(6), 572-575.

Bardosh, K., Waiswa, C. and Welburn, S.C., 2013. Conflict of interest: use of pyrethroids and amidines against tsetse and ticks in zoonotic sleeping sickness endemic areas of Uganda. Parasites and Vectors 6, 204.

Bett, B., Machila, N., Gathura, P.B., McDermott, J.J. and Eisler, M.C., 2004. Characterisation of shops selling veterinary medicines in a tsetse-infested area of Kenya. Preventive Veterinary Medicine 63, 29-38.

Bosu, W.K. and Ofori-Adjei, D., 1997. Survey of antibiotic prescribing patterns in government health facilities of the Wassa west district of Ghana. East African Medical Journal 74, 138–142.

Bryman, A., 2015. Social Research Methods (Oxford University Press, Oxford).

Campbell, J., Buchan, J., Cometto, G., David, B., Dussault, G., Fogstad, H., Fronteira, I., Lozano, R., Nyonator, F., Pablos-Méndez, A., Quain, E.E., Starrs, A. and Tangcharoensathien, V. 2013. Human resources for health and universal health coverage: fostering equity and effective coverage. Bulletin of the World Health Organisation 91, 854-845.

Catley, A., 2002. Community-based animal health care and pastoral livelihoods. In: Ethiopian Veterinary Association 16th Annual Conference, Animal health and poverty reduction strategies, 5th-6th June 2002, Addis Ababa, Ethiopia.

Grace, D., 2003. Rational Drug Use: To better manage trypanosomosis and trypanocide resistance. Working Paper 4, International Livestock Research Institute, Nairobi, Kenya.

Grace, D., Randolph, T., Affognon, H., Dramane, D., Diall, O. and Clausen, P-H., 2009. Characterisation and validation of farmers' knowledge and practice of cattle trypanosomiasis management in the cotton zone of West Africa. Acta Tropica 111, 137-138.

Grasswitz, T.R., Leyland, T.J., Musiime, J.T., Owens, S.J. and Sones, K.R., 2004. Status of the veterinary pharmaceutical sector in Kenya. In: The veterinary pharmaceutical industry in Africa: a study of Kenya, Uganda and South Africa (African Union/Inter-African Bureau for Animal Resources, Nairobi).

Heffernan, C. and Misturelli, F., 2002. The Delivery of Veterinary Services to the Poor: Preliminary findings from Kenya (Veterinary Epidemiology and Economics Research Unit, Reading).

Kadarmideen, H., Abdulai, A., Janssen-Tapken, U. and Awuor Ouma, E., 2006. Developing optimised cattle breeding schemes, with special focus on trypanotolerance, based on the demands and opportunities of poor livestock keepers (North-South Centre Research for Development, Zurich). http://www.northsouth.ethz.ch/programmes/agricultural_research/concluded_livestock/projects/cattle_breeding. Accessed 16 Mar 2015.

Kiringe, J.W., 2006. A survey of traditional health remedies used by the Maasai of Southern Kaijiado District, Kenya. Ethnobotany Research and Applications 4, 61-73.

Leyland, T., Lotira, R., Abebe, D., Bekele, G., and Catley A., 2014. Community-based Animal Health Workers in the Horn of Africa: An Evaluation for the US Office for Foreign Disaster Assistance (Feinstein International Center, Tufts University Africa Regional Office, Addis Ababa and Vetwork UK, Great Holland).

Machila, N., Fèvre, E.M., Maudlin, I. and Eisler, M.C., 2008. Farmer estimation of live bodyweight of cattle: Implications for veterinary drug dosing in East Africa. Preventive Veterinary Medicine 17, 394-403.

National Council for Law Reporting, 2012. Veterinary Surgeons and Veterinary Paraprofessionals Act. No 29 of 2011, Revised Edition 2012, Kenya Law Reports (National Council for Law Reporting, Nairobi).

OIE, 2014a. Responsible and prudent use of antimicrobial agents in veterinary medicine. Chapter 9.9, Article 6.9.1, Terrestrial Animal Health Code (OIE, Paris).

OIE, 2014b. Veterinary services. Chapter 3.1, Article 3.1.2. Terrestrial Animal Health Code (OIE, Paris).

Payton, M.E., Greenstone, M.H. and Schenker, N., 2003. Overlapping confidence intervals or standard error intervals: what do they mean in terms of statistical significance? Journal of Insect Science 3 (34), 1-6.

Sargison, N., 2011. Responsible use of anthelmintics for nematode control in sheep and cattle. In Practice 33, 318-327.

Sarmah, A.K., Meyer, M.T. and Boxall, A.B.A., 2006. A global perpective on the use, sales, exposure, pathways, occurrence, fate and effects of veterinary antibiotics in the environment. Chemosphere 65, 725-759.

Schenker, N. and Gentleman, J.F., 2001. On judging the significance of differences by examining the overlap between confidence intervals. The American Statistician 55, 182-186.

Sosa, A de J, Byarugaba, D.K., Amabile-Cuevas, C.F., Hsueh, P.R., Kariuki, S. and Okeke, I.N. 2010. Antimicrobial resistance in developing countries (Springer, New York).

WHO, 2008. A Guide to Developing Knowledge, Attitude and Practice Surveys (World Health Organization, Geneva).

Young, J., Kajume, J. and Wanyama, J., 2003. Animal health care in Kenya: The road to community-based animal health service delivery. Working paper 214 (Overseas Development Institute, London).