



Awareness of Antimicrobial Resistance among Primary Health Care Workers in Buyende District, Rural Eastern Uganda

Ahebwa Amelia¹, Akol Walter¹, Achong Emmanuel¹, Mugerwa Timothy¹, Nakayenga Aminah¹, Omega Phillip¹, Rebecca Nekaka¹ and Iramiot Jacob Stanley^{2*}

¹Department of Community and Public Health, Faculty of health Sciences, Busitema University, P.O.Box 1460, Mbale, Uganda.

²Department of Microbiology and Immunology, Faculty of health Sciences, Busitema University, P.O.Box 1460, Mbale, Uganda.

Authors' contributions

This work was carried out in collaboration between all authors. Authors AA, AW, AE, MT, NA and OP participated in the planning of the study, data entry and drafting of manuscript; author RN reviewed the manuscript and author IJS participated in the planning of the study, drafting and critical review of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/MRJI/2017/38832

Editor(s):

(1) Grzegorz Cieslar, Professor, Department and Clinic of Internal Diseases, Angiology and Physical Medicine, Medical University of Silesia, Poland.

Reviewers:

(1) J. Malathi, India.

(2) Gokben Ozbey, Firat University, Turkey.

(3) Yasmine Samy Moustafa, Egypt.

Complete Peer review History: <http://www.sciencedomain.org/review-history/23005>

Original Research Article

Received 15th November 2017

Accepted 17th January 2018

Published 3rd February 2018

ABSTRACT

Aim: The aim of this study was to assess the awareness of antimicrobial resistance among Primary Health Care Workers in Buyende district.

Methods: This was a cross-sectional study employing qualitative and quantitative methods. Administration of a questionnaire evaluating knowledge and practices of health workers in Buyende community was conducted. The study was designed to cover all health workers involved in prescribing and dispensing drugs in selected health facilities of Buyende district. The participants were from four health facilities (Kidera Health Center IV, Nkondo Health Center III, Buyende Health

*Corresponding author: E-mail: eramios@gmail.com;

Centre III and Miseru Health Center III) and ten private community drug shops. Health care workers were assigned to different cords for the data collection process. One hundred twenty-four (124) respondents participated in the survey, representing a majority of the health workers in Buyende district.

Results: Most respondents (75%) reported receiving information about antibiotic resistance with medical training school (67.2%) being the main source of information. Sixty-six percent (66%) of the participants believed that the widespread use of antibiotics is an important cause of resistance, while 60% attribute antimicrobial resistance to inadequate restrictions on antibiotic prescription due to advertising and promotion by pharmaceutical companies. Guidelines for the use of antibiotics against common infections and regular microbiological consultations/ward rounds were reported as crucial in controlling the problem of anti-microbial resistance. Though most health workers reported following clinical guidelines when prescribing antibiotics (79%), a substantial proportion still prescribed use of antibiotics for the treatment against common cold/cough (64%) and viral infections (44%).

Conclusion: The awareness of anti-microbial resistance is a public health problem in rural Eastern Uganda. Campaigns for appropriate prescription and awareness of anti-microbial resistance should include educating the public and rural health care workers with the aim of decreasing the emergence antibiotic resistant microbes.

Keywords: Antimicrobial resistance; awareness; primary health care workers.

1. INTRODUCTION

Antimicrobial resistance has become an issue of global public health concern contributing to mortality and morbidity in settings with limited diagnostic facilities and treatment options [1]. The rapid emergence of resistant bacteria is occurring worldwide, endangering the efficacy of antibiotics, which have transformed medical care and saved millions of lives [2]. The antibiotic resistance crisis has been attributed to the overuse and misuse of anti-bacterial drugs, as well as a lack of new drug development by the pharmaceutical industry due to reduced economic incentives and challenging regulatory requirements [3]. Globally, 3.7% of new cases and 20% of previously treated cases of tuberculosis are estimated to be caused by strains that are resistant to isoniazid and rifampicin. For decades, these anti-tuberculosis agents have been efficacious against tuberculosis, but today are rendered ineffective [4].

Antimicrobial resistance is especially challenging in low-income and resource-poor countries where the disease burden due to microbial infections is exacerbated with the misuse of antibiotics and the lack of clinical microbiology laboratories for diagnostic testing [5]. In sub-Saharan Africa, the situation is aggravated by poor hygiene, unreliable water supplies, civil conflicts and increasing numbers of immuno-compromised individuals such as those with HIV,

which facilitate both the evolution of resistant pathogens and their rapid spread in the community [6]. Due to a limited capacity for disease detection and surveillance, lack of training and the failure to implement proper guidelines by healthcare workers, the awareness of antibacterial resistance are less established in most of sub-Saharan Africa and therefore the ability to mitigate their consequences is significantly limited [6]. Throughout East Africa there is a heavy burden of community-acquired infectious disease. Unfortunately, the surveillance capacity for anti-microbial resistance [7] is minimal in most East African countries, and current data on AMR patterns of common pathogenic bacteria are sparse [8]. The aim of this study is to assess the understanding of antibiotic use and resistance among primary health care workers in Buyende district, a rural area located in Eastern Uganda.

2. MATERIALS AND METHODS

2.1 Study Design

This is a cross-sectional study employing qualitative and quantitative methods.

2.2 Study Site and Population

This study focused on health workers in the Buyende district. The participants were from four health facilities [Kidera Health Center IV, Nkondo Health Center III, Buyende Health Centre III and

Miseru Health Center III) and ten private community drug stores. The Buyende district was recently carved out of the Kamuli district and lies adjacent to the shores of Lake Kyoga in Eastern Uganda. Most of the occupants are farmers, and a small proportion of the population is involved in fishing in Lake Kyoga (Fig. 1).

2.3 Sampling

The study was designed to cover all health workers involved in prescribing and dispensing of drugs in the Buyende district. Health care workers were assigned to different cords for the data collection process.

2.4 Data Management

Completed questionnaires were checked for completeness and consistency prior to further data management. Data were double entered into a password-protected Microsoft excel database. To protect the integrity of the participants' responses from interviews and survey questionnaires, all the data related to the person were coded only known to the research team. Hard copies of the data, including survey questionnaires were kept in locked boxes and/or file cabinets. Only members of the study team

had access to project data. All data were reported as anonymous without referring to specific individuals.

2.5 Data Analysis

STATA version 14 was used to analyze data from the survey. Simple proportions were used to describe categorical and numerical data respectively.

3. RESULTS

3.1 Socio-Demographic Characteristics

One hundred twenty-four (124) respondents participated in the survey, representing a majority of the health workers in Buyende district. Most respondents fell in the 21-30 (53%) age category, while a minority are aged above 50 (1.5%). In terms of qualifications, 57.4% are nurses. Only two doctors (medical officers) (1.6%) were interviewed and presented as the most educated amongst the whole group. The other categories of health workers involve were Clinical Officers (Physician assistants), Pharmacists, dispensers and laboratory technicians.



Fig. 1. Map of Uganda showing the location of Buyende District

Table 1. Socio-demographic characteristics of respondents

Characteristic		Number	Percentage
Gender	Female	63	51
	Male	61	49
Age	15-20	36	29
	21-30	66	53
	31-40	20	16
	50+	2	1.5
Qualification	Nurse	71	57.4
	Clinical officer	7	5.9
	Medical officer	2	1.5
	Pharmacist/Dispenser	15	11.8
	Other	29	23.5
Had extra training in microbiology/infectious diseases	No	124	100
	Yes	0	0
Duration of practice	0-4 years	55	44.6
	5-9 years	40	32.3
	10-14 years	27	21.5
	Above 15 years	2	1.5

Others = Community health workers (Village health teams), Laboratory technicians

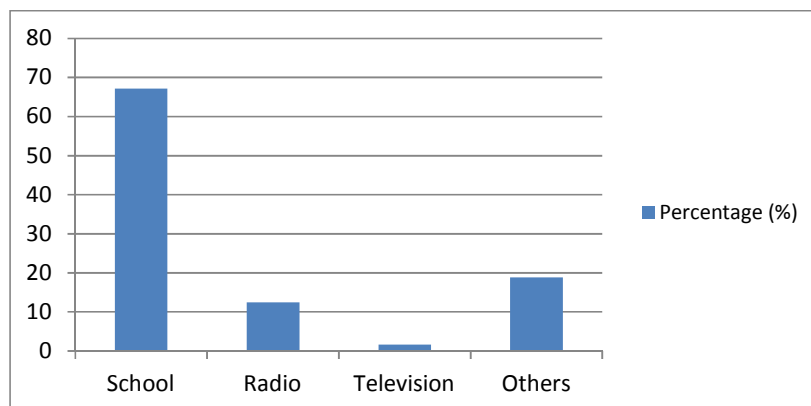
3.2 Knowledge about Antibiotic Resistance

Respondents answered questions to gauge their knowledge about antibiotic resistance. These questions ranged from basic information about antibiotic resistance to sources of information, to usefulness of potential interventions for antibiotic resistance. Amongst respondents, 75% reported having received some information about antibiotic resistance, while 25% reported not receiving any information and during our research was the first time they were interfacing with the existence of such a phenomenon. Sources of information varied amongst respondents. School was the main source (67.2%), followed by radio (12.5%) and other common avenues like newspapers, church, and

posters (18.8%) were the most common sources of information amongst those that had received information about antibiotic resistance (Fig. 2). Televised media (1.6%) contributed the least in the dissemination of information about antibiotic resistance.

3.3 Perceived Magnitude of the Problem of Antibiotic Resistance

Respondents answered questions to help gauge whether their perception of antibiotic resistance is a threat to public health; this was assessed on a scale ranging from minimally important to very important giving an allowance of “don’t know” for respondents who held no opinion on the question posed. The findings are summarized in Table 2.

**Fig. 2. Sources of information regarding antibiotic resistance**

Others = news papers, internet, conferences, peers

Table 2. Perception of antibiotic resistance

To what extent do you think the following contributes to antibiotic resistance?	Minimally important	Moderately important	Very important	Don't know
Widespread use of antibiotics	14(11.4%)	25(20%)	80 (64.3%)	5 (4.3%)
Inappropriate use of antibiotics	17 (13.8%)	21 (16.9%)	82 (66.2%)	4 (3.1%)
Inappropriate duration of antibiotic therapy	18 (14.7%)	26 (20.6%)	71(57.4%)	9 (7.4%)
Inadequate washing	28 (22.4%)	36 (28.9%)	67(53.7%)	4 (3%)
Inadequate restrictions on antibiotic prescription	24 (20%)	47(38%)	47(38%)	6 (4.9%)
Poor access to information on local antibiotic resistance patterns	16 (12.5%)	26(20.8%)	75(60.4%)	8(6.3%)
Lack of guidelines on antibiotic usage	16 (13.3%)	30 (24.4%)	63 (51.1%)	15 (11.1%)
Random mutations in microbes	30 (24.5%)	63(51%)	28(22.4%)	3(2%)
Patient's demands and expectations for antibiotics	28 (22.9%)	44 (35.4%)	44 (35.4%)	8 (6.25%)
Use of antibiotics in livestock industry	17 (13.4%)	37 (29.9%)	63 (50.7%)	7 (6%)
Role of pharmaceutical companies in advertising and promoting use of antibiotics	18 (14.7%)	26 (20.6%)	75 (60.3%)	5 (4.4%)

3.4 Mechanisms of Antibiotic Resistance

Half of the respondents (52.2%) reported knowing the mechanisms of antibiotic resistance while 47.8% had no prior knowledge. The respondents with prior knowledge were asked to outline the mechanisms involved and the correct answers obtained include mutations (56.3%), efflux pumps (34.7%) and modification of binding sites (1.5%). The wrong responses obtained included formation of spores, taking drugs without food, drug interactions and taking drugs with a lot of water which accounted for 7.5%.

3.5 Drivers of Antibiotic Resistance

The respondents with knowledge of the drivers of antibiotic resistance accounted for only 23.5% and those without any knowledge accounted for 76.5%. Some of the correct answers given included fake drugs, self-medication, inappropriate drug usage, inappropriate practices and absence of clinical guidelines.

3.6 Drugs That Have Become Ineffective Due to Antibiotic Resistance

The study found out that 75.4% of the respondents with knowledge on antibiotic

resistance reported knowing drugs that had become ineffective due to antibiotic resistance. The examples given included ciprofloxacin, amoxicillin, chloramphenicol and 24.6% of the respondents had no knowledge of any drugs that had become ineffective due to antibiotic resistance.

3.7 Knowledge of Drug Resistant Bacteria

Of the 124 participants, only 54.8% had knowledge of drug resistant bacteria and 45.2% didn't have any knowledge. The examples of drug resistant bacteria given included *Staphylococcus aureus*, *Neisseria gonorrhea*, *Mycobacterium tuberculosis* and *Streptococcus pneumoniae*.

3.8 Potential Interventions for Antibiotic Resistance

Respondents were asked to rate the usefulness of the different potential interventions for antibiotic resistance and the responses ranged from minimally important to very important. A provision of "don't know" was also included (Table 3).

Table 3. Showing potential antibiotic intervention and responses

Potential intervention	Minimally important	Moderately important	Very important	Don't know
Antibiotic restriction	11 (8.85%)	37 (29.85%)	70 (56.7%)	6 (4.5%)
Regular microbiological consultations/ ward rounds	15(11.9%)	20 (16.4%)	87(70.1%)	2 (1.5%)
Improving access up-to-date information on local antibiotic resistance patterns	0	12 (9.4%)	103 (82.8%)	9 (7.8%)
Ongoing education programme on appropriate antibiotic use	2(1.8%)	7(5.3%)	111(89.5%)	4 (3.5%)
Antibiotic recycling	27 (22.0%)	55 (44.1%)	26 (20.6%)	16 (13.2%)
Use of guidelines for use of antibiotics for common infections	9 (7.6%)	23 (18.2%)	88 (71.2%)	4 (3.0%)

3.9 Prescribing Practices in Relation to Antibiotic Resistance

Respondents answered questions related to the prescribing of antibiotics in the treatment of various infections and these are summarized below.

	Yes (%)	No (%)
Respondents who recommend use of antibiotics for common cold and cough	79(64)	21 (36)
Respondents who recommended use of antibiotics for viral infections	55(44)	69 (56)
Respondents who follow clinical guidelines when prescribing antibiotics	98 (79)	26 (21)
Have you ever heard of antibiotic resistance	93 (75)	31 (25)
Do you always take full course of medication?	93 (75)	31 (25)
Do you consult medical personnel before start of any medication?	97 (78)	27 (22)
Do you stop taking antibiotics when the symptoms are improving?	46 (37)	78 (63)

Although most of the health workers (65%) preferred to seek medical care from hospitals, a considerable proportion preferred to buy their drugs over the counter in drug shops and pharmacies (20%) (Fig. 3).

Over 50% of the primary health care workers report prescribing treatment after receiving a

laboratory report whereas more than 10% would not wait for the laboratory result.

Only half of respondents reported using guidelines in choosing the antibiotics. Availability, price and the severity of the disease were the other crucial factors considered in the choice of the antibiotics.

3.10 Qualitative Data on Prescribing Practices

3.10.1 Response to failure of treatment

When asked what they would do if a patient failed to respond to treatment, respondents suggested change of treatment repeating laboratory tests carrying out further investigation consultation and referral.

3.10.2 Mechanisms and drivers of antibiotic resistance

Most of the respondents were completely ignorant about the drivers of antibiotic resistance especially those with lower training, which includes nurses, nursing officers and midwives amongst others. Those of higher cadres like medical officers had a better understanding.

3.10.3 Mitigation of antibiotic resistance

Respondents were of the view that strong policies, more funding of research education, guideline compliance, performing laboratory tests and completion of treatment were ways of mitigating the problem of antibiotic resistance.

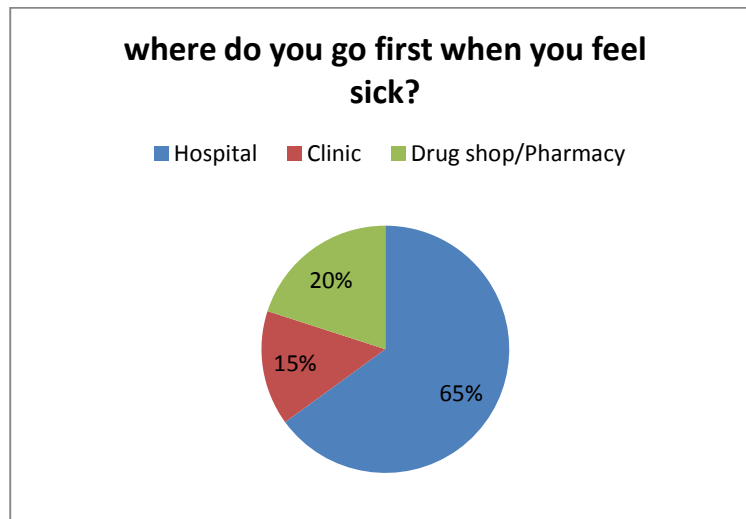


Fig. 3. Treatment seeking behaviors

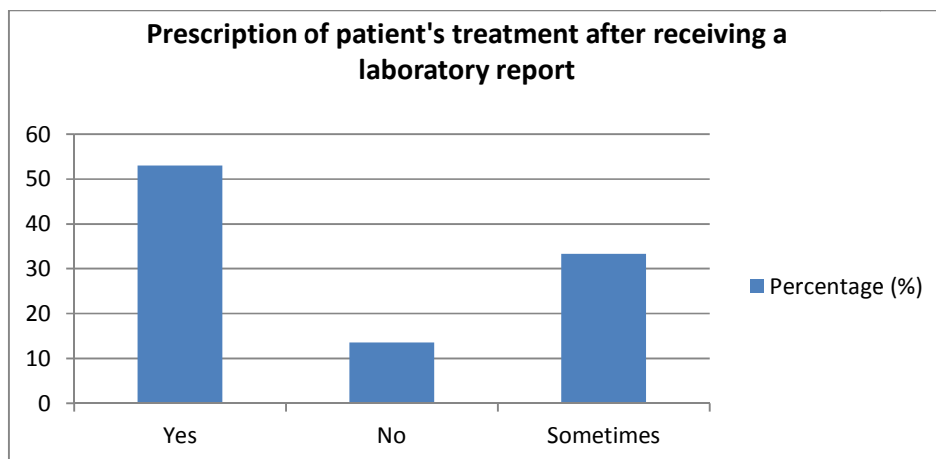


Fig. 4. Prescription of patient's treatment after receiving a laboratory report

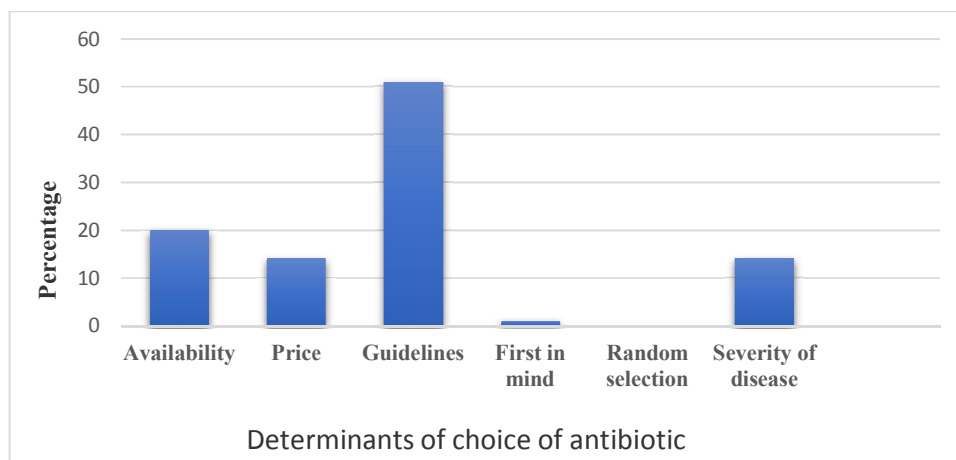


Fig. 5. Respondents' choice of antibiotics

Most of the respondents acknowledged that factors such as the wide spread use of antibiotics, the inappropriate use of antibiotics, poor hygiene, the lack of proper and implantation of guidelines on antibiotic usage, and the patients' demand and expectation for antibiotics as key contributors to antibiotic resistance.

4. DISCUSSION

4.1 Socio-Demographic Characteristics

The number of health workers has increased steadily in South Africa and Botswana since 2000 – meeting WHO targets. However, Sudan, Mali and Uganda still has a critical shortage of health workers since 2004 [9]. Though there is an intention to provide primary care services outside hospitals in Uganda evidenced by many buildings of health centre IIs, IIIs and IVs, they are not adequately staffed and often do not provide comprehensive primary care services. The Uganda health system is organized in a hierarchical manner according to the population they serve. National Referral Hospitals (30,000,000 population), Regional Referral Hospitals (2,000,000 population), District Health Services (District level, 500,000 population), Referral Facility - General Hospital (District level - 500,000 pop) or Health Centre IV (Country level - 100,000 pop), Health Sub-District level (70,000 population), Health Centre III - (sub-country level - 20,000 population), Health Centre II - (Parish Level - 5,000 population) and Health Centre I - (Village health Team - 1,000 population) [10]. Most of the staff are nurses and only two doctors. Most staff have less than five years of practice and none had extra training in microbiology/infectious diseases Table 1). Health worker density is not increasing in the lowest income countries because population growth is clearly outstripping growth in numbers of health workers [11] This situation is also common to many African countries [11]. Although training initially helped to improve health worker density, other measures are also needed to attain targets in low-income countries. Currently, most doctors trained in Uganda do not stay to work in government health services in their country, let alone in primary health care. Poor retention of doctors is attributed to insufficient resources spent on recruiting or retaining them, and they would face a poor working environment, difficult living experiences and a poor career path [12]. Health workers migrate to better paid jobs, either within their country or abroad [13]. Wealthier countries within Africa employ health workers

from lower income countries. In Uganda, a survey of alumni from Mbarara University of Science and Technology, which was set up in 1989 to train doctors for community health work, has shown that only 35% of its 790 medical graduates are currently working for the government, while 51% are working for HIV/AIDS-related non-governmental organizations (NGOs) and 12% have left the country [14]. Inadequate staffing in general and critical shortages of doctors may contribute to the high burden of antimicrobial resistance directly or indirectly.

4.2 Knowledge and Perceptions About Antibiotic Resistance

Most respondents (75%) reported having received some information about antibiotic resistance with school (67.2%) being the main source of information. Our findings are in agreement with studies done in Ethiopia on knowledge and beliefs in antimicrobial resistance among physicians and nurses in hospitals in the Amhara Region, Ethiopia. Similarly, the study in Ethiopia found that out of the 385 participants, 278 (72.2%) of the participants had received information on AMR [15].

Widespread use of antibiotics was believed to be important general causes of resistance to 66% of the participants followed by inadequate restrictions on antibiotic prescription and the role of pharmaceutical companies in advertising and promoting use of antibiotics (60%). Only half of the participants thought that inappropriate duration of antibiotic therapy, poor access to information on local antibiotic resistance patterns, use of antibiotics in livestock industry are useful intervention to decrease antibiotic resistance. The knowledge about antimicrobial resistance reported in this study is lower than the previous study from two tertiary care centers in Riyadh, Saudi Arabia and Malaysia [16], [7]. The difference in conclusion could be because the study in Saudi Arabia was done in a tertiary care center where the health workers are likely to be more knowledgeable about AMR than our centers which were set in rural health facilities. The Malaysian study was also done among final year students of medicine and pharmacy who are more likely to be more knowledgeable than health care workers in our rural setting with the low cadres dominating the system.

Only half of the health care workers had some knowledge on the mechanisms of drug

resistance. The respondents with some knowledge on the mechanisms of drug resistance could only identify mutations (56.3%), efflux pumps (34.7%) and modification of binding sites (1.5%) as responsible for drug resistance. The wrong responses obtained included formation of spores, taking drugs without food, drug interactions and taking drugs with a lot of water which accounted for 7.5%. Most respondents (76.5%) had no knowledge on the drivers of AMR. Some of the correct answers given included fake drugs, self-medication, misuse of drugs, weak practices and guidelines. The knowledge gaps existing among health workers highlight the need for further training in microbiology and infectious diseases.

Most respondents (75.4%) reported knowing drugs that had become ineffective due to antibiotic resistance. The examples given included ciprofloxacin, amoxicillin, chloramphenicol. The rest of the participants (24.6%) had no knowledge of any drugs that had become ineffective due to antibiotic resistance. Furthermore, 45.2% could not identify any bacteria that are known to have developed drug resistance. The correct examples of drug resistant bacteria given included *Staphylococcus aureus*, *Neisseria gonorrhea*, *Mycobacterium tuberculosis* and *Streptococcus pneumoniae*.

Our findings differ from those of the population from developed countries like Sweden whose knowledge of when antibiotics should be used as well as the risk of antibiotic resistance was good and homogeneous [17]. The knowledge difference between developed and developing countries may be explained by better financing of health care and availability of information on AMR in the developed world as opposed in developing countries.

4.3 Sources of Information Regarding Antibiotic Resistance

Whereas school was the main source of information about AMR (67.2%), the percentage of knowledgeable students should be increased with better education during medical training. This can be done through incorporating AMR in the curriculum of all health professional's training schools. Like other studies, the core of knowledge about anti-bacterial resistance was acquired during their formal training [18]. There is also need to increase awareness about AMR through audio, audio-visual and print media. Television. which currently attracts a lot of

viewership is less often used as a means of dissemination of information about antibiotic resistance (1.6%). The sources of information on antibiotic use and resistance among the prescribers in Ghana included email alerts from platforms they subscribe to, lectures at general meetings of professional associations, books, and Ghana Health Service/Food and Drugs Board (GHS/FDB) bulletin or circulars which were not common to our study population in Uganda [18].

4.4 Potential Interventions for Antibiotic Resistance

Most of health care workers believed that ongoing education programme on appropriate antibiotic use, improving access up-to-date information on local antibiotic resistance patterns, use of guidelines for antibiotics for common infections and regular microbiological consultations/ward rounds (89.5%, 82.8%, 71.2%, and 70.1%), were very important in controlling the problem of AMR. Antibiotic restriction and antibiotic recycling were also identified as very important by 56.7% and 20.6% of the people respectively.

4.5 Prescribing Practices in Relation to Antibiotic Resistance

Though majority of health workers reported following clinical guidelines when prescribing antibiotics (79%), a considerably substantial proportion of workers recommended use of antibiotics for treatment of common cold and cough (64%) and for treatment of viral infections (44%). On the contrary, only one-fifth of respondents in a study in Sweden agreed that common colds are cured more quickly with antibiotics, which is the same level as is reported in the Netherlands [19] and Australia [20]. This difference could be due to poor access to information in the developing world.

5. CONCLUSIONS

The awareness of anti-microbial resistance is low in rural Eastern Uganda. Campaigns for rational prescribing of antimicrobials should include directing information at the public aiming to increase awareness of resistance in the public and the rural health care work force. The health care work force in rural Eastern Uganda is dominated by the low cadres with generally poor understanding of antibiotic resistance.

6. RECOMMENDATIONS

Periodic evaluation of antibiotic resistance patterns should be practiced by co-ordinating with the practising laboratories and be made available to Primary health care workers. We also recommend topics related to antimicrobial resistance to be incorporated in the training curricula of all medical training institution to improve awareness of the problem, continuous medical education on antimicrobial resistance and to ensure availability of information on antimicrobial resistance on local media in Rural Eastern Uganda.

CONSENT AND ETHICAL APPROVAL

The study sought for approval from the institutional review board of Busitema University, district and community leaders granted permission and at an individual level, written consent was obtained from each participant before data collection. Respondents received a detailed description of the research, confidentiality provisions and the fact that their participation was voluntary and that they could withdraw at any point if they so deemed. The principles of privacy and confidentiality were upheld.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Gootz T. The global problem of antibiotic resistance. *Crit Rev Immunol*. 2010;30:79–93.
- Zhabiz Golkar OB, Donald Gene Pace. Bacteriophage therapy: A potential solution for the antibiotic resistance crisis. *J Infect Dev Ctries*. 2014;8(2):129-36.
- Gould IM, Bal AM. New antibiotic agents in the pipeline and how they can help overcome microbial resistance virulence. 2013;4:185-91.
- Carlet J. Antibiotic resistance: Protecting antibiotics - The declaration of the world alliance against antibiotic resistance. *Indian J Crit Care Med*. 2014;18:643-5.
- Jordi VaTP. Update on antibacterial resistance in low-income countries: Factors favoring the emergence of resistance. *The Open Infectious Diseases Journal*. 2010;4:38-54.
- Kariuki S, Dougan G. Antibacterial resistance in sub-Saharan Africa: An underestimated emergency. *Ann NY Acad Sci*. 2014;1323:43–55.
- Shazia Qasim Jamshed RE, Kingston Rajiah, Abdul Kareem Al-Shami, Siti Hadijah Shamsudin, Mohammad Jamshed Ahmad Siddiqui, et al. Understanding of antibiotic use and resistance among final-year pharmacy and medical students: A pilot study. *J Infect Dev Ctries*. 2014;8(6):780-5.
- Ampaire L, Muhindo A, Orikiriza P, Mwanga-Amumpaire J, Bebell L, Boum Y. A review of antimicrobial resistance in East Africa. *African Journal of Laboratory Medicine*. DOI:http://doi.org/10.4102/ajlmv5i1432. 2016.
- Willcox ML, Peersman W, Daou P, Diakit  C, Bajunirwe F, Mubangizi V, Mant D. Human resources for primary health care in sub-Saharan Africa: progress or stagnation? *Human Resources for Health*. 2015;13:76. DOI:http://doi.org/10.1186/s12960-015-0073-8.
- Ministry of Health. Inventory of Health Institutions in Uganda, Kampala: Ministry of Health; 2000.
- Kinfu Y D, Poz MR, Mercer H, Evans DB. The health worker shortage in Africa: Are enough physicians and nurses being trained?. *Bull World Health Organ*. 2009;87:225–30.
- Moosa S WS, Hoffmann K, Poppe A, Nkomazana O, Peersman W. Why there is an inverse primary-care law in Africa. *Lancet Global Health*. 2013;1:e:332–3.
- Moosa S WS, Hoffmann K, Poppe A, Nkomazana O, Peersman W. The inverse primary care law in sub-Saharan Africa: a qualitative study of the views of migrant health workers. *Br J Gen Pract*. 2014;64:e:321–8.
- Bajunirwe F TL, Zhang M, Kerry VB, Bangsberg DR. Influence of the US President's Emergency Plan for AIDS Relief (PEPFAR) on career choices and emigration of health-profession graduates from a Ugandan medical school: A cross-sectional study. *BMJ Open BMC Health Serv Res* 2017 Jun 20. 2017;17(1):422.
- Abera B, Kibret M, Mulu W. Knowledge and beliefs on antimicrobial resistance among physicians and nurses in hospitals in Amhara Region, Ethiopia. *BMC*

- Pharmacology and Toxicology. 2014;15(1): 26.
16. Adel Alothman A, Algwizani, Mohammed Alsulaiman, Abdullah Alalwan, Salih Binsalih, Mohammad Bosaeed. Knowledge and attitude of physicians toward prescribing antibiotics and the risk of resistance in two reference hospitals. Infectious Diseases: Research and Treatment. 2016;9:33–8.
 17. Malin Andre´ AV, Johanna Berg, Cecilia Stalsby Lundborg. A survey of public knowledge and awareness related to antibiotic use and resistance in Sweden. J Antimicrob Chemother; 2010.
 18. Asante KP BE, Abdulai MA, Buabeng KO, Mahama E, Dzabeng F, Gavor E, Annan EA, Owusu-Agyei S, Gyansa-Lutterodt M. Knowledge of antibiotic resistance and antibiotic prescription practices among prescribers in the Brong Ahafo Region of Ghana; A cross-sectional study. Ghana Antimicrobial Resistance Working Group. 2013;3. BMC Health Serv Res. 2017;17(1):422.
 19. Cals JW BD, Lardinois RJ. Public beliefs on antibiotics and respiratory tract infections: An internet-based questionnaire study. Br J Gen Pract. 2007;57:942–7.
 20. Wutzke SE AM, Kehoe LA. Evaluation of a national programme to reduce inappropriate use of antibiotics for upper respiratory tract infections: Effects on consumer awareness, beliefs, attitudes and behaviour in Australia. Health Promot Int. 2007;22:53–64.

© 2017 Amelia et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sciencedomain.org/review-history/23005>