Kingston University London

FACULTY OF SCIENCE, ENGINEERING AND COMPUTING

School of Life Sciences, Pharmacy and Chemistry

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Jasmine Bagri

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Perceptions of use and efficacy of antimicrobials by the public, farmers, medical and Veterinary professionals.

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Professor Mark Fielder, Professor Philip Terry, Dr Simon Gould

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Abstract

Background: Antibiotic resistance is now a global threat due to the misuse of antibiotics worldwide in both human and animals medicine.

Objectives: The main aim of this research is to look at how antibiotics are used and perceived by different groups of individuals; Agriculture, veterinary, medical and the public in order to identify areas where more resources are required.

Sources of data: A questionnaire was circulated online for participants to complete anomalously.

Results: The questionnaire was completed by a total of 874 participants globally with the majority from the UK. Results of the listed diseases were sub-divided in categories; viral, bacterial, pathogenic and syndromic. Of the viral diseases 'foot and mouth disease' showed the highest 'Yes' response with 17% (152) with the public being the highest groups. Both MRSA 23% (204) and Salmonella 22% (196) were the highest bacterial diseases that participants stated couldn't not effectively be treated with antibiotics, in response to salmonella almost a quarter were from medical professionals.

Conclusion: Results from this questionnaire give an insight in to how antibiotics are used by different groups of individuals and their understanding of the development of resistance. This provides a platform to further develop specific areas that can be targeted. For example, education is a continual part of the process of reducing the uses of antibiotics.

Introduction

Background of the topic

Antibiotics have been in medical use since 1928 when Sir Alexander Fleming first discovered the revolutionary drug penicillin (Ventola, 2015), over the following years more were discovered and through modern day medicine have become more accessible (Ventola, 2015). However in turn there has been an increase in antimicrobial resistance (AMR) in the years following up until today (O'Neill, 2014).
AMR occurs when a microorganism becomes resistant to the effect of the drug used to kill or inhibit the organism, this then leaves the microbe able to survive and spread, allowing the clonal expansion of the resistant gene (Anon, 2017). Despite there being a number of reports previously published on antimicrobial resistance and the potential effects for some time, AMR is still an ongoing global threat (Rather et al, 2017), with the chief medical officer Dame Sally Davies adding AMR to the UK's risk register (Kissel et al, 2013).

Not only have antibiotics been used to save millions of patients' lives but have also played an important role in facilitating major advances in medicine and surgery (Ventola, 2015). Antibiotics have prevented and/or treated infections that can occur in chemotherapy patients, patients with chronic diseases such as diabetes as well as surgeries such as organ transplants, joint replacements or cardiac surgery (Ventola, 2017). With an increase of other conditions such as diabetes and obesity, more people are becoming susceptible to infections which in turn means a potential increase in the number of antibiotics required (Anon (1), 2017). Other consequences might include the possibility of treatment failure, increased hospitalisation and prolonged illness (Anon (2), 2017). AMR already presents serious social and economic burdens. It is estimated to be responsible for 25,000 deaths annually in the EU, it is projected that AMR will cause 10 million deaths globally and cause more deaths than cancer by 2050 (O'Neill, 2014). Antibiotic resistance, as previously stated is a global health issue as well as a one health issue yet people are still not fully aware of the potential threat at both individual and community level (Rather, 2017). In 1943 it was noted by Sir Alexander Fleming that microbes were 'educated' to resist penicillin (Gould et al, 2013), when penicillin resistance first became an issue in the 1950s.

Although finding a new class of antibiotics will help with the treatment of bacterial infections, resistance will still occur in years to come, therefore it's important to change the uses and perceptions of how antibiotics are used.

Antibiotics are not only important in human medicine but also play an important role in agriculture and veterinary medicine, it is therefore important have to a good understanding as to how antibiotics are perceived and used in these different areas. This research will focus on the perceptions and uses of antibiotics in humans medicine alongside agriculture and veterinary medicine showing the importance of 'One Health'.

Antibiotic use Human Medicine

The European Antimicrobial Resistance Surveillance Network (EARS-net) reports on levels of multidrug resistance of the following pathogens*, Enterococcus* spp*., Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumanii, Psedudomonas b aeruginosa* and *Enterobacteriaceae* resistant to cephalosporin's, quinolones, and carbapenems (McKenna, 2013).

In hospitals, some of the most commonly found resistant bacteria include *Escherichia coli, K. pneumoniae, Ps. aeruginosa, S. aureus* and *Acinetobacter* species (ECDC, 2016). Hospital acquired infections (HAI) are been recognised as a critical problem, affecting the quality of healthcare (Cornejo-Juarez et al, 2015). The emergence of multidrug resistance bacteria (MDRB) has developed into a public health concern particularly for those patients admitted to intensive care units (Cornejo-Juarez et al, 2015).

In 2016 it was estimated by the World Health Organisation (WHO) there were 490 000 new cases of Multi Drug Resistant-Tuberculosis (MDR- TB), with only 25% of these cases detected and reported. This form of Tuberculosis (TB) is resistant to the two commonly used anti-TB drugs, rifampicin and isoniazid the most effective first-line drug. Treatment of MDR-TB is now longer and not as effective as it once was as non- resistant TB, of all new cases reported MDR-TB has increased by 4.1% in 2016 (WHO, 2018). In the last 70 years, only 2 new TB drugs have come to market, research and development (R&D) investment into TB drugs is underfunded and at its lowest since 2008 (WHO, 2017) showing more funding is needed in research to help protect future lives against infections such as MDR-TB.

Several distinct classes of antibiotics were discovered in the 1950s and 1960s, however very few new classes have successfully been bought to market in recent years (WHO, 2017). Within the past 10 years there has only been 2 new antibiotics that have come to market, Telavancin and Ceftaroline Fosamil (Brooks, 2014). Telavancin, part of the vancomycin class of antibiotics is used to treat infections with Gram positive organisms such as Methicillin-resistant *Staphylococcus aureus*. Ceftaroline fosamil, a fifth-generation cephalosporin is also used to treat Gram positive infections (Rodvold, 2015), whilst both are useful drugs the real challenge is to find antibiotics that work against Gram-negative bacteria, this has been identified as a critical priority by The World Health Organisation (WHO) (Table 1).

Table 1. Prioritization of different pathogens and their resistance (WHO, 2017)

	Pathogen	Resistance
Critical Priority	*Acinetobacter baumannii*	Carbapenem resistance
	Pseudomonas aeruginosa	Carbapenem-resistant
	Enterobacteriaceae	Carbapenem-resistant 3rd gen. Cephalosporin-resistant
High Priority	*Enterococcus faecium*	Vancomycin-resistant
	Staphylococcus aureus	Vancomycin-resistant Methicillin-resistant
	Helicobacter pylori	Clarithromycin-resistant
	Campylobacter species	Fluoroquinolone-resistant
	Salmonella species	Fluoroquinolone-resistant
	Neisseria gonorrhoeae	3rd gen. Cephalosporins- resistant Fluoroquinolones resistant
Medium Priority	*Streptococcus pneumoniae*	penicillin-non-susceptible
	Haemophilus influenzae	ampicillin-resistant
	Shigella species	Fluoroquinolones resistant

With increased political commitment to decrease antimicrobial resistance at a global, regional and nation level, the sixty-eighth World Health Assembly have endorsed the Global action plan to promote the development of new antibiotics. The aim of the Global action plan to ensure the continued availability of treatment options, one of the main objectives of the plan is to increase the R&D for new antibacterial treatments, this however cannot solely be resolved by the development of a single antibiotic but an ongoing program of drug discovery going forward (WHO, 2017).

Antibiotic Use in Agriculture and Aquaculture

Up to 70% of all antibiotics globally are consumed by animals, compared to the 30% consumed by humans (O'Neill, 2015) with such a high proportion it is fundamental to understand why this is to aid in the reduction of AMR. However due to poor surveillance and data collection in many countries it is difficult to know the total annual global consumption of antibiotics in agriculture, estimates range from 63,000 tonnes (Van Boeckel, 2015) to over 240,000 tones (Delia, 2015).

There are three main reasons as to why antibiotics are used in agriculture, firstly the treatment of disease in sick animals, secondly antibiotics are also used as a prophylaxis, this is when antibiotics are given to healthy animals to prevent diseases during illness in the herd and finally antibiotics are used as a growth promoter given to healthy animals to increase feed-to gain efficiency, by preventing infection so growth of the animals is not impended (O'Neill, 2015). Use of antibiotics as growth promoters was banned in the EU in 2006 (Scarafile, 2016).

There appears to be major knowledge gaps about the extent of antimicrobial that are used in livestock globally, relatively few countries have surveillance systems monitoring the quantity of antimicrobials used in food producing animals. A survey conducted by the World Health for Animal Health the Oficina International de Epizootias (OIE) in 2012, found only 27% of OIE member counties utilized an official system for collecting data on antimicrobial use in livestock (Teillant, 2015). Better surveillance would help pinpoint areas where the use

of antibiotics could be reduced. What is known is the antibiotics that are used in animals, whilst some of the antibiotics used are not current treatments in human medicine, others such as tetracycline, penicillin and sulfonamides are used in the treatment of human diseases (Landers, 2012). Of the 41 antibiotics approved for use by the FDA in food producing animals in the USA, 31 of those are categorised as being medically important for human use (O'Neill, 2015). This shows the importance of 'One Health', a principle that recognises human, animal health and the environment as being interconnected and that diseases transmitted from humans to animals and *vice versa* are tackled together rather than being treated as two separate issues (WHO, 2017).

Its estimated that the global consumption of antibiotics will increase by 67% from 2010, 2030, with consumption amongst BRIC (Brazil, Russia, India and China) countries increasing by 99% in that same time (O'Neill, 2015). Highlighting why it is so important to understand how antibiotics are being used to help prevent such a high increase.

The use of antibiotics in aquaculture and its impact on the environment is an ongoing and growing concern (Watts et al, 2017). Being able to identify the amount of antibiotic being passed into the environment is very difficult, just like the use of antibiotics in food production, there is a need for better data (O'Neill, 2015). The use of antibiotics within aquaculture can be reduced as has been shown in Norway (Anon, 2016), a reduction of 99% between; 1987-2013 was achieved by improving farm hygiene. This was achieved with better selection of farm sites where there was good water exchange (Anon, 2016), and with stricter regulations, from 1989 it was mandatory to show copies of prescriptions issued to fish farmers to the Norwegian Government Fish Inspection and the Quality control service (O'Neill, 2015). This shows that reduction in the use of antibiotics can be achieved with better regulation enforced by government.

Antibiotic use in Veterinary Medicine

Antibiotics in veterinary medicine are widely used for therapeutic, metaphylactic or prophylactic treatment of bacterial infections (Hughes, 2012). Whilst there is data presented on the sales of antimicrobials in veterinary medicine by the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) and the Veterinary Medicines

Directorate (VMD) in the UK little information is provided about the diseases that the antimicrobial are being prescribed for and nothing about the actual amount given to the animal (Briyne, 2014).

The use and misuse of antibiotics in animals potentially contributes to the development of AMR, one reason for this is due to the failure of ensuring that drugs are only used in accordance to the principals of the 'ethical veterinary practice'(Donaldson, 2009). It has been suggested that the use of some antibiotics such as cephalosporin's and fluoroquinolones should be banned in use of animals to preserve their use in human medicine (Donaldson, 2009).

The use of antimicrobial agents are frequently prescribed to animals such as cats and dogs, there is evidence to suggest a link between this treatment and the development of resistance (Singleton et al, 2017). Clavulanic acid potentiated amoxicillin was the most frequently prescribed antimicrobials agent in dogs and among cats cefovercin was one of the most common prescribed (Singleton et al, 2017). For rabbits, it was found that the most common antimicrobial used were Fluoroquinolones, which is commonly used in humans (Radford et al, 2011). There are also concerns on antibacterial use in veterinary teaching hospitals showed that antibacterial usage is common with amoxicillin the most frequently prescribed antibacterial in most countries (Radford et al., 2011).
To date, there are limited studies based in the UK regarding how antimicrobials are used in veterinary practices. There are also concerns over the use of antimicrobials in situations where bacterial infections are unlikely, inappropriate duration and drug choice as well as incorrect dosages (Hughes, 2012).

The public perceptions on the use and misuse of antibiotics.

Due to research, more is known in terms of uses of antibiotics in humans compared to that in agriculture and veterinary medicines, both survey research and qualitative research shows that there is generally limited understanding and awareness of antibiotic resistance (Brookes-Howell et al, 2011). To go forward and educate the public it is important to gain an understanding of the level of public understanding and attitudes towards antibiotics and antibiotics resistance (Napoliano, 2013). A high proportion of antibiotics used in human

health are prescribed by General Practitioners (GPs) (Llor, 2014). A recent study based in the UK, showed that 55% of GPs felt under pressure to prescribe antibiotics by patients, a further 44% of GPs also admitted that they prescribed antibiotic to make patients leave the surgery (Cole, 2014). The question might be asked that if patients were more aware of how antibiotics work and why they are prescribed, then patients may be less inclined to asked GPs to prescribe them. To help reduce AMR it is important that stakeholders and users have some understanding of what AMR is, and the implications this has on the treatment prospect going forward as antibiotics are believed to be quick and effective treatment by the public (Michael, 2014). However, members of the public are not aware that antibiotics are only effective against bacteria and not viruses such as the common cold (Al-Haddad et al, 106). A study found that 10.5% of respondents expected to be prescribed a course of antibiotics for a common cold (Gualano et al, 2015). Another contributing factor is when patients don't complete their course of antibiotics. One study showed that 11.3% of respondents did not compete their prescribed course of antibiotics, when asked why, 65% responded stating they stopped when they either felt better or forgot to take the medication (McNulty et al, 2007). This shows more education is required for the public to understand the effectiveness and correct uses of antibiotics.

Self-medication with antibiotics with and without prescription.

Self-medication with antibiotics is clearly an important issue, it is one of the most common reasons for the development of human pathogen resistance to antibiotic drugs (Michael et al, 2014). Therefore, it is important to spread more awareness among the public population about the adverse effects of antibiotic overuse (Rather et al, 2017). However, in some areas of the world self- medication is not by choice, recent studies have suggested that self-medication is more prevalent in economically deprived communities (Bennadi, 2014), these also are potentially areas where antibiotics can be sold legally without a prescription (Morgan et al, 2011). These are areas where better regulations are needed with the help of the government to prevent the incorrect use of antibiotics. For antibiotics to work, the correct class of drug needs to be prescribed along with correct dose and duration against a known and identified organism. This is a specific point of requirement detailed in Lord O'Neill's AMR Review publication, if these factors are not considered the antibiotics may have, at best, limited affect and could lead to the development of resistance. Common

sources of self-medication are from previous prescriptions, friends and information from news articles (Bennadi, 2014).

Policies in place to reduce AMR

In 2013, the UK Government released its 5-year strategy to reduce the number of antibiotics used, this included, in people, agriculture, animals and wider environment. However, it failed to provide specific guidelines for reducing farm antibiotic use, the strategy only contained general advice for farmers and vets, leaving it to the farmers themselves to decide on what is the correct form of treatment. (DoH, 2015).

'A European One Health Action Plan against Antimicrobial Resistance' also known as 'One Health' has the main goal to preserve the effective treatment of infections in both humans, animals and the environment. Key objectives include making the EU a best practice region, this includes better surveillance and implementing monitoring programs. Boosting research, and finally to ensure this is on a global level not just among the EU (Anon (3), 2017). It is important that human and animal health are recognised as one, they are interconnected so should therefore be tackled as one (Anon (3), 2017).

In 2016 antibiotic use in food producing animals dropped by 27% in the UK, a target was set by the government to reduce antibiotic use from 62mg/Kg to 50mg/kg, this target was exceeded and reduced to 45mg/kg following the recommendations from the 2016 report on Antimicrobial resistance by Lord Jim O'Neill (Anon (3), 2017).

In the UK sales of Colistin in human health, considered as one of the critically important treatments have dropped by 83% now accounting for less than 1% of all antibiotics sold for use in humans in 2016 (anon, 2017).

Aims

The current study will look at the uses and perceptions of antibiotics in agriculture, by veterinary and medical professionals, farmers and the public. The data was collected through an online questionnaire filled out anonymously by the. The questions are intended to probe how each of these sector group uses and perceives the value of antimicrobials, the results will allow an indication of what areas needs addressing in terms of training/ guidance/ education both in terms of what stakeholders already know but also how the

relevant information might be delivered. From a One Health perspective, it is important that not only are the considerations in human medicine discussed but also animal medicine and how that might impact the wider environment all with focus improving the understanding antibiotic resistance to stakeholder groups.

Methods

A questionnaire (Appendix 1.1) was used to evaluate the use and opinions on antibiotics and antibiotic resistance of the participants. The questionnaire was created in a computer based software called Qualtrics, this was also the same platform where participants answered the questionnaire. The questionnaire was open to anyone that gained access to the webpage link provided link. The questionnaire was open from April 2017- October 2017, distribution of the questionnaire was via social media applications such a Facebook, twitter and LinkedIn with an anonymous web link, business cards were also created with a link and QR code, these were handed out at various conferences (American Society for Microbiology (ASM) Annual Conference 2017 and Society of Applied Microbiology (Sfam) Conference 2017). Veterinary practices in the Surrey/ London area were also contacted via e-mail as well as some governing bodies.

Questions 1-7 were aimed to gain an understanding the participants' general understanding of antibiotics and antibiotic resistance. Questions 8- 12 were aimed to gain the participants level of knowledge of antibiotics and antibiotic resistance. Question 13 involved a list of diseases where the participants were asked if antibiotics could be used to effectively treat. Following on questions were more generic, asking more personal information such as age, gender, ethnicity, country of residence and medical science knowledge.

There were 24 questions to answer in the questionnaire taking approximately 10-15 minutes to complete.

Questions 1, 2, 3, 4, 5, 8, 11, 12, 15 were answered by response categories; "Yes", "No", "Not Sure'/ 'Don't Know"- participant were asked to select one answer.

Questions 6, 10 and 16 were answered by checking all responses that applied, participants could choose more than one response if they wanted to.

Questions 21, 22, 23, were answered by ticking a box based upon the response that relates to them the most.
Questions 7, 9 and 24 were answered by a numbers scale (e.g. On a scale of 0-4, “0” being no risk of harm to health, and to “4” being a high risk of harm to health). Participant were asked to tick a number depending on their answer.
Questions 7b, 14 and 20 were answered with participants being able to write their own response to the question.
Question 13 which involved a table of different diseases, participants responded by checking the boxes that reflected their response.
Questions 17, 18, 19 were answered by checking the box that depending on their response.

Participants were asked to complete the question in accordance to their own opinion. Participation was voluntary; before starting the questionnaire, participants were given a brief of the background (in the appendix 1.1) of why the survey was being carried out as well as a consent form, this stated that the questionnaire was anonymous, participants were asked at the end of the questionnaire to give a random phrase/number, so facilitating the participant’s removal from the questionnaire if required. A debrief was also given at the end of the questionnaire, this contained further contact details and external links if the participant wanted further information about antibiotic resistance. Ethical approval was obtained from Kingston University Ethics committee before the questionnaire could be distributed. This questionnaire was passed by the Ethical board at Kingston University (ethics approval number: 161716). Checks were undertaken that the questions were not misleading or biased and abided by ethics guidelines.

Data Analysis

Analysis of data was undertaken with the data being downloaded into Microsoft excel and then into SPSS (publishers name please). The main test used to analyse the data was a chi-square test as well as descriptive statistics – such as detail here please.

Questionnaire Results

Demographic Data

A total of 875 participants completed the questionnaire; 1 participant was removed as the answerers provided did not match their professional background. Results are split into 7 sections;

1. Participant characteristics
2. General questions relating to antibiotic use
3. Understanding of antibiotic resistance
4. Understanding of diseases
5. Source of information
6. Comparisons between Countries
7. Free text responses

Participant Characteristics

A total number of 874 participants are included, 57.5% (503) were female, 41.6% (364) were male, 0.5% (4) other and 0.3% (3) stated they would rather not say. The average age of participants was 42 years (Std.Deviation $\pm$12.8 years), the lowest age stated was 16 and the highest stated was 77, 10 of the respondents didn't state their age. Participants were also asked their religion; Table 2 shows the results of the religions of the participants. The Highest response to religion was 'No religion' followed by 'Christian'.

Table 2. Percentages of participants within each category of religious beliefs.

Religion	Number of Respondents
No Religion	512 (58.5%)
Christian	268 (30.7%)
Sikh	31 (3.5%)
Muslim	26 (3.0%)
Other	22 (2.5%)
Jewish	6 (0.7%)
Hindu	5 (0.6%)
Buddhist	4 (0.5%)

Participants were then asked their ethnicity, results showed; White 87.9% (768), Asian 7.4% (65), Mixed 2.1% (18), Other 1.7% (15) and Black 0.9% (8). The questionnaire reached over 20 countries as participants were asked their country of resident, results are shown in table 3. Table 3 shows countries with 4 or more participants, there were a further 18 countries with 3 or fewer participants. (Full list in appendix 1.1)

Table 3. The country of residence of the questionnaire participants

Country of Residence	Number of Respondents
UK	735 (84.0%)
USA	35 (4.0%)
Australia	21 (2.4%)
Canada	20 (2.3%)
Pakistan	8 (0.9%)
Netherlands	7 (0.8%)
Italy	5 (0.6%)
Germany	4 (0.5%)
New Zealand	4 (0.5%)
Spain	4 (0.5%)
Switzerland	4 (0.5%)

Finally, participants were asked their highest-level qualification, results showed ‘Graduate’ 37% (324), Postgraduate 36.5% (319), ‘A-levels/ BTEC level 3’ 16.2% (142), ‘GCSE’ 4.7% (41), ‘Other’ 3.9% (34), NVQ Level 3 1% (9) and ‘None’ 0.6% (5).

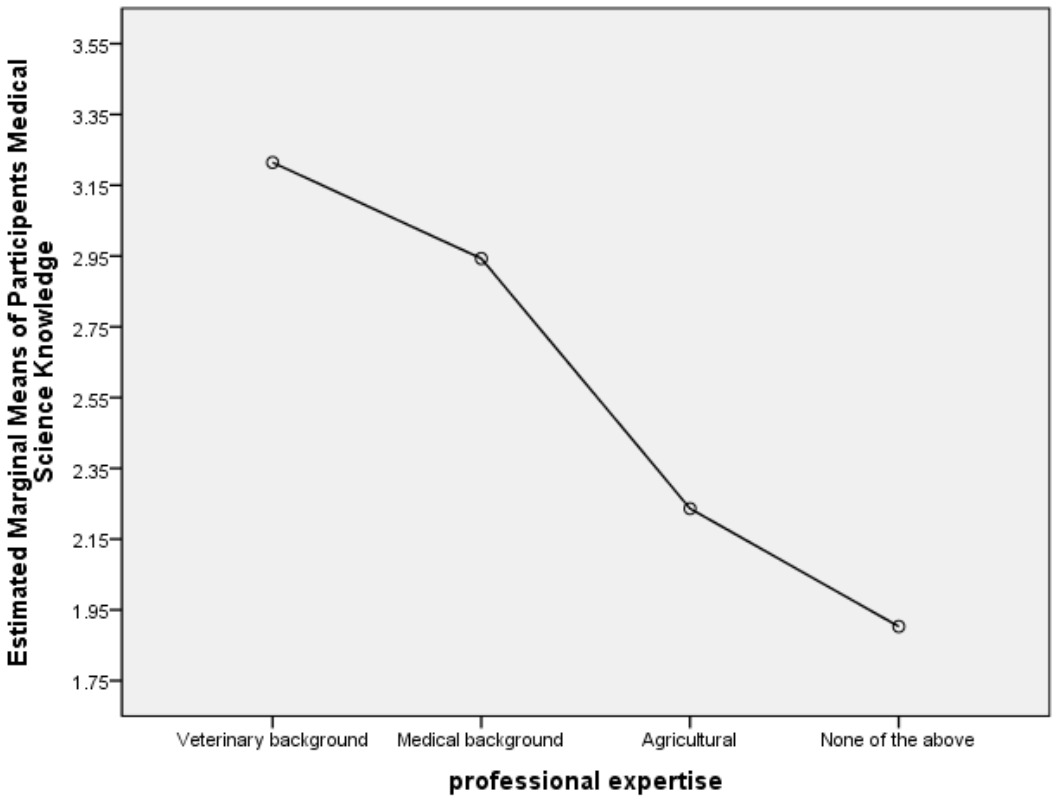
General questions relating to participants use of antibiotics

Respondents were asked a series of questions regarding their knowledge and usage of antibiotics, this section included the following questions;

1. On a scale of 0-5 (5 being the highest) rank your medical science knowledge
2. Have you previously taken antibiotics?
3. Did you finish the course of antibiotics?
4. Have you heard of antibiotics?
5. Do you feel antibiotics cause harm?

Participants were asked on a scale of 0 (being low) to 5 (being high) what they ranked their medical science knowledge as Figure 1 shows the means of participant's knowledge from the four different groups.

Figure 1: Responses of the four groups on their medical science knowledge showing the means of participants medical science knowledge



Responses from the four groups were significantly different (F= (3,870) = 99.46, p=0.000). Those with a veterinary background showed the greatest level of medical knowledge with a mean score of 3.2, (SD ±0.7) with the lowest being the public at 1.8. (SD ±0.8). Post hoc analysis showed a significant difference between: Veterinary background and agriculture: p=0.000; Veterinary background and public: p= 0.000; and Medical background and agriculture: p= 0.0000.

Participants were asked if they had previously taken antibiotics, different responses included, 'Yes', 'No' and 'Don't know'. Table 4 shows the responses from the four groups.

Table 4: Responses of the four professional groups on whether they had previously taken antibiotics

	Veterinary	**Medical**	**Agricultural**	**Public**
Yes	98.2% (55)	98.8% (173)	100.0% (55)	96.4% (567)
No	1.8% (1)	0.6% (1)	0.0% (0)	3.1% (18)
Don't know	0.0% (0)	0.6% (1)	0.0% (0)	0.5% (3)

(Number of participants shown in brackets)

Majority of participates that responded to this had previously taken antibiotics. A chi-square test was used to identify if there was a significant difference in responses across professional groups, in this case there was not a significant difference in how the groups responded to the question ($X^2(6) = 5.84$, $p<0.442$).

Following on, participants were then asked if they had finished their course of antibiotics, those respondents answered 'No' to having taken antibiotics were then asked to skipped to question 3. Responses to this question included, 'Yes', 'No' and 'Don't know'. Table 5 shows the results from this question.

Table 5: Responses of the four professional groups on whether they finished their course of antibiotics

	Veterinary	**Medical**	**Agricultural**	**Public**
Yes	92.8% (52)	92.6% (162)	92.7% (51)	90.0% (529)
No	3.6% (2)	5.7% (10)	7.3% (4)	5.3% (31)
Don't know	1.8% (1)	1.1% (2)	0.0% (0)	1.5% (9)
Question Skipped	1.8% (1)	0.6% (1)	0.0% (0)	3.2% (18)

Results showed no significant difference ($X^2(9) = 7.44$, $p<0.0591$) in responses across professional groups. Again, a high majority answered 'Yes' to finishing the course of antibiotics, the lowest response was from the public where 90.0% answered 'Yes'. Agricultural showed to have the highest response for not finishing the course of antibiotics followed by the medics and then the public. Although vets showed to have the lowest response for 'No', they had the highest response to 'Don't know' followed by the public and medical background. However, none of these differences were significant.
Participants were then asked if they had heard of antibiotic resistance, table 6 shows the results from the data.

Table 6: Responses of the four professional groups on having heard of antibiotics resistance

	Veterinary	**Medical**	**Agricultural**	**Public**
Yes	100.0% (56)	99.4% (174)	100.0% (55)	96.3% (566)
No	0.0% (0)	0.6% (1)	0.0% (0)	3.4% (20)
Not Sure	0.0% (0)	0.0% (0)	0.0% (0)	0.3% (2)

Results showed no significant difference between the response from the four groups ($X^2(6) = 8.75$, $p<0.188$), majority of all participants answered 'Yes' to having heard of antibiotic resistance.
Respondents were also asked if they felt that antibiotics cause harm, responses were recorded on a scale of 0 (being not harmful) to 5(being very harmful), results showed no significant difference ($F= (3,870) = 2.41$, $p<0.066$) from the responses from the different

groups. Majority of all participants from all four groups answered '1' on the scale indicating low levels of harm.

Table 7 shows the responses from the four groups to the question 'Are antibiotics an important part of medical treatment today?', responses included 'Yes', 'No' and 'Don't know.

Table 7: Responses of the four professional groups on whether the respondents think antibiotics are an important part of medical treatment.

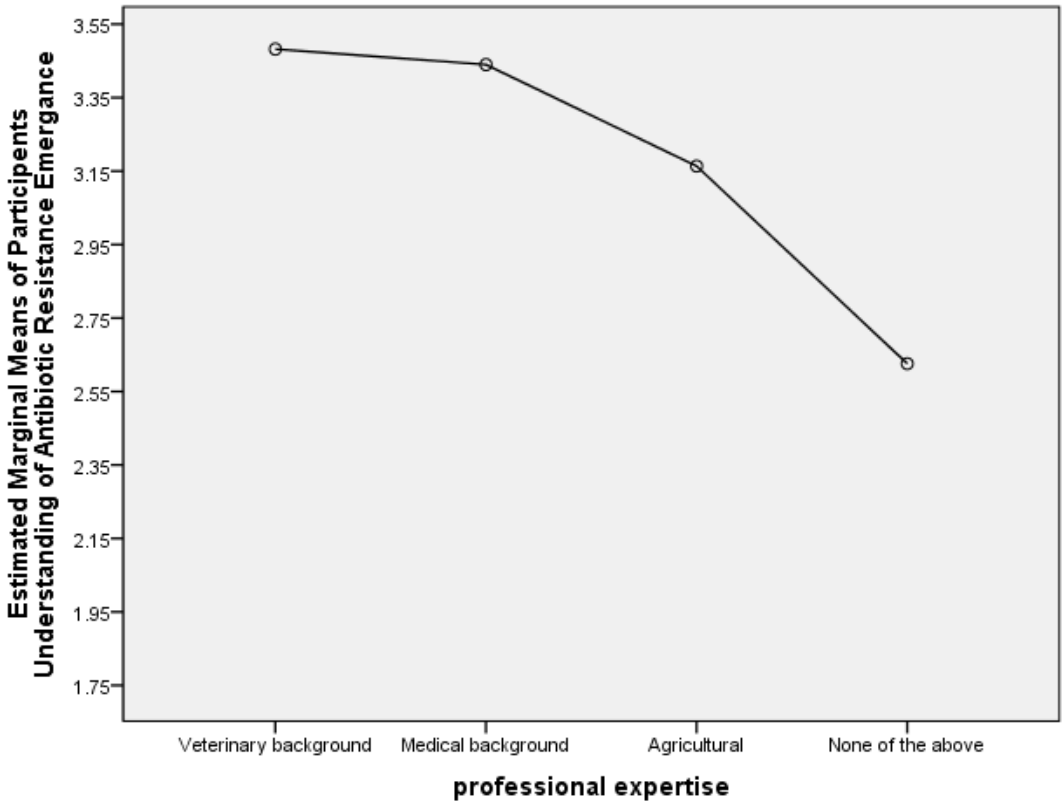
	Veterinary	**Medical**	**Agricultural**	**Public**
Yes	100.0% (56)	93.7% (164)	100.0% (55)	93.9% (522)
No	0.0% (0)	4.0% (7)	0.0% (0)	1.9% (11)
Not Sure	0.0% (0)	2.3% (4)	0.0% (0)	4.2% (25)

Results showed no significant difference ($X^2(6) = 11.77$, $p<0.067$) between the different groups responses as a high percentage of all participants answered 'Yes', out of the 874, only 47 participants stated either 'No' or 'Not sure'. The medical respondents showed the highest 'No' response, whereas the public responded higher to 'Not Sure'. Veterinary and agricultural participants only answered 'Yes' to antibiotics being an important part of medical treatment.

Participants understanding of Antibiotic Resistance

Section 3 examined the participants understating of antibiotic resistance, again, using a scale of 0 (being not aware) to 4 (being very aware) participants were asked 'Do you have an understanding of how antibiotic resistance emerges?' Figure 2 shows the marginal means of antibiotic resistance emergence from the 4 different groups.

Figure 2: Responses of the four groups on their understanding of antibiotic resistance knowledge. Data represents Means of participant's understanding of antibiotic resistance emergence from the 4 different professional backgrounds.



There was a significant difference between professional groups (F= (3,870) = 34.30, p<0.000) in how participants responded to the question. Veterinary, medical and agricultural showed similar results with means >3 with the public showing a lower mean score of 2.6 (SD ±1.2). Post tests showed significant differences specifically between veterinary background and public: p<0.000; Medical background; and public: p<0.000 Agriculture and public: p<0.002.

Participants were then asked their understanding of the term antibiotic resistance, from the following four statements, 'My body is resistant to the bacteria', 'The bacteria in my body are not killed by the antibiotic', 'The bacteria are resistant to the antibiotic' and 'Stops me getting an infection in the future'. Table 8 shows the responses from the four different participant groups.

Table 8: Responses from the four professional groups on their understanding of the term "Antibiotic Resistance"

	Veterinary		Medical		Agricultural		Public	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
My body is resistant to the bacteria	1.8% (1)	98.2% (55)	4.6% (8)	95.4% (167)	1.8% (1)	98.2% (54)	6.9% (37)	93.7% (551)
The bacteria in my body are not killed by the antibiotic	80.4% (45)	19.6% (11)	57.7% (101)	42.3% (74)	54.6% (30)	45.5% (25)	59.5% (350)	40.5% (238)
The bacteria are resistant to the antibiotic	76.8% (43)	23.2% (13)	81.1% (142)	18.9% (33)	72.7% (40)	27.3% (15)	75.5% (444)	24.5% (144)
Stops me getting an infection in the future	0.0% (0)	100.0% (56)	0.6% (1)	99.4% (174)	1.8% (1)	98.2% (54)	1.5% (9)	98.45% (579)

Results showed that the highest 'Yes' response across all groups was 'The bacteria are resistant to the antibiotic', this response showed no significant difference across groups ($X^2(3) = 2.86$, $p<0.414$), as majority of participants answered the same way, 'Yes' the highest 'Yes' response was from the medics, the highest 'No' response was from agricultural which was similar to veterinary and the public. This was then followed by 'The bacteria in my body are not killed by the antibiotic', responses varied and showed a significant difference across groups ($X^2(3) = 3.98$, $p<0.013$), the highest response was from the veterinary professionals, much higher compared to the other background, medics at 57.7%, agricultural 54.6% and public at 59.5%. Agricultural, medical and public showed a similar 'Yes'/'No' split, compared to veterinary that had a much lower response to 'No' compared to the others that were all above 40%. The remaining responses, 'My body is resistant to the bacteria' and 'Stops me getting an infection in the future' majority of participants did not agree with, and there was

no significant difference ($X^2(3) = 3.98$, p=0.264 and $X^2(3) = 1.87$, p=0.600) as all groups showed a high 'No' percentage.

Participants understanding of the different diseases that can be treated with antibiotics.

Question 14 looked at participants understanding of different diseases including viral, bacterial, pathogenic and syndromic. Participants were asked could antibiotic be used to effectively treated the different diseases. Responses included; 'I don't know this disease', 'I know this disease but don't know this if antibiotics will work on it', 'No' and 'Yes'. Table 9 shows the results for all the diseases from the four different participant groups. A chi-square test was used to identify if there were significant differences in the way the different participant groups responded.

Table 9: Responses from the four professional groups on weather different diseases should be treated with antibiotics or not.

(separate document A3)

Table 10 focuses on the syndromic diseases, this includes HIV and AIDS and shows the responses from the different groups on could antibiotics be used to treat the disease.

HIV was the first disease to be answered, results show there was a significant difference in the way the different participant groups responded ($X^2(9) = 45.76$, $p<0.001$). The majority of the participant groups answered 'No' to antibiotics treating HIV. Antibiotics are not used to treat HIV and it's not a bacterial infection and therefore wouldn't be effective. Veterinary and medical backgrounds showed similar results with over 93% stating 'No' compared to a lower percentage (74%-75%) from agricultural and public which also showed similar responses. Public and agriculture showed the highest percentage of 'I know this disease but don't' know if antibiotics will work (18%-20%) a much lower response from veterinary and medical (1%-4%).

Table 10: Responses from the four groups on whether antibiotics will treat HIV and AIDs

		HIV	Aids
Veterinary	I don't know this disease	1.8% (1)	1.8% (1)
	I know this disease but don't know if antibiotics will treat	3.6% (2)	3.6% (2)
	No	94.6% (53)	89.3% (50)
	Yes	0.0% (0)	5.4% (3)
Agricultural	I don't know this disease	0.0% (0)	0.0% (0)
	I know this disease but don't know if antibiotics will treat	20.0% (11)	23.6% (13)
	No	74.5% (41)	70.9% (39)
	Yes	5.5% (3)	5.5% (3)
Medical	I don't know this disease	0.6% (1)	0.6% (1)
	I know this disease but don't know if antibiotics will treat	1.1% (2)	1.7% (3)
	No	93.1% (163)	90.3% (158)
	Yes	5.1% (9)	7.4% (13)
Public	I don't know this disease	1.0% (6)	1.0% (6)
	I know this disease but don't know if antibiotics will treat	18.4% (108)	19.0% (112)
	No	75.2% (442)	73.3% (431)
	Yes	5.4% (32)	6.6% (39)

AIDS is a syndromic disease which is a collective set of signs and symptoms that appear together as a disease and therefore are not treated with antibiotics. Results showed a significant difference in the way the participant groups responded, (X^2 (9) = 42.93, p=0.000. The majority of participants groups answered 'No'. Again, the groups seemed to show similar responses, medical and veterinary professionals produced similar results as did agriculture and public. Agriculture showed the highest percentage of 'I know this disease but don't know if antibiotics will work on it effectively' however this in actual figures is 13 participants. Public also showed similar results of participants stating "I know this disease but don't know if antibiotics will treat."

Table 11 shows the results of all the viral diseases that were listed in question 14 and the responses from the different participant groups. Responses included; 'I don't know this diseases', 'I know this disease but don't know this if antibiotics will treat', 'No' and '

Table 11: Responses from the four groups on whether antibiotics will treat different diseases (Viral diseases)

		Cold Virus	Influenza	Viral meningitis	Foot & Mouth Disease	Bird (Avian) Flu	Measles
V	I don't know this disease	0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	I know this disease but don't know if antibiotics will work in it	1.8% (1)	1.8% (1)	0.0% (0)	5.4% (3)	0.0% (0)	8.9% (5)
	No	94.6% (53)	96.4% (54)	94.6% (53)	83.9% (47)	96.4% (54)	87.5% (49)
	Yes	3.6% (2)	1.8% (1)	5.4% (3)	10.7% (6)	3.6% (2)	3.6% (2)
A	I don't know this disease	0.0% (0)	0.0% (0)	3.6% (2)	3.6% (2)	1.8% (1)	3.6% (2)
	I know this disease but don't know if antibiotics will work on it	3.6% (2)	12.7% (7)	10.9% (6)	29.1% (16)	23.6% (13)	14.5% (8)
	No	94.5% (52)	76.4% (42)	72.7% (40)	54.5% (30)	67.3% (37)	69.1% (38)
	Yes	1.8% (1)	10.9% (6)	12.7% (7)	12.7% (7)	7.3% (4)	12.7% (7)
M	I don't know this disease	0.0% (0)	0.0% (0)	0.0% (0)	2.3% (4)	1.8% (1)	0.6% (1)

	I know this disease but don't know if antibiotics will work on it	1.1% (2)	1.1% (2)	2.3% (4)	25.7% (45)	7.4% (13)	9.1% (16)
	No	97.7% (171)	92.6% (162)	90.3% (158)	53.7% (94)	80.0% (140)	83.4% (146)
	Yes	1.1% (2)	6.3% (11)	7.4% (13)	18.3% (32)	10.9% (19)	6.9% (12)
P	I don't know this disease	0.2% (1)	1.2% (7)	2.4% (14)	5.8% (34)	1.4% (8)	1.5% (9)
	I know this disease but don't know if antibiotics will work on it	2.9% (17)	7.5% (44)	13.9% (82)	42.3% (249)	21.1% (124)	23.3% (137)
	No	91.2% (536)	79.3% (466)	74.7% (439)	33.7% (198)	62.9% (370)	63.1% (371)
	Yes	5.8% (34)	12.1% (71)	9.0% (53)	18.2% (107)	14.6% (86)	12.1% (71)

Key: Veterinary (V), Agriculture (A), Medical (M), P (Public)

Cold virus, is a viral disease and therefore treating with antibiotics is ineffective, results showed no significant difference ($X^2(9) = 10.76$, $p<0.292$) in the way the different groups responded, 'No' was the highest response among all groups. The highest response to 'Yes' from the public with lower responses from the other groups, only 1 participant stated 'I don't know this disease'.

Veterinary and medical showed nearly identical results for influenza as cold virus, unlike agriculture and public where their response to 'I know this disease but don't know if antibiotics will work on it.' increased by over 50% as did their response to 'Yes'. Results showed a significant difference ($X^2(9) = 30.80$, $p<0.001$) in the way respondents answered. In response to the question, if antibiotics are effective treating viral meningitis, responses from the four participant groups showed a significant difference ($X^2(9) = 38.28$, $p<0.001$). Medical and veterinary background showed to have similar results with >90% answering 'No', agriculture and public also have the majority answering 'No' however at a lower percentage of 72%-75%.

Results for foot and mouth disease showed majority of participants from all groups answered 'No'. A high percentage (42.3%) of the public stated 'I know this disease but don't know if antibiotics will work on It' and were the lowest group to state 'No'. Both agricultural and veterinary participants also showed higher responses to 'I know this disease but don't

know if antibiotics will work on it'(25%-29%), foot and mouth diseases was the highest disease that participant had heard of; but didn't know if antibiotics would treat comparted to the other viral diseases. Responses from the different participant groups showed to have a significant difference ($X^2(9) = 76.86$ $p<0.001$).

When asked if antibiotics could effectively be used to treat bird (avian) flu, majority of all participants answered 'No', however the responses varied across groups showing a significant difference ($X^2(9) = 46.41$, $p<0.001$). Agricultural and public showed to have similar results, medical background responses varied with 23.6% stating 'I know this disease but don't know if antibiotics will treat' and 10.9% answered 'Yes', higher response compared to veterinary background.

The final disease within the viral disease category was measles. Again medical and veterinary showed to have similar results as did agricultural and the public, responses showed a significant difference across groups ($X^2(9) = 39.40$, $p<0.001$). The highest response across all professional backgrounds was 'No'.

Table 12 shows the results for the parasitic diseases from question 13, in this case the only one was malaria. As malaria is a parasite it is treated with a range of antimalarial tablets. Stated in table 12 is the responses from the four different groups on whether antibiotics are effectively used to treat malaria.

Table 12: Responses from the four professional groups on whether antibiotics will treat Malaria

		Malaria
Veterinary	I don't know this disease	0.0% (0)
	I know this disease but don't know if antibiotics will work on it	12.5% (7)
	No	60.7% (34)
	Yes	28.6% (15)
Agricultural	I don't know this disease	1.8% (1)
	I know this disease but don't know if antibiotics will work on it	25.5% (14)
	No	52.7% (29)
	Yes	20.0% (11)
Medical	I don't know this disease	1.7% (3)
	I know this disease but don't know if antibiotics will work on it	5.7% (10)
	No	66.9% (117)
	Yes	25.7% (45%)
Public	I don't know this disease	1.0% (6)
	I know this disease but don't know if antibiotics will work on it	24.3% (143)
	No	52.6% (309)
	Yes	22.1% (103)

Results showed that the highest response from all four categories was 'No', medical and veterinary shows the highest at (60%-67%) followed by agriculture and public both at 52%. Responses differed across groups ($X^2(9) = 33.878$, $p<0.001$).

Table 13 is the final table to show results from question 13, this table includes results for bacterial diseases, these diseases can be treated by a range of different antibiotics.

Table 13: Responses from the four professional groups on whether antibiotics will treat different diseases (Bacterial diseases)

		TB	Syphilis	Gonorrhoea	Bacterial Meningitis	Bacterial pneumonia	*E.coli*	*Salmonella*	*MRSA*	*Staph. aureus*
V	I don't know this disease	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	1.8% (1)	0.0% (0)
	I know this disease but don't know if antibiotics will treat	5.4% (3)	14.3% (8)	12.5% (7)	3.6% (2)	0.0% (0)	1.8% (1)	1.8% (1)	7.1% (4)	1.8% (1)
	No	5.4% (3)	3.6% (2)	3.6% (2)	1.8% (1)	1.8% (1)	1.8% (1)	7.1% (4)	17.9% (10)	3.6% (2)
	Yes	89.3% (50)	82.1% (46)	83.9% (47)	94.6% (53)	98.3% (55)	96.4% (54)	91.1% (51)	73.2% (41)	94.6% (53)
A	I don't know this disease	1.8% (1)	3.6% (2)	3.6% (2)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	5.5% (3)	9.1% (5)
	I know this disease but don't know if antibiotics will treat	16.4% (9)	21.8% (12)	27.3% (15)	1.8% (1)	1.8% (1)	7.3% (4)	12.7% (7)	10.9% (6)	5.5% (3)
	No	16.4% (9)	10.9% (6)	5.5% (3)	0.0% (0)	0.0% (0)	9.1% (5)	14.5% (8)	16.4% (9)	0.0% (0)
	Yes	65.5% (36)	63.6% (35)	63.6% (35)	98.0% (54)	98.2% (54)	83.6% (46)	72.7% (40)	67.3% (37)	85.5% (47)
M	I don't know this disease	0.0% (0)	0.6% (1)	0.6% (1)	0.0% (0)	0.0% (0)	0.6% (1)	0.6% (1)	0.6% (1)	2.9% (5)
	I know this disease but don't know if antibiotics will treat	4.6% (8)	12.0% (21)	10.3% (18)	1.1% (2)	0.6% (1)	3.4% (6)	10.9% (19)	4.6% (8)	2.3% (4)
	No	12.6% (22)	5.1% (9)	5.7% (10)	1.7% (3)	1.7% (3)	6.9% (12)	26.3% (46)	16.0% (28)	2.9% (5)
	Yes	82.9% (145)	82.3% (144)	83.4% (146)	97.1% (170)	97.7% (171)	89.1% (156)	62.3% (109)	78.9% (138)	92.0% (161)
P	I don't know this disease	1.5% (9)	2.2% (13)	2.2% (13)	1.0% (6)	1.5% (9)	1.4% (8)	1.0% (6)	5.8% (34)	16.7% (98)
	I know this disease but don't know if antibiotics will treat	23.0% (135)	23.6% (139)	23.8% (140)	10.4% (61)	7.7% (45)	21.6% (127)	25.3% (149)	20.2% (119)	17.3% (102)
	No	13.3% (78)	9.9% (58)	7.5% (44)	2.2% (13)	2.2% (13)	13.8% (81)	23.5% (138)	21.9% (129)	5.8% (34)
	Yes	62.2% (366)	64.3% (378)	66.5% (391)	86.4% (508)	88.6% (521)	63.3% (372)	50.2% (295)	52.0% (306)	60.2% (354)

In response to question 13, could antibiotics effectively treat Tuberculosis (TB), majority of participants answered 'Yes', however results did vary from the different groups showing a significant difference ($X^2(9) = 50.00$, $p<0.001$). Medical and veterinary showed similar results as did agriculture and the public. 16%-23% of agriculture and public stated 'I know this disease but don't know if antibiotics will treat', whereas a slightly lower response rate was found for both the veterinary and medical professionals at 4%-6%. All groups also showed similar results in response to syphilis, again another bacterial disease. Again, responses from the four groups varied significantly ($X^2(9) = 27.56$, $p=0.001$.)

In response to whether antibiotics effectively treat Gonorrhoea, a high majority of participants respond with 'Yes' to antibiotics effectively treating gonorrhoea, highest responses were from veterinary and medical which showed similar responses throughout. Responses from agriculture and public also showed similarities, 63%-66% stated 'Yes', both also showed the highest response to 'I know this disease but don't know if antibiotics will treat' at 23%-27%. As responses varied between the groups chi square test showed a significant difference ($X^2(9) = 27.90$, $p<0.001$).

Results for bacterial meningitis again showed majority responded 'Yes', there was a significant difference in responses between groups ($X^2(9) = 25.93$, $p<0.002$). Veterinary, medical and agriculture showed similar responses over 94% stated 'Yes' with a small number (1%-4%)of participants stating 'I know this disease but don't know if antibiotics will work on it.' The response from the public showed a lower response to 'Yes' at 86.4% and a higher response to 'I know this disease but don't know if antibiotics will treat' at 10.4%. The public were also the only group to state 'I don't know this disease.

Bacterial pneumonia showed varied responses compared to bacterial meningitis again a chi square test showed a significant difference ($X^2(9) = 25.02$, $p<0.003$). Veterinary, agriculture and medical showed similar responses, over 98% stated 'Yes' compared to public at 87%. The public were the only group to state 'I don't know this disease' at 1.5%, in response to 'I know this disease but don't know if antibiotics will treat' only 1 participant from both agriculture and medical agreed compared to the public at 7.7%.

Results in response to antibiotic effectively treating *E. coli* showed veterinary to have the highest response to 'Yes' at 98% leaving only 1 participant within the veterinary groups stating 'No'. Agriculture and public showed similar results 83%-89% stated 'Yes' with 7%-9%

stating ‘No’. One possible reason for a higher response to ‘No’ from the medical background could be due to resistance to that diseases. The public showed a response to ‘Yes’ at 63%, lower than the other groups and a higher response to I know this disease but don’t know if antibiotics will treat’ at 21.6%, a significant difference $X^2(9) = 71.14$, $p<0.00$) was shown in the way the different groups responded.

Participants response to whether antibiotics effectively treat salmonella varied more so than the responses from other diseases, veterinary showed the highest response to ‘Yes’, a much lower response from the medical background, the lowest ‘Yes’ response to any bacterial disease. As previously stated one reason this could be is due to antibiotic resistance, medical may feel that antibiotic cannot effectively treat salmonella. Public was the highest group to state ‘I know this disease but don’t know if antibiotics will work on it’ followed by the agriculture and medical professionals, as the results varied there was a significant difference in the way they responded ($X^2(9) = 55.98$, $p<0.001$).
Responses varied significantly between groups ($X^2(5) = 55.96$, $p<0.001$) when answering if antibiotics could effectively treat MRSA, majority of the participants answered ‘Yes’, however the public response was the lowest compared to the other groups, 20% of the public answered; ‘I know this disease but don’t know if antibiotics will work on it’ with a further 21.9% answering ‘No’.
What was interesting when looking at the results to *Staphylococcus aureus* was that a higher percentage of agriculture, medical and the public stated ‘I don’t know this disease’ compared to MRSA. Meticillin resistant *Staphylococcus aureus* (MRSA) is a strain of *Staphylococcus aureus* however results showed more participants knew MRSA compared to *Staphylococcus aureus* bar the veterinary background. Results did also show a variation in the responses from the different groups showing a significant difference ($X^2(9) = 93.98$, $p<0.001$). Veterinary showed the highest response to ‘Yes’ at 94.6% followed by the medical background at 92%.

Participants sources of information

Question 16 involved asking the participants where they have previously picked up information on antibiotics. Responses included; 'Social media', 'News', 'GP/Hospital, 'Friends/Family' and other 'Other'. Table 14 shows the responses from the four different groups.

Table 14: Responses from the four professional groups on where they tend to pick up information about antibiotic resistance

	Veterinary		**Medical**		**Agricultural**		**Public**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Social media	32.1% (18)	67.9% (38)	30.3% (53)	69.7% (122)	38.2% (21)	61.8% (34)	30.4% (179)	69.6% (409)
News	57.1% (32)	42.9% (24)	57.7% (101)	42.3% (74)	81.8% (45)	18.2% (10)	81.1% (477)	18.8% (111)
GP/Hospital	37.5% (37.5)	62.5% (35)	63.4% (111)	36.6% (64)	36.4% (20)	63.6% (35)	49.1% (289)	50.9% (299)
Friends/Family	35.7% (20)	64.3% (36)	30.3% (53)	69.7% (122)	18.2% (10)	81.8% (45)	35.0% (206)	65.0% (382)
Other	80.4% (45)	19.6% (11)	57.1% (100)	42.9% (75)	61.8% (34)	38.2% (21)	31.8% (187)	68.2% (401)

In response to social media, responses from the four groups didn't show a significant difference ($X^2(3) = 1.49$, $p<0.685$), 30%-38% stated 'Yes' across all groups 61%-70% stated 'No'. Agricultural respondents were the highest group to state 'Yes' (38.2%) however not by a high amount compared to the other groups. In response to 'News' there was a significant difference in the way they responded, medical and veterinary showed similar results at 57% as did agriculture and public respondents at a higher response of 81%. Whereas results from

GP/Hospital, showed medical to have the highest response followed by the public. Both veterinary and agriculture showed lower response showing a significant difference ($X^2(3) = 20.31$, p=0.000) in the way the groups responded.

Responses in all groups showed no significant difference ($X^2(3) = 7.323$, p=0.062), all groups showed low responses to using friends and family as a source of information, the highest groups to state 'Yes' were veterinary and the public. Responses were lower from the medical professionals and agricultural.

Finally, the last response was 'Other', responses from the other groups showed a significant difference ($X^2(3) = 84.33$, p<0.001), veterinary were the highest group to state 'Yes'. Other sources for veterinary could be professional conferences, published paper and government/ regulatory guidelines. Medical and agricultural also showed higher responses to 'Other', agricultural and medical, again sources could be similar to that of the veterinary background. Another possible source for agriculture could also be their veterinarian. Public was the lowest group to state 'Yes'. Another possible 'Other' source which was stated on the list is the 'Web', this tends to a common place where individuals find out medical information.

Discussion

In an era of increasing antibiotic resistance it is important to understand the views of different stakeholder groups in relation to the use, efficacy and abuse of these drugs as it is important to gain an insight in the knowledge base around the development of antibiotic resistance. During this project a questionnaire-based approach was used to canvas opinions as to an individual's perceptions of antibiotic use from different professional's backgrounds including those from a medical, veterinary and agricultural standpoint as well as the views of the public. This helped to identify where information gaps are present, where work is needed in engaging the public in an attempt to further inform various groups and to try and help reduce the amount of antibiotic used and so help the fight against antibiotic resistance.

Participants characteristics

The average age of the participants was 42 years; comparisons were made to see if participants differed in their responses due to their age. Age was split in to 'Younger' (<45) and 'Older' (>45) so see if age effected the way in which participants responded to questions. There were no significant changes as both groups showed similar results in terms of the way they responded. Gender was also analysed to see if there were any differences, apart from more female respondents then males there were no other major differences, however AMR is certainly not a gender based issue.

The country with the highest participation of the questionnaire was the UK (84%), this was somewhat expected as this is where the questionnaire originated, despite this the questionnaire was answered globally from Europe as far as Australia. A higher participation number would have helped to establish if perception and uses differed depending on the countries. As stated in the results a comparison was made between the four highest responding countries, this included UK, USA, Australia and Canada, apart from the UK the other counties participation rates were low (>4%). Therefore even though comparisons were made apart from those participants from Canada which has the lowest response to antibiotic resistance being a concern to them, there were no real differences. However, with

only 20 participants from Canada in total it cannot be taken as a reflection on the whole country.

An estimation of the Understanding of AMR/ antibiotics by participants in the current study

One of the first questions put to the participants was whether they had ever taken antibiotics. The results showed that the majority of the participants had previously taken antibiotics, following on from this question, participants were also asked if they had finished the course of antibiotics prescribed. These are important questions in that they give an insight to how closely people follow dosing advice in terms of completing the course they are prescribed. It was noted that only a small number of participants stating they either didn't finished the course or didn't know if they had, which is encouraging in many ways. However, it is still vitally important to get the message across to patients and carers that course completion is critical so there is a clear need to continue with education focused on ensuring that the message of correct dosing and course completion of prescribed antibiotics is imparted to all the groups represented in the current study. This question has come to prominence in recent times with the publication of a paper in the BMJ which posed the question whether antibiotics should be prescribed for the full 7 days or whether this time course should be reduced (Llewelyn et al, 2017). Although an opinion piece calling for some evidence-based studies to ascertain if this is indeed a viable consideration, from anecdotal evidence, some people took this to mean that a reduction in antibiotic course was now acceptable. What is clearly required is that this type of consideration needs a solid research base to support the suggestions made if applicable. It also highlights how important clear messaging is when considering taking subjects such as this to a more public audience. In the meantime, the message given by Public Health England, that a course of antibiotics must be completed as described by the prescribing physician. This view is also taken by the British Veterinary association so there is a 'One Health' consensus on this issue.

In the current study, 97% of participants stated they had heard of antibiotic resistance, with only 21 (2.4%, 21/874) of participants stating 'No'. It is therefore interesting to speculate that this highlighted understanding could be a result of actions such as the media campaigns and highlighting of the subject lead by a number of prominent people such as Dame Sally Davies and Lord Jim O'Neill. It is notable that the production of Lord Jim O'Neill's reports

(available on the AMR Review website) are written for both a professional and none professional audience to allow access to the information contained in there.

Viral diseases

Viral diseases, stated in Table 9, show a list of diseases not effectively treated with antibiotics, results showed there were similar trends in the ways the different groups responded. Generally, the groups that responded in a similar way were the veterinary and medical professionals and then the agriculture and public, this was expected in a way as the veterinary and medical professionals have scientific/ medical training whereas the agriculture and public may have different qualifications in other areas.

Firstly, looking at the veterinary professionals, across all diseases the majority responded 'No' showing they understand that antibiotic cannot be used to treat viral diseases. However, one disease showed some variances compared to the other diseases, this was foot and mouth disease. Results for foot and mouth disease showed a lower percentage stating 'No' and the highest stating 'Yes', in animals found to be infected in foot and mouth disease it is compulsory (in the UK) to slaughter the animals, this is to prevent further spread for the disease (DEFRA, 2011). This reflected in the responses from the other groups in that foot and mouth disease was the lowest response to 'No' out of all the viral diseases. One possible reason for a higher response to 'Yes' especially from the medical professionals is that antibiotics are given to treat any secondary infections. The public showed to have a high response to 'I know this disease but don't know if antibiotics will treat it', again another possible reason for this is from the media, 2001 saw an outbreak of foot and mouth disease and was heavily in the media, this could be where individuals have heard of the term foot and mouth but not sure of the treatment.

Measles again showed similar trends in the way in which the different groups responded, as previously stated veterinary and medical professionals showed similar results as did agriculture and the public. There is no actual treatment for measles, suggested treatment by the NHS is ibroprofen for pain relief along with plenty of liquid to prevent dehydration (NHS,2018). Despite this a number participants from all groups still stated either 'Yes' for

antibiotic treatment along with ‘I know this disease but don’t know if antibiotics will work’, higher responses were from agriculture and public.

Previous papers have stated that antibiotics used for the treatment of the common cold need to be prevented as it is not effective on viral bacteria (Holzinger et al). A UK based study conducted over 16 years found that the proportion of patients with coughs and colds who were prescribed antibiotics, this rose from 36% in 1999 to 51% in 2011, an approximate increase of 15% despite new GP prescribing regulations (Hawker et al, 2014).
However, results show that majority across all groups stated ‘No’ in response to can antibiotics effectively treat which is a positive response. Veterinary and medical professional generally responded in the same way to influenza apart from more stated ‘Yes’ to antibiotics can effectively treat the disease, a possible reason for this especially in a medical setting is treating any secondary disease. Again, a similar pattern in response was recorded from both agriculture and the public that showed a slightly lower level of understanding. With an increase in the media regarding the use of antibiotic use for colds and how it is not effective, most recently the BBC published an article ‘Stop prescribing 'precious' antibiotics for sore throats, GPs told’ encourages the public not to expect antibiotic for illness such as colds. Promising as this is, this is a continuous process in educating not only the public but also continued professional practice for health professionals.

Results from viral meningitis again shows the majority stating ‘No’ from all groups, a possible reason as viral meningitis to why compared to other viral diseases had a higher ‘No’ response is due to ‘viral’ being in the name of the disease, an assumption could be that participants that may not have heard viral meningitis selected ‘No’ as they may know antibiotics don’t treat viral diseases.

Bacterial diseases

Results from bacterial diseases again generally showed similar trends in that veterinary and medical responded in a similar way as did agriculture and the public. As all diseases listed in table 11 were bacterial it was expected to see high responses to ‘Yes’.

Salmonella showed to have one of the lowest response's to 'Yes' from the medical professionals and the public, antibiotics are not initially given for 1st line treatment. Salmonella is classed a self-limiting illness and are usually only given in severe cases, patients are usually just told to keep hydrated however patients under the age of 1, over 60 or immunocompromised are given antibiotic treatment for 7 days or 14 days for immunocompromised patients (NHS, 2018). Treatment in animals is similar, treatment is reserved for patients with serve bloody diarrhea, antibiotic treatment is based on the results from sensitivity test and usually given for 10 days (FECAVA, 2009).

Participants response when asked if MRSA could effectively be treated by antibiotics was highlighted as one of the lowest 'Yes' responses from all professional backgrounds. As previously stated before MRSA is a bacterial infection and is treated with antibiotics, a possibility as to why is occurred is resistance, MRSA is a strain of *Staphylococcus aureus* which is resistant to methicillin a narrow spectrum antibiotic, part of the penicillin class of antibiotic (NHS, 2018). Treatment for MRSA is limited due to resistance, recommended treatment is Teicoplanin 600 mg given Intravenously (IV) every 12 hours for 3 doses and then every 24 hours (NICE, 2018). The public to have the highest response to 'I know this disease but don't know if antibiotics will l work on it' one reason for this is influenced by the media, both 2016 and 2017 saw the media reports news on MRSA, this is both before and during the circulation of the question for this research. Following on from MRSA, participants were then asked their option in *Staphylococcus aureus,* data showed that more participants from medical, agricultural and public stated 'I don't know this disease' than MRSA. As stated previously MRSA is a different strain of *Staphylococcus aureus* which questions whether participants truly understand what MRSA is.

For both bacterial meningitis and bacterial pneumonia showed the highest 'Yes', all groups answered in a very similar, in some cases identical way for both diseases. One possible reason why there was such a high 'Yes' response could be due to 'bacterial' being in the title. When comparing the results from both viral and bacterial meningitis looking at the two responses 'I don't know this disease' and 'I know this disease but don't know if antibiotic will treat' generally responded in a similar way indicating that most knew of meningitis and that maybe by indicating either viral or bacterial indicated a more obvious answer.

Both syphilis and gonorrhoea are sexually transmitted diseases, when comparing the data, results showed the different groups answered in a very similar way to both diseases. Again, there were correlations in that way medical and veterinary responded compared to both agriculture and the public. Both medical and veterinary showed to have more of an understanding to both diseases with >15% stating 'I know this disease but don't know if antibiotics will work on it' compared to agriculture and public at >27%, medical and veterinary also had lower responses to 'No'. One possible reason for all groups responding with 'No' maybe as previously stated, resistance, especially in gonorrhoea. Super gonorrhoea is a form of gonorrhoea that is resistant to a range of antibiotic (Unmet et al, 2014) participants may have been referring to this when responding to the question. As previously stated syphilis showed very similar results to gonorrhea, again not as common but syphilis is also resistant to certain antibiotics (WHO, 2016).

Syndromic diseases

Results from HIV showed majority stating 'No', a small percentage from all groups bar veterinary stated 'Yes', a possible reason could be because HIV is a virus that attacks the immune system to therefore it antibiotics maybe given to treat/ prevent any secondary infections due to a poor immune system. AIDs showed to have similar results to HIV apart from it showed slightly higher responses to 'Yes'. Unlike HIV, AIDS is not a virus but a set of symptoms caused by the HIV virus, again it effects the immune system so therefore individuals are potentially more susceptible to infection; therefore antibiotics are given to treat secondary infections not HIV itself.

Source of information

In response to where participants pick up information on antibiotic resistance 'Other' seemed to be the most predominant response across all groups apart from the public. Results showed similar trends between veterinary and agriculture, veterinarians biggest source of information was other followed by news, agriculture showed news to be the biggest source followed by other. Starting with veterinary professionals potential other

sources of information, for vets this could include government regulations for example, antimicrobial prescribing guidance and legal legislation furthermore research papers/ publications and other veterinarians. In relation to other sources for agriculture this could involve weekly magazines such as farmer weekly, advice from other farmers and a vital other source could be advice from their vet. News was a popular source throughout all the groups, this shows that individuals take note of what's reported regarding antibiotics which is why it is important the correct information is portrayed. Identifying that 'News' is a popular source of information it may be a good idea to report more on antibiotic resistance and the impact it is having globally.

With modern day technology and the rise of social media it was expected that social media would have more of an impact however lower responses throughout part from agriculture. Farmers maybe using social media such as Facebook where there are forums that farmers can share information and advice on topics.

Along with the rise of social media also brings a rise in 'Fake News' which consists of deliberate disinformation. Results from the questionnaire showed participants do use social media as a source of information, therefore important that these platforms are regularly monitored so individuals aren't given the wrong information.

One source which was not listed was the 'web', this could from the NHS website to different forums such as 'MumsNet', often individuals use the web as their first point call, an improvement to the questionnaire would be firstly add in 'web' as a source' and secondly to ask those participants answering 'Other' to specify where.

It is important to gauge where individuals are picking up information as this can help when providing education and the best way to pass the information.

Free text responses

When participants were asked 'If you feel they are harmful?', common responses (listed in results) shows generally that participants feel antibiotics are harmful. A small proportion stated either 'N/A' not giving any indication or not harmful, such as 'Not harmful', 'I don't think so', 'I don't believe they in themselves are harmful'. Those participants that stated they didn't feel they were harmful generally did not leave a reason as to why compared to participants that felt antibiotics are harmful tended to leave an explanation as to why.

Common responses as to why included ‘Antibiotics are harmful because they can contribute to antibiotic resistance if used in the wrong way or when they are not required’, Potential side effects, increase of possible resistance for future infections against antibiotics’ and ‘When overused and not taken as directed when bought from the internet and misused’. A common response was ‘Side Effects’ it is important to understand that all medication has side effects and that shouldn’t discourage the use of medication when needed. Overall in response to this question many referred to ‘antibiotic resistance’, ‘side effects’ and ‘Body becoming immune’, this shouldn’t prevent individuals from using antibiotics if they require them (have a bacterial infection/disease).

Participants were also asked if they could state any recent articles that refer to the use of antibiotics, the most common response was ‘NHS website’ although no actual articles were stated participants may have just stated where they have read any information on antibiotics, following on from this BBC showed to have a huge impact on individuals, not only through news articles but also BBC programs such as Country file and Panorama. However mainstream media may entail some bias which may shape individual’s beliefs and understanding without them receiving the full information. Other published papers were also mentioned from scientific literature along with farming and veterinary literature, the most stated was the report by Lord Jim O’ Neill (link previously stated), this could be because it focused on One health so therefore was relatable to everyone not just on specific profession.

Finally, participants were asked ‘*Is antibiotic resistance a concern to you?’,* 93% of all participants stated ‘Yes’ with the remaining 7% stating ‘No’. A positive sign as antibiotic resistance is listed as one of the top global threats by the World Health Organisation. Those participants that stated ‘No’ responses included ‘Antibiotics have worked for me’, ‘Because there is research into making antibiotic more effective’ and ‘I don’t know enough about antibiotics’. Although research is being done for example into new antibiotics, it is important that the uses and perceptions are changed so that in the future it will help to prevent the cycle starting again. It is clear that more education is needed from the response to this question, individuals stated they don’t know enough on antibiotics and that because they have previously taken antibiotics then they will work again in the future, this may not

be the case and individuals need to informed of this and educated in what can be done to prevent this, without them understanding the causes of resistance future resistance can't be prevented. This education could take place via workshops in local communities/GP surgeries/ schools where all ages can access the correct information. Following on it is positive that the majority of the participants are concerned about antibiotic resistance, responses included 'Simple infections becoming compromised', 'Effects operations' and 'Increased deaths due to antibiotics not working'. It is clear to see that the individuals gauge the severity of AMR from the high level of concern. Although participant have stated their concern more could be done in regards to helping them understand the implications that some of these points entail, such as over prescribing, ineffective treatment, overuse and effecting operations so again have the correct information. For example, an individual may need to have antibiotics to treat a bacterial infection however they may believe that they are contributing to future resistance. It is important that the message is clear antibiotic should be taken when needed to treat a bacterial infection and with doctors advise. Public engagement is very important in doing this by ensuring everyone understands what causes resistance and what can be done prevent this in the future. It is with everyone's participation that can help to reduce AMR.

Future work

After collecting and interpreting the data it is clear what improvement could be made for future work. Firstly, when asking professional backgrounds especially for medical and veterinary a more specific category would be of help, splitting both groups to 'Clinical' and 'Non-clinical' this way it would have been clear as to who had received medical training and those that hadn't. As questions were based on individuals uses of antibiotic, it's not entirely sure if responses were based upon personal use of antibiotics or uses on others or animals, therefore more specific questions would have helped identify if the participant were answering questions from their own use or other human or animal.
Question 6 asked for participants for their understanding of antibiotic resistance, 4 options were given to them to select from, reflecting on this now another option should have been

'Our body is resistant to the antibiotic', having this option would have given us more idea of participants understanding.

More work needs to be done to develop rapid diagnostic tools, this would not only help support vets and farmers but also aid in human medicine, especially for those are unsure about the differences between bacterial and viral diseases, with clear indication this will help support GPs especially. To further our knowledge on how antibiotics are used and perceived running focus groups asking specific questions regarding AMR and how this could potentially impact individual's lives could reveal some interesting results, this could similarly be done with vets and farmers.

Overall this research has given a broad indication of what individuals understand regarding antibiotic resistance, however there are still gaps and this is what needs to be exploited to target education not only to the public but also to clinically trained professionals, this was shown in the results from Question 13 especially regarding effective treatment for different diseases.

Comparison between highest responding countries

Most of the participants that responded to the study were residents of the UK (735, 84.1%), the following highest participating countries were USA (35, 4.0%), Australia (21, 2.4%) and Canada (20, 2.3%). A comparison was made between the four most represented countries to see if any results differed.

Responses from the four nationalities didn't show a significant difference ($X^2(6) = 2.557$, p=0.862) in the way they responded, as all were close to 100% to having taken antibiotics.

Comparison between the four countries to the question 'Have you head of antibiotic resistance' Table 15 shows the response which included; 'Yes', 'No', and 'Not Sure'.

Table 15: Responses from the top 4 highest responding countries on whether they have heard of antibiotic resistance

	Australia	Canada	UK	USA
Yes	95.2% (20)	80.0% (16)	97.8% (719)	100.0% (35)

No	4.8% (1)	20.0% (4)	1.9% (14)	0.0% (0)
Not Sure	0.0% (0)	0.0% (0)	0.3% (2)	0.0% (0)

Again, responses from the four groups were similar and didn't show a significant difference ($X^2(6) = 2.557$, p=0.862), majority of participants across the 4 countries answered 'Yes'.

Table 16: Responses from the top 4 highest responding countries on if the feel antibiotics resistance is a concern to them

	Australia	Canada	UK	USA
Yes	100.0% (21)	65.0% (13)	93.5% (687)	100% (35)
No	0.0% (0)	35.0% (7)	6.5% (48)	0.0% (0)

In response to the question as to whether the participants felt that antibiotic resistance is a concern to them varied and showed a significant difference ($X^2(3) = 29.339$, p=0.000). Both USA and Australia answered 100% 'Yes', Canada showed the highest response to 'No' at 35%, with UK at 6.5%.

The last comparison made was between the four highest responding countries and their professional expertise (see table 17).

Table 17: The professional expertise of the top 4 highest responding countries

	Australia	Canada	UK	USA
Veterinary Background	0.0% (0)	0.0% (0)	6.5% (48)	2.9% (1)
Medical Background	23.8% (5)	30.0% (6)	19.7% (145)	22.9% (8)
Agricultural Background	9.5%(2)	10.0% (2)	5.6% (41)	20.0% (7)
None of the Above (Public)	66.7%(14)	60.0% (12)	68.2% (501)	54.3% (19)

Responses from the four different countries show a significant difference ($X^2(9) = 17.359$, p=0.043. Many of the participants within all four countries were 'None of the above' also

classed the public, all the veterinary professional respondents were from the UK with the exception of one that was from USA. It was notable that the majority of the Agricultural professionals were from the UK.

Free text responses

The free text responses were derived from participant comments made in their own words and not highlighting responses set as part of the questionnaire. This allows for an examination of what the respondent feels in their own words and allows there to be a more expansive answer to the question posed. The questions posed and the responses given are listed below:

If you feel they [antibiotics] are harmful?

Participants were asked if they felt antibiotic were harmful, a box was provided below for them to respond. The most common responses included;

- Side Effects
- Body can become immune to antibiotics
- If not taken with the advice of a medical professional –prescription from doctor
- Overuse, causing resistance
- Harmful when not actually needed
- Weakens immune systems
- Condition dependent
- Kills good/friendly bacteria in the body
- If course not finished this could lead to future resistance
- Allergic reactions/ Anaphylactic
- Over prescribed
- Future Resistance

- Misuse
- Self-diagnosis/ Self Medication
- Negatively effects other organs

Recent articles that refer to the use of antibiotics?

Participants were asked to state any recent articles they had read that refer to the use of antibiotics, majority of the responses didn't include specific articles, responses were generally where they had picked up the information. Common answers included;

- NHS website
- WHO factsheets
- BBC News
- BBC programs (Country files, Panorama)
- Social media (Facebook)
- Scientific Journals
- Veterinary Literature
- Articles in New Scientist Magazine

Is antibiotic resistance a concern to you?

Participants were asked if they felt antibiotic were a concern to them, this is split in to 'Yes' and 'No'. A total of 41 participants answered 'No', common reasons given were;

- I don't know enough on antibiotics
- I don't take antibiotics that often
- I'm a healthy individual so don't need antibiotics
- Antibiotics have worked for me in the past
- Not affected

- Not concerned
- I don’t use them as I’m up to date on vaccinations
- Research is being carried out so no need to be concerned

With the participants that answered ‘Yes’, common trends in their responses were;

- Increased deaths
- Ineffective treatments/ harder to treat diseases
- No new antibiotics
- Effect operations
- Future resistance
- Overuse
- Over prescribing
- Reverting to the pre-antibiotic era

Conclusion

Results from this questionnaire give an insight in to different groups of individuals uses, plus their understanding of antibiotics and the development of resistance. This provides a platform to further develop specific areas that can be targeted. For example, education is a continual part of the process of reducing the uses of antibiotics, in particular the differences between treatment requirements for bacterial vs viral diseases, this in turn may help to change individuals' perceptions in regards to antibiotics. With continued efforts from regulatory bodies from both human and animals medicine the 'One Health' message should be highlighted going forward as one with the other would be less effective.

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Appendix

1.1

Information Form

Dear Participant

Perceptions of the uses and efficacies of antimicrobials by the public, farmers and veterinary professionals.

We are asking you to help us with a study which involves filling in an online survey. We are doing this study to find out more about people's understading of the uses and effectiveness of antimicrobials (drugs that fight infections). We are asking peole with different kinds of work experience and knowledge to fill in the questionnaire.

If you agree, we ask you to click 'continue' below and complete the questions that appear on screen.

Examples of questions:

- Have you heard about antibiotic resistance?
- Should Antibiotics be used to treat disease or prevent disease?

Participants can withdraw at any time without prejudice.

All information that we obtain from you will be maintained in a strictly confidential manner and will be anonymous. No names will be attached to any data arising from the study. You will be alloactaed a participant number after starting the study; if you wish to withdraw your data after completing the survey, you will need to provide this participant number to me so I that I can remove your data from the study.You can skip any question if you wish to. You can do this at any time up to September 2017 when the study closes. The only people who will have access to the information will be myself and my study supervisor, Professor Phillip Terry. In the reporting of the project, no information will be released which will enable the reader to identify who the respondent was.

If you have any questions or problems, please contact me.

My email is p.terry@kingston.ac.uk

Yours sincerely,

Jasmine Bagri

Contact details:

1. Student researcher: Jasmine Bagri, email: p.terry@kingston.ac.uk

2. Member of supervising staff: Professor Phillip Terry email: p.terry@kingston.ac.uk

Consent form

Statement by participant

- I confirm that I have read and understood the information sheet/letter of invitation for this study. I have been informed of the purpose, risks, and benefits of taking part in the study called:

Perceptions of the uses and efficacies of antimicrobials by the public, farmers and veterinary professionals.

- I understand what my involvement will entail and that any questions about the task have been answered to my satisfaction.

- I understand that my participation is entirely voluntary, and that I can withdraw at any time without prejudice.

- I understand that all information obtained will be confidential.

- I agree that research data gathered for the study may be published provided that I cannot be identified as a subject.

- Contact information has been provided should I (a) wish to seek further information from the investigator at any time for purposes of clarification (b) wish to make a complaint.

If you agree to the above and wish to provide your consent, please click ‘continue’ below

Debrief

Perceptions of the uses and efficacies of antimicrobials by the public, farmers and veterinary professionals.

Thank you very much for taking part.

Drugs to treat many kinds of bacterial infection are becoming less effective due to the emergence of resistance by the target bacteria. The aim of the study is to compare people with different professional backgrounds to assess their understandng of the nature of the problem, its scale and its implications.

Please contact myself at the following email address (Jasmine Bagri p.terry@kingston.ac.uk or the study supervisor (Professor Philip Terry; P.Terry@kingston.ac.uk) if you have any questions regarding this study.

Thank you again for your co-operation.

If you require any further information on antimicrobial resistance then visit the World Health Organizations (WHO) website: http://www.who.int/mediacentre/factsheets/fs194/en/

Questionnaire

Survey on Attitudes towards Antibiotics

Our team at Kingston University is undertaking a survey to find out about people's perceptions and attitudes in relation to the use of antibiotics in treating infectious diseases.
We would be extremely grateful if you could spare a few minutes to participate in this survey. You can access the survey questionnaire at: TBA
There are 24 questions to answer in this questionnaire, and it should take approximately 10-15 minutes to complete. You can skip any question if you wish to. The answers to the questions will remain completely anonymous and confidential, and will not be traceable to any individual. The data will be stored securely for a maximum of 5 years, after which it will be destroyed. Ethical approval for this survey has been obtained from the Kingston University's Faculty of Science, Engineering and Computing Ethical Committee.

If you have any questions about this project or the survey, you can contact the project team at:
1. TBC
2. TBC

☐ ***I consent to the anonymous inclusion of my responses above for further analysis and possible publication as part of the overall study*** *(please tick of you do consent)*

QUESTIONNAIRE

1. Have you ever taken Antibiotics?
   - ☐ YES
   - ☐ NO (If no please move to question 3)
   - ☐ DON'T KNOW

2. When you last took antibiotics, did you take all the medication prescribed in the course?
   - ☐ YES
   - ☐ NO
   - ☐ DON'T KNOW

3. In your opinion, are antibiotics effective in treating infectious disease?
   - ☐ YES
   - ☐ NO
   - ☐ SOMETIMES
   - ☐ DON'T KNOW

4. Are antibiotics an important part of medical treatment today?
   - ☐ YES
   - ☐ NO
   - ☐ NOT SURE

5. Have you heard about antibiotic resistance?
   - ☐ YES
   - ☐ NO
   - ☐ NOT SURE

6. Imagine that you have contracted an infectious disease, which of the comments below describes your understanding of antibiotic resistance in this situation? Tick all that apply
   - ☐ My body is resistant to the antibiotics
   - ☐ The bacteria in my body, causing the infection, are not killed by the antibiotic
   - ☐ The bacteria are resistant to the antibiotic
   - ☐ Stops me getting infections in the future

7. Do you think that the use of antibiotics may cause you harm? On a scale of 0-4, “0” being no risk of harm to health, and to “4” being a high risk of harm to health.

   0 1 2 3 4

7b. If you feel that antibiotics are potentially harmful please indicate why below.

8. In your opinion, should antibiotics be given to treat infections caused by viruses such as colds?

   - YES
   - NO
   - DON’T KNOW

9. Do you have an understanding of how antibiotic resistance emerges? Please score your understanding on the scale below with “0” being not aware at all through to “4” being very aware

   0 1 2 3 4

10. Should Antibiotics be used to treat disease or prevent disease?
    - TREAT DISEASE
    - PREVENT DISEASE
    - BOTH TREAT AND PREVENT
    - NEITHER TREAT NOR PREVENT
    - DON’T KNOW

11. Do we have enough effective antibiotics to treat diseases for which antibiotics are commonly prescribed (for thiose diseases that we currently encounter)?
    - YES
    - NO
    - DON’T KNOW

12. Are antibiotics generally safe for children?
    - YES
    - NO
    - CONDITION DEPENDANT
    - DON’T KNOW

13. Place a tick against <u>any</u> of the following infections that you think could be treated effectively using antibiotics:

	Yes	No	I don't know this disease	I know the dsease but don't know if antibiotics will work on it
HIV				
AIDS				
Cold virus				
Influenza				
Malaria				
Tuberculosis				
Syphilis				
Gonorrhoea				
Bacterial Meningitis				
Viral Meningitis				
Bacterial pneumonia				
E. coli				
foot and mouth disease				
Bird (Avian) flu				
Salmonella				
Measles				
MRSA				
Staphylococcus aureus				

14. Have you heard of/read any recent articles that refer to the use of antibiotics in the treatment of disease? If so, please give brief details in the box below.

15. Is antibiotic resistance of concern to you?

- ☐ YES
- ☐ NO
- ☐ PLEASE EXPLAIN YOUR ANSWER IN THE BOX BELOW:

16. Where have you picked up any information about antibiotics? (Tick all that apply)
    - ☐ News (newspaper/television/internet etc)
    - ☐ Social media (facebook/twitter etc)
    - ☐ GP/Hospital
    - ☐ friends/family
    - ☐ other

17. Please indicate your age in the box below:

    [ ]

18. What is your gender?
    - ☐ Female
    - ☐ Male
    - ☐ Other
    - ☐ Rather not say

19. What is your ethnicity?
    - ☐ White
    - ☐ Black
    - ☐ Asian
    - ☐ Mixed

20. Country of residence (Please state below)

    [ ]

21. Do you have any professional expertise in the following areas?

☐ Medical background
☐ Veterinary background
☐ Agricultural
☐ None of the above

22. What is your religion?
    - ☐ Christian
    - ☐ Muslim
    - ☐ Jewish
    - ☐ Hindu
    - ☐ Sikh
    - ☐ Buddhist
    - ☐ no religion
    - ☐ Other

23. What is your highest level of educational qualification?

- Post-graduate (eg PGCE, MSc PhD)
- Graduate (eg BA/BSc Hons)
- A-levels/BTEC level 3
- GCSE
- NVQ level 2
- none of the above
- Other (please state)

24. On a scale of 0-4, what do you consider your level of medical science knowledge to be? (4= very advanced and 0=very poor)

0 1 2 3 4

THANK YOU FOR YOUR TIME IN COMPLETING THIS QUESTIONNAIRE