Public awareness and understanding about spread of antimicrobial resistance linked with food chain

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ABSTRACT

Objective: To assess the awareness of antibiotic use in livestock, spread of antimicrobial resistance linked with food chain and ways to address the issue of antimicrobial resistance in general population of Wah City, Pakistan.
Study Design: Cross sectional descriptive study.
Place and Duration: Department of Community Medicine**,** Army Medical College (AMC), NUMS from 1st July to 31st December 2017.
Methodology: A two-stage cluster random sampling technique was used with a sample size of 400. The data were collected by administering a validated, structured questionnaire with sociodemographic characteristics as independent variables and dependent variables of awareness of Antimicrobial Resistance being a public health threat, treatment challenges due to resistant pathogens, and antibiotics used in livestock production.
Results: More than half of the participants 240 (60.4%) out of the total of 400 were aware of Antimicrobial Resistance (AMR) being serious public health concern that can have serious implications on individual and family. More than half of the respondents 256 (64.1%) were aware of treatment challenges due to resistant pathogens. Overall, 77.3% i.e., 309 participants out of 400 were aware of antibiotics being used in livestock production in their country. More than sixty percent respondents had Knowledge regrading food chain as a contributor to AMR but only 37% knew about the spread of antimicrobial resistance through food chain.
Most participants agreed that the simple actions like hand washing and complete vaccination in children could help tackle the problem of antimicrobial resistance, with numbers rising to 80% - 91%.
Conclusion: Study results indicated that awareness regarding antibiotics used in livestock production was high but knowledge about food chain as a contributor to emergence and spread of Antimicrobial Resistance through food chain was quite low.
Keywords: Agriculture, Antibiotics, Antibiotic resistance, Antimicrobial resistance, Livestock, Food chain.

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INTRODUCTION

Antimicrobials, especially antibiotics are used widely in humans, livestock farming, plants, crops, and aquaculture[1]. Antimicrobial Resistance (AMR) mechanisms because of its dynamics in all sectors is an evolutionary process for microorganisms like viruses, bacteria, fungi, and parasites. AMR related crisis is not only accelerated by the excessive use of antibiotics in human healthcare settings but also misuse of antimicrobials in livestock farming, fruits, vegetable, and fish production[2]. In Low Middle Income Countries (LMICs) lack of enforcement of legislation along with the misuse and overuse of antimicrobials; lack of access to clean water, sanitation and hygiene for both humans and animals as well as poor infection and disease prevention and control in health-care facilities and animal farms are contributing to make the issue of AMR more complex and harder to combat[1-4]. Antimicrobial resistance has become a big public health menace because the antimicrobial-resistant pathogens found in food products of animal origin, and agriculture/manure impacted environments are easily transmitted to humans and disseminated in the environment through animal wastes[3,4].

Dr Margaret Chan, former Director-General of WHO warned

that Common infections such as pneumonia will kill again, she also stated "Antimicrobial resistance is a slow-motion tsunami and a global crisis that must be managed with the utmost urgency"[5]. The current Director-General of WHO, Dr. Tedros Adhanom Ghebreyesus remarked "A world in which the drugs don't work is a threat to global health security"[6].

It has been reported that Low-and middle-income countries (LMICs) will face a significant loss in gross domestic product (GDP) by the year 2050 due to AMR[7]. The global threat of AMR is expected to accelerate the economic decline in the post-pandemic period because the use of antibiotics has increased during COVID 19 pandemic to combat secondary bacterial infections[7,8]. Also, protein rich diet was promoted to boost immune system (resulting in increased demand of food producing animals) which might be associated with rise in AMR after the post COVID scenario[9].

Multidrug resistant strains are showing decreased effectiveness of antibiotics against infections (e.g. Tuberculosis, Malaria and Foodborne diseases) the reasons are many some of which include poor sanitation and water infrastructure; new pathogens; use of antibiotics in animal husbandry and the transfer of antibiotic resistance to human[10]. The epidemic of first XDR typhoid resulted in untreatable, complex, and prolonged infection in Pakistani citizens[11-13]. In 2017, Sixty three percent of typhoid cases and 70% of deaths in children below 15 years of age due to Typhoid resulted in Pakistan. Local government shifted focus on adequate sanitation measures and widespread immunization to control the outbreak, consequently Pakistan became the first country to introduce Typhoid Conjugate Vaccine (TCV) in its routine immunization program in 2019[11,12].

It is estimated that by 2050, human population would grow by 50% with subsequent increase in demand for food[14]. By 2050, global rise in demand for animal protein is projected to be 76% but in LMICs it is forecasted to rise by 200%[12]. Routine use of antimicrobials in livestock production was estimated to rise by 67% between 2010 and 2030[14,15]. Situation in Pakistan is no different, consumer preference has shifted toward animal products and our country is in top 10 animal producing countries[16,17]. Alarmingly high use of antimicrobials in broiler sector for prophylaxis and growth have been reported[4]. It is estimated that the annual consumption of antimicrobials in the commercial broiler production in Pakistan is 568 tons way more than the standard requirement[4,16]. Similarly, the presence of *Salmonella spp*. in raw milk and antibiotic resistance genes in the aquaculture systems of Pakistan have been reported[11,16].

Global efforts are underway to restrict the antimicrobial use especially antibiotic use in agriculture farming of animals and crops to control AMR as this menace has a potential to influence the timely achievement of SDGs, Sustainable Development Goals[7,9,17,18]. Pakistan endorsed the AMR action plan (WHO/OIE/FAO) on antimicrobial resistance and is working to implement measures that are in line with the key actions highlighted by the Global Antimicrobial Resistance and Surveillance System (GLASS) across all sectors in the context of the "One Health approach" that focuses on interconnected health of humans, animals, and environment[4,16,18].

Antimicrobial Resistance requires integrated, holistic action especially in LMICs like Pakistan where people lack knowledge and awareness about excessive use of antimicrobials in food production resulting in dissemination of bacteria/genes that can reach humans via food chain

The study captured information about general publics' awareness and knowledge of antibiotic use in agriculture including food animals and accelerated spread of AMR linked with food systems to close the knowledge gaps for future targeted educational campaigns which will help in empowering the general population in this regard.

The study was conducted to assess the awareness of antibiotic use in livestock, spread of antimicrobial resistance linked with food chain and ways to address the issue of antimicrobial resistance in general population of Wah City, Pakistan.

METHODOLOGY

A cross-sectional descriptive study using the two-stage cluster sample of four hundred residents was conducted with data collection from the union councils of Wah. IRB Approval (Letter no. ERC/MS-17 Com/Med) to conduct this study was obtained on 18th July 2017 from the ethical review committee of AMC (Army Medical College) under the affiliation of National University of Medical Sciences (NUMS), Rawalpindi, Pakistan. The urban area of Wah is located 50 Km towards the Northwest of Rawalpindi/Islamabad, Pakistan. Wah City is one of the ten union councils of Tehsil Taxila, district Rawalpindi. The study setting was Wah Cantt and sampling frame was obtained from the Wah Cantt's station headquarters, with approval and permission from local authorities. Four sectors from the overall twenty seven sectors of Wah Cantt were randomly chosen with lottery method. Two interviewers were hired and trained to systematically collect data by employing face to face interview from the first person contacted in every fifth household of each sector who matched the eligibility criteria. Inclusion of participants was 16 years of age or older, able to read English or Urdu language, and mentally and physically capable of answering. Exclusion involved the households where no response was found by being locked or absence of adult at the time of survey, or on refusal to participate in the survey. Also excluded were respondents, mentally or physically incapable of giving responses or self-completing the questionnaire.

A total of four hundred respondents whose questionnaires were fully completed were included in final analysis. A pretested, closed-ended, self- administered questionnaire was adapted from previously used World Health Organization (WHO) multi-country survey[19]. Questionnaire was translated from English to Urdu language (Urdu translation was assessed for accuracy by using the standard forward and backward method) and was administered in both languages by face-to-face interview. Sociodemographic characteristics were taken as independent variables and the dependent variables included awareness of Antimicrobial Resistance being a public health threat, treatment challenges due to resistant pathogens, and antibiotics used in livestock production. Knowledge was assessed for factors accelerating the spread and emergence of AMR, food chain as a contributor to AMR and spread of AMR through food chain.

A set of six variables related to knowledge about actions that would help address the problem of AMR were also included to assess the mindset and practical ways of mitigating the impact of AMR.

Data Analysis: Data analysis were done using SPSS-27. Mean and Standard Deviation (SD) were calculated for continuous variable. Frequency and percentages were recorded for assessing awareness around the use of antibiotics in agriculture including food producing animals and antimicrobial resistance spread regarding this practice. Also, awareness was evaluated in relation to general and socio demographic characteristics of respondents. Six items (Six statements) to assess participants' knowledge were included and respondents were asked whether they felt the actions would help address the problem of AMR. Respondents were asked to record their response to the six statements according to the following 5-point Likert scale: 1=strongly agree to 5=strongly disagree. On analysis the combined classification of those who chose "strongly agree" or "agree somewhat" to the knowledge questions as having agreed and those who responded to "strongly disagree" or "disagree somewhat" as having disagreed. Chi-square test of significance was used to analyze association of social variables with dependent variables, *p-V*alue of less than and equal to 0.05 was taken as significant.

RESULTS

A study population of adults in the age group of sixteen years and older completed the survey with the total of 400 respondents, 239 males (59.75%) and 161 females (40.25%) with a male to female ratio of 1.5:1 (239:161). Mean age of the participants was recorded to be 37.48 + 10.08 years with 16 years as minimum age was and the maximum age of 72 years. All the respondents belonged to the urban region (densely populated city of Wah). Out of the total respondents 132 (33%) belonged to the household category of 'married and at least one child under sixteen', 71(17.8%) belonged to the category of 'married adults only', and 11(2.8%) were 'one adult and at least one child under the age of 16'. The general and socio-demographic characteristics of the study population were stratified as gender, age in groups, education attainment, occupation, and monthly household income.

Participants were asked about being aware of Antimicrobial Resistance a serious public health concern that can have serious implications on individual and family, 240 (60.4%) were aware of this public health threat, 102 (25.6%) said no and 61 (14.4%) reported don't know. Respondents were asked about being aware of treatment challenges due to resistant pathogens, 256 (64.1%) said yes, 56 (14%) said no and 88 (22%) said don't know. To explore awareness of antibiotic use in food producing animals, survey participants were asked whether they thought that antibiotics are widely used in livestock production in their country.

Overall, 77.3% i.e., 309 participants out of 400 were aware of antibiotics being used in livestock production in their country, with 29 (7.2%) replying not being aware and 62 (15.5%) saying they do not know. Respondents were questioned about their understanding about the drivers of antimicrobial resistance such as overuse and misuse of antibiotics/antimicrobials in human and animals which are accelerating the spread and emergence of AMR, 204 (51%) were aware of this phenomenon. Knowledge regrading food chain as a contributor to AMR and also the spread of antimicrobial resistance through food chain (resistant pathogens can spread from person to person or between people and animals, including from food of animal origin) were also assessed and results are shown in table -I.

Table-I: Responses to statements asked about awareness and spread of antimicrobial resistance and its relationship with food chain (N=400)

VARIABLES	YES	NO	DON'T KNOW
Knowledge of Antimicrobial resistance being a serious public health concern	240 (60.4%)	102 (25.6%)	61 (14.4%)
Infections that are treated with antibiotics would be impossible or difficult to treat if bacteria are developing resistance	256 (64.1%)	56 (14%)	88 (22%)
awareness about antibiotics used in livestock production	309 (77.3%)	29 (7.2%)	62 (15.5%)
"Overuse and misuse of antibiotics in humans and animals is accelerating antimicrobial resistance"	204 (51%)	79 (19.8%)	117 (29.2%)
Knowledge about antimicrobial resistance linked with food chain	264 (66%)	78 (19.5%)	58 (14.5%)
Knowledge regrading spread of antimicrobial resistance through food chain	148 (37%)	172 (43 %)	80 (20%)

Awareness about the use of antibiotics in livestock production in relation to social determinants showed more females 126 (78.3%, x^2 = 1.133, p = 0.568), married 258 (80.9%, x^2 = 11.857, p = 0.003), 35-54 years age group 200 (97.1, x^2 = 113.695, p < 0.000), Master's or equivalent 55 (90.2%, x^2 = 36.006, p < 0.000) were aware. In occupation, other's category 130 (86.1%, x^2 =12.659, p = 0.013) and respondents in highest monthly household income group 45(97.8%) were aware of the antibiotics used in agriculture including livestock (Table-II).

The response from the statement "Overuse and misuse of antibiotics in humans and animals is accelerating antimicrobial resistance" was analyzed about socio-demographic context. Out of the two hundred and four (51%) respondents who agreed it to be the correct statement, 159 (66.5%, x^2 = 5.876, p= 0.053) were females, in marital status more married 179 (56.1%, x^2= 20.965, p < 0.000). Within age groups people in > 55year-olds group were more aware 15 (75.0%, x^2 = 90.495, p < 0.000).

Table-II: Awareness of antibiotics used in livestock production in relation to socio-demographic characteristics (N=400)

Socio-demographic characters	Yes	No	Do not know	Total (N = 400)	Chi square (x^2) & p-Value
Male	183 (76.6%)	20 (8.4%)	36 (15.1%)	239 (59.8%)	$x^2 = 1.133$ p = 0.568
Female	126 (78.3%)	9 (5.6%)	26 (16.1%)	161 (40.3%)	
16-34 years	91 (52.3%)	22 (12.6%)	61 (35.1%)	174 (43.5%)	$x^2 =$ 113.695 p < 0.000
35-54 years	200 (97.1%)	6 (2.9%)	0.0 (0.0%)	206 (51.5%)	
> 55 years	18 (90.0%)	1 (5.0%)	1.0 (5.0%)	20 (100%)	
Primary/middle	45 (61.6%)	6 (8.2%)	22 (30.1%)	73 (100%)	$x^2 = 36.006$ p < 0.000
Higher secondary	96 (68.6%)	15 (10.7%)	29 (20.7%)	140	
Bachelor's	113 (89.7%)	5 (4.0%)	8 (6.3%)	126	
Master's or equivalent	55 (90.2%)	3 (4.9%)	3 (4.9%)	61	
Government employees	101 (72.1%)	13 (9.3%)	26 (18.6%)	140 (100%)	$x^2 = 12.659$ p = 0.013
Private employees	78 (71.6%)	12 (11.0%)	19 (17.4%)	109 (100%)	
Other	130 (86.1%)	4 (2.6%)	17 (11.3%)	151 (100%)	
< 30000 PKR	187 (70.3%)	26 (9.8%)	53 (19.9%)	266 (100%)	$x^2 = 24.429$ p < 0.000
> 30000- 64000 PKR	77 (87.5%)	2 (2.3%)	9 (10.2%)	88 (100%)	
> 65000 PKR	45 (97.8%)	1 (2.2%)	0 (0.0%)	46 (100%)	
Total (N = 400)	309	29	62	400	

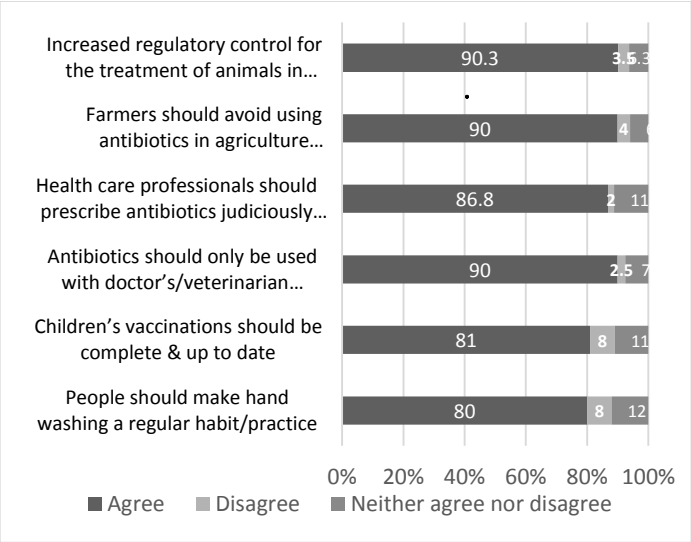

Figure-1: Actions to help address the problem of Antimicrobial Resistance (N= 400)

Survey participants' responses to six questions to explore levels of awareness as well as understanding around simple ways to tackle the problem of AMR are shown in Figure-1. The results reveal that majority of the participants agree with the practice of hand washing 361 (90.3%), complete and updated children's vaccination 360 (90%), and health care professional's careful prescription of antibiotics 360 (90%). Majority of the respondents also agreed that Antibiotics should only be used with doctor's/ veterinarian's prescription 347 (86.8%), avoidance of antibiotics in food producing animals and agriculture by farmers 324 (81%) and 320 (80%) agreeing that increased regulatory control for the treatment of animals in farming is needed (Figure-1).

DISCUSSION

AMR is a complex issue linked with high infectious disease burden, poor infection control, inadequate sanitation, and inappropriate antimicrobial use (AMU) practices having the potential to financially burden families and communities with lost wages and health care costs[6]. In Asia, AMU in chicken's production is expected to increase by 129% between 2010 and 2030 due to expanding population, shift to large-scale animal farms, and weak antibiotic stewardship[13]. Veterinary use of excessive antimicrobials for prophylactic, metaphylactic, therapeutic and growth purpose to reduce management costs and increase returns on investment are a common practice in LMICs[3,20,21]. In LMICs farmers have the options to get antibiotics/antimicrobials from unregulated supply chains due to over-the-counter availability or through unauthorized drug dealers[1,3]. Though antibiotic use in crops is relatively low as compared to medical and veterinary use but still it contributes to disseminating AMR as cultivation of soil for crops production require land spreading of manure, fertilizer or soil conditioner which contain enteric antimicrobial resistance in manures due to animal wastes[21,22].

In our study 60.4% of respondents were aware of AMR being a public health threat and results were similar to the multi-country survey where 62% of the respondents believed it to be a global health concern[19]. Sixty four percent participants were aware of treatment challenges due to resistant pathogens. Numerous educational campaigns have been carried out worldwide and shown active and positive pledge from healthcare professionals and members of the public to combat antimicrobial resistance making people more committed to personal actions and positive changes in self-reported knowledge[16,20]. WHO has not only played a lead role in gaining governments' attention to alleviate mitigation efforts but has also acted in raising community awareness of AMR[16].

Results in our study indicated that almost three fourth of the participants were aware of antibiotics used in livestock production and the results were similar to the multi-country survey by WHO where 62% of the participants thought that antibiotics are widely used in agriculture (including in food producing animals) in their country[19]. Respondents in Sudan were most likely to agree with this statement (89%) as compared to participants in Serbia (53%), Indonesia (52%) and Barbados (40%) who were least likely to be aware of this practice[19].

Study participants were asked to indicate whether they thought the actions would help address the menace of antibiotic resistance. In our study encouragingly, most participants agreed that the actions could help tackle the problem of antimicrobial

resistance, with numbers rising to 80% to 91%. Our findings were similar to the multi-country survey carried out in 12 countries where the percentage in relation to People should wash their hands regularly was recorded up to 90%[19].

Majority of participants in our study agreed that the simple actions of regular hand washing and keeping children's vaccination up to date could help, with numbers as high as 90%. The results of our study were similar to study conducted by Desai et al[23] Hand hygiene and vaccination are being promoted throughout the world to help tackle AMR[24]. The epidemic of first XDR typhoid in Pakistani resulted in high losses such as morbidity and mortality as well as increased length of stay in hospital and health-care expenditure. Adherence to timely receipt of the vaccines is necessary to combat antimicrobial resistance especially for LMIC which continue to fall behind international benchmarks for completing current Expanded Program on Immunization (EPI)[25].

The knowledge regarding avoidance of antibiotic by Farmers in livestock and agriculture in our study was 81%. In a multi-country survey by WHO, more than 60% of the participants with the average of seventy three percent with 83 % of study participants from China, 81% from the Russian Federation, and Serbia agreed that this practice by farmers could help address AMR[19]. Participants in Indonesia (64%) and Viet Nam (16%) were least likely to agree with the statement. In our study 80% of the respondents agreed to the statement "increased regulatory control for the Treatment of Animals in farming is needed", and results were similar to the study published by Ellen Goddard et al in 2017 reporting the net agreement of more than 52 % in participants from Canada and 55% from Germany[26].

Educational campaigns to raise public awareness about AMR, good hygiene habits, complete children's vaccination also targeting locals' concerns/refusals regarding immunization, Reinforcing the link between hygiene and infection prevention is very useful for all times, as was observed during the COVID-19 pandemic in 2020.

CONCLUSION

Study results indicated that awareness regarding antibiotics used in livestock production was high but knowledge about food chain as a contributor to emergence and spread of Antimicrobial Resistance through food chain was quite low.

Recommendations:

- In Pakistan vigilant assessment of agroecosystem in context of AMR is required.
- It is crucial to promote awareness of AMR, concept of One Health and importance of prudent use of these precious drugs in humans and animals in all stakeholders to control the Global crisis of AMR.
- Antimicrobial Resistance requires integrated, holistic action especially involving general population in LMIC like Pakistan.
- Raising knowledge and awareness about excessive use of antimicrobials in food production which results in AMR is of utmost importance especially in the COVID-19 Pandemic where the effectiveness of these preciousmedicines is crucial.

AUTHOR'S CONTRIBUTION

Shan H: Conceived idea, Designed methodology, Data analysis, Statistical analysis, Data interpretation, Manuscript writing.
Maqbool S: Data interpretation, Final proof reading.
Hassan U: Data Interpretation, Critical review, Final proof reading
Noor A: Data Analysis, Critical review, Manuscript writing

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