Occurrence and risk factors associated with antimicrobial resistance of *E. coli*

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**Abstract**

Antimicrobial resistance is current worldwide One Health issues in the areas of human, animal, and environmental fields due to the extensive use and misuse of antimicrobials in the human and animal fields for growth promotion, prophylaxis and therapeutics. The transfer of antibiotic resistance *E. coli* from animals to humans is of concern in recent times. The β-lactam antibiotics have been used successfully to treat infections caused by pathogenic *E. coli*. However, currently, the utility of β-lactams is being challenged severely by a large number of hydrolytic enzymes the β-lactamases expressed by bacteria. The β-lactam antibiotics have been used successfully to treat infections caused by pathogenic *E. coli*. However, currently, the utility of β-lactams is being challenged severely by a large number of hydrolytic enzymes the β-lactamases expressed by bacteria. The handling and consumption of poultry or poultry products is the risk factors repeatedly associated with the transmission of bacterial pathogens to the human population. The control and prevention of such treatments require the knowledge, attitude and practices of using antimicrobials in poultry farm as recommended by different scholars. Successful management of infections caused by such resistant strains requires an understanding of the diversity of β-lactamases, their unambiguous detection, and molecular mechanisms underlying their expression and spread with regard to the most relevant information about individual bacterial species. Properly using the antibiotics as its recommended time intervals and dosages, using specific spectrum rather than broad spectrum, reduce the using of antibiotic as prophylaxis and growth promoters in Animal feeds and training of farmers and other community on the public health importance and risk factors associated with the antimicrobial resistant bacterial infections.
Introduction

Currently the significant failures in treatments of bacteria in field of Veterinary and medical medicine is caused by the emergence of antibiotic-resistant zoonotic bacterial infection in feed of Animal origin [1-30]. The multi-drug resistance is usually emerged from unrecommended rules to use of antibiotics in animal and human health sector [11]. Zoonotic infectious diseases are rooted in unsustainable and unjust human-animal relationships [20]. The handling and consumption of poultry or poultry products is the risk factors repeatedly associated with the transmission of bacterial pathogens to the human population [14]. Globally, the inappropriate dispensing and use of antibiotics to treat such zoonotic bacteria in animals and the utilization of antibiotic growth promoter in poultry feed has contributed to established and the development of bacterial antimicrobial resistance [8,23]. According to the report of Rahman et al. (2020) antibiotics resistant Escherichia coli (E. coli) was common in poultry products with the prevalence of 12.8% broiler chicken and 7.61% in the layer chicken in association with presence of the AmpC beta-lactamase producing gene (CiTM) in 4.56% and 3.26% of broiler and layer chicken, respectively.

The transfer of antibiotic resistance from animals to humans is of concern in recent times [19]. Extended-spectrum beta-lactamase-producing (ESBL) Escherichia coli, has emerged as a global health threat [5,25]. The control and prevention of such traits require the knowledge, attitude and practices of using antimicrobials in poultry farm as recommended by different scholars [26]. despite, the information, the knowledge and attitude toward the prevalence of antimicrobial resistance E.coli in the animal farms in Ethiopia is rare [12]. The b-lactam antibiotics have been used successfully to treat infections caused by pathogenic E. coli. However, currently, the utility of b-lactams is being challenged severely by a large number of hydrolytic enzymes the b-lactamases expressed by bacteria [4]. The b-lactam antibiotics have been used successfully to treat infections caused by pathogenic E. coli. However, currently, the utility of b-lactams is being challenged severely by a large number of hydrolytic enzymes the b-lactamases expressed by bacteria [16].

Antimicrobials must be understood as any kind of agent with inhibitory or killing properties to a microorganism [2]. In order to prevent itself from such challenges, the bacteria can use different mechanism including hydrolyze the β-lactam core of the antibiotic by producing β-lactamases enzymes that affect the effective uses of such antibiotics in treatment of infection disease and growth promoter in animal feeds as it develops antibiotics resistance human and animals [23]. The ESBL genes are frequently encoded on transferable plasmids that encode resistance genes, and the acquisition of these resistant genes by commensal or fecal isolates leads, in turn, to Multidrug Resistant (MDR) pathogens [30]. The occurrence of Extended-Spectrum Beta-Lactamase (ESBL)-producing bacteria due to extensive cephalexin use in the human and food animal is of particular concern. ESBL-producing bacteria was firstly isolated from human clinical practice, but, in recent years, they have been detected in food-producing animals and becoming the food safety issues [10]. One of the groups of antibiotics used to treat the pathogenic bacteria in the world is Beta lactams, however its efficacy is significantly affected by Extended-Spectrum Lactamases (ESBL) enzyme produced by multidrug resistant strains of gram-negative bacilli [3]. The b-lactam antibiotics have been used successfully to treat infections caused by pathogenic E. coli. However, currently, the utility of b-lactams is being challenged severely by a large number of hydrolytic enzymes-the b-lactamases expressed by bacteria [4]. The study conducted on the Antibiotic use in Poultry Production in central Ethiopia from Antibiotic Stewardship Perspective by Meazene et al. (2020) clearly demonstrated lack of awareness about antibiotic use and also lack of polices and regulatory system on antibiotic use, in the country as a whole lead to the propagation of antibiotic resistant bacteria and foster accumulation of antibiotic residues in poultry products in the study area, however, it playing an important roles in treatments to reduce mortality and morbidity of pathogenic bacterial infection, antimicrobials treatment have been hindered by the development of drug resistant bacterial infections [30]. Therefore, the aim of current review is to elaborate information concerned about the occurrence and risk factors associated with antimicrobial resistant E. coli.

Use of antibiotics

Now days, production animals are exposed to antimicrobial not only during the treatments of infected animals, but also animals can be accessed to antimicrobial during consumption of commercial feed which supplemented with antibiotics as disease prevention and as growth promoters in livestock [11]. For more than fifty years antibiotics (streptomycin, sulfauxisidine, and streptothricin) were used as animal growth promoters in United state (USA) and other developing countries and it shown a significant production result particularly to pig and chicken feed [22]. One main risk factors in antimicrobial resistant was the using non-specific broad spectrum antibiotic in treatments of animals or Homans infection so that in order to reduce this challenges, novel antimicrobial therapies are needed with increased specificity for the site of infection. Photo pharmacology could enable such specificity by allowing for the control of antibiotic activity with light, as exemplified by Trans/Cis-Tetra-Orthochloroazobenzene-Trimethoprim (TCAT) conjugates [15]. For at least 50 years, farms in the United States and other developed countries have used antibiotics as Antimicrobial Growth Promoters (AGPs). AGP was first introduced in the mid-1950s. The use of antibiotics as AGP were for first reported. beta-lactamase (ESBL) has significantly influenced antibiotic choices for controlling severe E. coli infections [28].

Causes of Drug resistance

Antimicrobial resistance is current world wide One Health issues in the areas of human, animal, and environmental fields due to the extensive use and misuse of antimicrobials in the human and animal fields as for growth promotion, prophylaxis and therapeutics [21]. Antibiotics are commonly used to treat infections caused by E. coli and can reduce morbidity and mortality rates. Unfortunately, as a result of self-medication and the overuse of antibiotics in the poultry business to increase the population, these harmful bacteria are becoming resistant to various first line antibiotics, rendering them ineffective [16]. Escherichia coli has been widely used to monitor AMR in livestock and food of animal origin. This is because Escherichia coli can be found in the digestive tracts of warm-blooded animals [11]. cephalosporins and monobactams are third generation beta lactam antibiotics that usually hydrolyzed by enzyme generated by bacteria called extended-spectrum beta-lactamase. The gene encoding for this enzyme can easily transferred between bacteria as it encoded in plasmid as plasmid is horizontally
Antimicrobial agent | Target resistance gene | Primers Sequence | Amplicon size (base pair) | Annealing temperature (°C) | Reference
---|---|---|---|---|---
Streptomycin | aad (A1) | F: 5’- TATCCAGCTAAGGCGCAACT- 3’ R: 5’- ATTGCGGACTACCTTGGT- 3’ | 447 | 58 | (Puno-Sarmiento et al 2013)
Tetracycline | tet (A) | F: 5’- CCTCAGCTTCTCAACGCGTG- 3’ R: 5’- GCACCTTGCTGATGACTCTT- 3’ | 634 | 56 | (Puno-Sarmiento et al 2013)
tet (B) | F: 5’- GGTTCACTCGAACGACGTCA- 3’ R: 5’- CTGTCCGACAAGTTGCATGA- 3’ | 577 | 37 | (Puno-Sarmiento et al 2013)
Fluoroquinolone | qnr | F:5’- GGGTATGGATATTATTGATAAAG-3’ R: 5’- CTAACTCCGGCAGCACTATTTA- 3’ | 670 | 50 | (Li 2005)
Gentamicin | aac (3)-(IV) | F: 5’- CTTCAGGATGGCAAGTTGGT- 3’ R: 5’- TCAATCGTGTTCCGCTCAT- 3’ | 286 | 55 | (Van et al 2008)
Sulfonamide | sul (1) | F: 5’- TTGCCGGATCTGAACTCAG- 3’ R: 5’- ATGATCTAACCCGGCTCTC- 3’ | 822 | 47 | (Van et al 2008)
Cephalothin | bla (SHV) | F: 5’- TGCGCTGGTGTATTCCTC- 3’ R: 5’- CGCAGATAAACACCAAGT- 3’ | 768 | 52 | (Van et al 2008)
Ampicillin | CITM | F: 5’- TGGCCGAACTGACAGGCAAA- 3’ R: 5’- TTCTCCTGAACGTGGCTGGC- 3’ | 462 | 47 | (Van et al 2008)
Erythromycin | ere | F: 5’- GCGGTGCTGCTGATTGAG- 3’ R: 5’- CGACTCTATTCGAGAAGGC- 3’ | 419 | 52 | (Van et al 2008)
Chloramphenicol | cat (1) | F: 5’- AAGTGCTGCTGAATCAACC- 3’ R: 5’- TGAATCTCATAAACGTCTGCC- 3’ | 547 | 55 | (Van et al 2008)
cml (A) | F: 5’- CGCCACCGGTGTTGTTATC- 3’ R: 5’- CACCTTGCTGCCAACTTAG- 3’ | 698 | 55 | (Van et al 2008)
Approach to prevent antibiotic resistance caused by beta lactamase

One of the approaches to addressing the antibiotic resistance caused by beta-lactamases is to develop beta-lactam antibiotics stable beta-lactam antibiotics, such as extended-spectrum cephalosporins, another method is to produce beta-lactam antibiotics in combination with existing beta-lactam antibiotics with beta-lactamase inhibitors. The common beta-lactam antibiotics include amoxicillin/clavulanic acid, ampicillin/sublactam, and piperocillin/tazobactam [13,24].

The menace is further compounded by the highly flexible genome of Escherichia coli, and propensity of resistance dissemination through horizontal gene transfer and clonal spread. Successful management of infections caused by such resistant strains requires an understanding of the diversity of beta-lactamases, their unambiguous detection, and molecular mechanisms underlying their expression and spread with regard to the most relevant information about individual bacterial species [4]. Beta-lactam antibiotics act by inhibiting the bacterial cell wall biosynthesis; they are the most available antibiotics which treat a number of bacterial infections. A broad spectrum of bacteria can be killed by beta-lactams and its toxicity to humans is very low this implies that, the resistance to beta-lactam antibiotics is severe threat, 5 bacteria and other infection causing microbes are remarkably developed several ways to become resistant to antibiotics and other antimicrobial drugs. The MHCs of oxyimino-beta-lactams and clavulanic acid were determined at a fixed concentration of 4 mg/l. The production of Escherichia coli extended-spectrum beta-lactamases (ESBLs) was determined using the Double-Disk Synergy Test (DDST). Specifically, this was performed with cefotaxime (30 μg) and ceftazidime (30 μg) disks placed at a distance of 20 mm (center to center) from the amoxicillin-clavulanic acid disk (20/10 μg).

Promoting the appropriate or prudent use of antimicrobials from the doctor and the pharmacist to the patient is the determinant in reversing the increasing rates of AMR [9]. By employing a variety of prevention strategies, including proper personal hygiene, prescreening for carrier status before hospital admission, disinfection of hospital rooms, and careful monitoring of antimicrobial prescribing, marked progress can be achieved in the control of drug-resistant pathogens, which can translate into more effective antimicrobial therapy [6]. Early and continuous access to data on antibiotic use and AMR made it possible to focus activities on areas of concern. Another factor identified was the long-term control and eradication of infectious animal diseases, including coordinated activities against endemic diseases, which reduced the need to use antibiotics. Structures and strategies for that purpose established at the national level have since proven useful in counteracting [29]. Develop awareness of the community to the Problems of AMR, the ban import and use of resistant ant developed antibiotics, continuous surveillance on antibiotic resistance pattern in animals and animal product and prevention of Specific Resistance, bacteria through good hygiene [29].

Conclusion and recommendation

Antimicrobial resistance is current world wide One Health issues in the areas of human, animal, and environmental fields due to the extensive use and misuse of antimicrobials in the human and animal fields as for growth promotion, prophylaxis and therapeutics. The beta-lactam antibiotics have been used successfully to treat infections caused by pathogenic Escherichia coli. However, currently, the utility of beta-lactams is being challenged severely by a large number of hydrolytic enzymes the beta-lactamases expressed by bacteria. Successful management of infections caused by such resistant strains requires an understanding of the diversity of beta-lactamases, their unambiguous detection, and molecular mechanisms underlying their expression and spread with regard to the most relevant information about individual bacterial species.

Based on the above conclusion the following recommendation was forwarded:

- Properly using the antibiotics as its recommended time intervals and dosages.
- Using specific spectrum rather than broad spectrum.
- Reduce the using of antibiotic as prophylaxis and growth promoters in Animal feeds.
- Frequently conducting of antibiotics resistance Bacterial species surveillances on animals and food of animal origin.
- Confirming of antibiotics medication history of live animals before processing and consumption food of animal origin.
- Prevention and controls of antibiotics resistance bacteria in food animal farms.
- Training of farmers and other community on the public health importance and risk factors associated with the antimicrobial resistant bacterial infections.

References

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