

Detection of extended-spectrum beta-lactamase-producing *E. coli* and *Klebsiella* spp in effluents of different hospitals sewage in Biratnagar, Nepal

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Research note

Keywords: Hospital sewage, *Klebsiella*, *E. coli*, MDR, ESBL, Water

Posted Date: September 26th, 2019

DOI: <https://doi.org/10.21203/rs.2.13196/v3>

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Version of Record: A version of this preprint was published on October 4th, 2019. See the published version at <https://doi.org/10.1186/s13104-019-4689-y>.

Abstract

Objective This study was aimed to determine prevalence and resistance pattern like multidrug resistant (MDR) or ESBL nature of *E. coli* and *Klebsiella* spp from various sewage drain samples with an idea to deliver baseline information that could be utilized for defining guidelines for the treatment of hospital sewages. **Results** Of 10 sewage samples analyzed, 7 (70%) contained *E. coli* while 6 (60%) contained *Klebsiella*. Except one sample, all positive samples contained both *E. coli* and *Klebsiella* spp. *E. coli* isolates were resistant to ampicillin, amoxicillin, ceftazidime, cefuroxime, and cefpodoxime; while 85.7% were resistant to amoxicillin/clavulanate, ceftazidime, cefotaxime and ceftriaxone. 71.4%, 57.1%, 42.9%, and 28.6% were resistant to aztreonam, trimethoprim/sulfamethoxazole, nitrofurantoin, and gentamicin. Most were sensitive to chloramphenicol, ofloxacin, ciprofloxacin, and azithromycin. 85.7% and 57.1% of *E. coli* were MDR and ESBL isolates respectively. *Klebsiella* were resistant to ampicillin, amoxicillin, and amoxicillin/clavulanate. 83.4% of *Klebsiella* were resistant to ceftazidime. 66.7% of strains were resistant to cefuroxime, ceftazidime, cefotaxime, ceftriaxone, and cefpodoxime. *Klebsiella* showed 50% resistant to aztreonam and trimethoprim/sulfamethoxazole, while 33.3% were resistant to chloramphenicol, nitrofurantoin, ofloxacin, and ciprofloxacin. *Klebsiella* were sensitive to azithromycin and gentamicin. 66.7% and 33.3% of *Klebsiella* were MDR and ESBL isolates respectively.

Introduction

Sewage designates raw sewage, sewage sludge or septic tank waste containing about 95.5% water and 0.1% to 0.5% organic and inorganic materials. Hospital wastewaters are generated in different sections of hospital like surgery units, ICU, laboratories, patient wards, clinical wards, laundries and possess a quite variable compositions depending on the activities involved [1]. A variety of microorganisms are present in water for examples bacteria, fungi, protozoa etc. Bacteria like *Shigella*, *E. coli*, *Klebsiella*, *Vibrio*, *Salmonella*, etc. are found in sewage drain water [2]. Coliforms are mainly from family *Enterobacteriaceae* that are aerobic or facultative aerobic, gram negative, non-spore forming enteric bacilli and basically found in human colon which are introduced into environment by human feces [3, 4].

Antibiotics are fractionally metabolized by patients and are then ejected into the hospital sewage. Along with excreta, they pass through sewage system and end up in the environment, mainly in the water area [5]. Hospital sewage discharge a variety of multi resistant bacteria and substances like antimicrobial, pharmaceutical, disinfectants, heavy metals, radioisotopes, and drugs not metabolized by patients [6].

Multiple drug resistance (MDR) for Gram negative and Gram-positive bacteria means "resistant to three or more antimicrobial classes." Extended-spectrum β -lactamases (ESBL) are enzymes that impart resistant to extended-spectrum (third generation) cephalosporins (eg. ceftazidime, cefotaxime and ceftriaxone) and monobactams (eg. aztreonam). The most common ESBL producing bacteria are few strains of *E. coli* and *Klebsiella pneumoniae* [7, 8].

The main aim of this study was to determine prevalence and resistance pattern like MDR or ESBL nature of *E. coli* and *Klebsiella pneumoniae* from various sewage drain samples since they can cause serious public health problem. This study could deliver baseline information that could be utilized for defining guidelines for the treatment of hospital sewages.

Methods

Sample collection method and characteristics

During March to October 2018, a total of 10 sewage samples were collected aseptically from different hospitals of Biratnagar city (Table 1). For this, the sample was collected nearby the center of the flow channel, at approximately 10-15 cm depth from the water surface, where the turbulence was at maximum and the possibility of settling was minimized. Skimming the water surface or dragging the bottle was avoided. The sewage water was first mixed and then 500 ml sample was taken in the sterile high-density polyethylene (HDPE) bottle aseptically. Each sample bottle was properly labelled with date, code number and time with the help of the marker.

Sample transportation and processing

Samples collected were placed on 4°C ice box to inhibit the growth of microorganisms and were immediately transported (within 2 hours) to microbiology research lab for the analysis. Distilled water was used as control during analysis.

Isolation and Identification of *E. coli* and *Klebsiella* spp

The samples collected from the hospital wastewater were serially diluted in 0.85% saline water and dilution 10^{-2} and 10^{-3} were inoculated onto Eosin Methylene Blue (EMB) Agar and MacConkey Agar for *Escherichia coli* and *Klebsiella* spp by spread plate method and were incubated aerobically at 37 °C for 24-48 hours. After incubation, colonies were picked on their colony morphology like colonial appearance, size, elevation, color, margin, and opacity. All the selected colonies were, then, sub-cultured on nutrient agar plate to obtain pure culture for the microscopic and biochemical identification. TSI (triple sugar iron), SIM (sulfate/indole/motility), Methyl Red test, Voges–Proskauer test, citrate agar, catalase test, oxidase test, and urea hydrolysis test were performed to identify the organisms [9].

Antimicrobial susceptibility tests

The identified isolates of *Escherichia coli* and *Klebsiella* spp were submitted to antimicrobial susceptibility testing according to the guidelines of the Clinical and Laboratory Standards Institute [10]. The isolates were inoculated onto Mueller-Hinton agar medium using turbidity of 0.5 McFarland standard. The following antimicrobial disk (Himedia, Mumbai, India) were used: Ampicillin (AMP)(10 µg), Amoxicillin (AMX)(10 µg), Amoxicillin/clavulanate (AMC)(20/10 µg), Cefoxitin (CX)(30 µg), Ceftazidime (CAZ)(30 µg), Ceftriaxone (CTR)(30 µg), Cefpodoxime (CPD)(10 µg), Cefuroxime (CXM)(30 µg),

Aztreonam (AT)(30 µg), Chloramphenicol (C)(30 µg), Azithromycin (AZM)(15 µg), Gentamicin (GEN)(30 µg), Ciprofloxacin (CIP)(5 µg), Ofloxacin (OF)(5 µg), Nitrofurantoin (NIT)(300 µg), and Trimethoprim/sulfamethoxazole (COT)(1·25/23·75 µg). The swabbed MHA plates with the discs were incubated at 37 °C for 24 hours. Zone of inhibition was measured and interpreted using the standard chart [10]. Due to unavailability of ATCC culture, sensitive *E. coli* and *Klebsiella pneumoniae* strains with established antibiogram were used as control.

Criterion for Multidrug Resistance

Isolates which demonstrated the resistance to at least one agent in three or more classes of the drug were defined as multidrug resistant (MDR) [10, 11].

ESBL detection

Isolates exhibiting a zone of inhibition of growth for ceftazidime and ceftriaxone ≤ 22 mm and ≤ 25 mm, respectively, were submitted to the combined disc test to check for ESBL-producing strains [12]. The combined disc methodology used to detect ESBL-producing *E. coli* and *Klebsiella* spp was performed as per CLSI [10]. The antimicrobials used were ceftazidime (30 µg) and ceftazidime/clavulanic acid (30/10 µg), and cefotaxime (30 µg) and cefotaxime/clavulanic acid (30/10 µg). Results were interpreted as per the criteria established by the CLSI [10]. An increase of 5 mm in a zone of inhibition of growth for combined drugs to ceftazidime or cefotaxime were confirmatory for ESBL-producing strains [10, 12].

Multiple antibiotic resistance (MAR) index

MAR index is the number of antibiotics to which test isolate displayed resistance divided by the total number of antibiotics to which the test organism has been evaluated for sensitivity. MAR index for each isolate was calculated as per the guidelines of Krumperman [13].

Data Analysis

The data were statistically analyzed using Statistical Package for Social Sciences (SPSS v21) software package. Chi-square test at p-value <0.05 was considered statistically significant.

Results

Out of 10 samples analyzed, 7 (70%) contained *E. coli* while 6 (60%) contained *Klebsiella*. Except one sample, all positive samples contained both *E. coli* and *Klebsiella* spp.

Colonies with green metallic sheen on EMB agar on further analysis were confirmed to be *E. coli*. Microscopic examinations revealed them to be gram negative non-capsulated bacilli (1SH, 2SH, 3TMC, 5LG, 8KZ, 9KZ, 10KZ). All the 7 isolates were motile, non-hydrogen sulfide producers; VP, citrate, oxidase negative while was indole, methyl red, catalase, urease, TSI (acid/acid with gas) positive. Pink colored, highly mucoid colonies in EMB Agar on further examinations were found to be *Klebsiella pneumoniae*.

Microscopic examinations revealed them to be gram negative capsulated bacilli (1SH, 2SH, 3TMC, 5LG, 8KZ, 10KZ). All the 6 isolates were non-motile, non-hydrogen sulfide producers; indole, MR, oxidase negative while was VP, citrate, catalase, urease, TSI (acid/acid with gas) positive.

Out of 7 samples (n = 7) of *E. coli*, all the isolates were resistant to ampicillin, amoxicillin, cefoxitin, cefuroxime, and cefpodoxime. 85.7% of *E. coli* were resistant to amoxicillin/clavulanate and cephalosporins like ceftazidime, cefotaxime and ceftriaxone. The resistance shown by *E. coli* to aztreonam, Trimethoprim/sulfamethoxazole, nitrofurantoin, and gentamicin were 71.4%, 57.1%, 42.9%, and 28.6% respectively (Table 2). 14.3% of strains were resistant to chloramphenicol and fluoroquinolones like ofloxacin, ciprofloxacin. All the strains were sensitive to azithromycin. Out of 7 isolates, 6 (85.7%) of *E. coli* (1SH, 2SH, 3TMC, 5LG, 9KZ, 10KZ) were multidrug resistant (MDR) bacteria. Notably 4 isolates (57.1%) of *E. coli* (1SH, 2SH, 9KZ, 10KZ) were confirmed as ESBL producing isolates.

Klebsiella pneumoniae were resistant to ampicillin, amoxicillin, and amoxicillin/clavulanate. 83.4% of *Klebsiella* were resistant to cefoxitin; while 66.7% were resistant to cefuroxime, ceftazidime, cefotaxime, ceftriaxone, and cefpodoxime (Table 2). *Klebsiella* showed 50% resistant to aztreonam and Trimethoprim/sulfamethoxazole. 33.3% of strains were resistant to chloramphenicol, nitrofurantoin, ofloxacin, and ciprofloxacin. Only 16.7% of strains were resistant to azithromycin while were fully sensitive to gentamicin. Out of 6 *Klebsiella*, only 4 (66.7%) (1SH, 2SH, 3TMC, 8KZ) were MDR. Two isolates (33.3%) of *Klebsiella* (2SH, 8KZ) were confirmed to be ESBL producing isolates.

Multiple antibiotic resistance (MAR) indices of bacteria revealed that none of *E. coli* and *Klebsiella* were susceptible or resistant to all the seventeen tested drugs (Fig 1). Of all 7 *E. coli*, 1 (14.3%) was resistant to 6 drugs (MARI= 0.353), 1 (14.3%) was resistant to 9 drugs (MARI= 0.529), 3 (42.9%) were resistant to 11 drugs (MARI= 0.647), and 2 (28.6%) was to 14 drugs (MARI= 0.824). Of all 6 *Klebsiella*, 1 (16.7%) was resistant to 3 drugs (MARI= 0.176), 1 (16.7%) was resistant to 4 drugs (MARI= 0.235), 2 (33.3%) were resistant to 10 drugs (MARI= 0.588), 1 (16.7%) was resistant to 15 drugs (MARI= 0.882), and 1 (16.7%) was to 16 drugs (MARI= 0.941).

There is no significant relationship between the type of bacterial strains (like *E. coli* and *Klebsiella*) and their response to the antibiotics at df=1, p=0.05.

Discussion

The main aim of this study was to determine prevalence and resistance pattern like MDR or ESBL nature of *E. coli* and *Klebsiella pneumoniae* from various sewage drain samples. Presence of 70% of *E. coli* and 60% of *Klebsiella* in sewage may have direct link with the human feces in many cases [14]. Sewage mass is liquid mass containing excessive amount of organic matter which acts as a nutrient medium for all the bacteria [15]. Excessive number of MDR and ESBL *E. coli* and *Klebsiella* show that drainage system of Biratnagar hospitals is highly infectious and life threatening if contaminated with water and food [16].

The result of *E. coli* showing 100% resistance to ampicillin, amoxicillin, cefoxitin, cefuroxime, and cefpodoxime was higher than Belachew et al [17] showing 91.3% resistance to ampicillin, 70% resistance to cefuroxime and ceftriaxone, Cefpodoxime (74%), amoxicillin/clavulanate (52%), cefoxitin (43%), ceftazidime (65%). In this study, 85.7% of *E. coli* were resistant to amoxicillin/clavulanate, ceftazidime, cefotaxime and ceftriaxone. Resistance to nitrofurantoin was similar in Belachew et al [17]. Resistance to aztreonam and chloramphenicol were higher than the findings of Florica et al [18]. On the contrary, resistance to trimethoprim/sulfamethoxazole (57.1%), gentamicin (28.6%) and ciprofloxacin (14.3%) in our study was lower than Belachew et al [17] showing 67%, 43%, and 52% respectively. It has been observed that none of the hospitals in Biratnagar have waste treatment system as a result, 85.7% of *E. coli* species had multi-drug resistance, which is, higher compared to previously reported results in Ethiopia (78%) [17] and Romania (60.34%) [18]. Such a high resistance rate may be a result of poor waste management practice, lack of treatment plants for healthcare institutions and poor antimicrobial usage in Biratnagar.

Klebsiella pneumoniae showed 100% resistance to ampicillin and amoxicillin/clavulanate which was higher than the study of Ethiopia (94%) [17] and Romania (70.7%) [18]. Resistance to penicillin antibiotics like ampicillin has become very common in the world and our finding is in line with this evidence. Resistance of 66.7% for ceftazidime, cefotaxime, and ceftriaxone was higher than the findings of Romania [18] as 8.6%, 17.2% and 13.8% respectively. Resistance shown by Trimethoprim/sulfamethoxazole (50%), chloramphenicol (33.3%) and ciprofloxacin (33.3%) were much higher than found in Romania as 22.4%, 5.2% and 6.9%. Similarly, the resistance to cefoxitin, cefuroxime, cefpodoxime, and nitrofurantoin in this study was found to be much higher than other studies [17]. A high rate of MDR (66.7%) was observed for *Klebsiella* spp which was higher than results reported in Ethiopia (40.5%) [17], Romania (33%) [18] and Mexico (50%) [19]. However, MDR rate of the current finding was lower than previously reported results in Brazil (77.5%) [20]. Such variation may be due to the difference in antimicrobial use and availability of waste treatment system in hospital sewage [17].

Conclusion

This study builds the importance to enquire the involvement of hospital liquid waste discharge in the development and distribution of antibiotics resistance in the environment. There is rise in resistant bacteria like *E. coli* and *Klebsiella* in hospital wastewater. The government must implement some rules and laws for proper treatment of hospital wastewater before entry to main municipal wastewater. Sewage treatment plant must be established in hospital for their effluents and sludge coming from the hospital's units.

Limitations

The standard strain *E. coli* (ATCC 25922) and *K. pneumoniae* (ATCC 13883) could not be used.

Abbreviations

MDR: Multiple drug resistance; ESBL: Extended-spectrum b- lactamases; ICU: Intensive Care Unit; HDPE: High Density Polyethylene; EMB: Eosin Methylene Blue; TSI: Triple Sugar Iron; SIM: Sulfate/ Indole/ Motility; CLSI: Clinical and Laboratory Standards Institute; MHA: Mueller-Hinton agar; AMP: Ampicillin; AMX: Amoxicillin; AMC: Amoxicillin/clavulanate; CX: Cefoxitin; CAZ: Ceftazidime; CTR: Ceftriaxone; CPD: Cefpodoxime; CXM: Cefuroxime; AT: Aztreonam; C: Chloramphenicol; AZM: Azithromycin; GEN: Gentamicin; CIP: Ciprofloxacin; OF: Ofloxacin; NIT: Nitrofurantoin; COT: Trimethoprim/sulfamethoxazole; µg: Microgram; ml: Milliliter; MAR: Multiple antibiotic resistance; MAR: Multiple antibiotic resistance indices; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

Research approval was taken from AASRA Research and Education Academy Counsel, Biratnagar and Microbiology Department of MMAMC, Biratnagar, Nepal. Informed written consent was obtained from all participants.

Authors' contributions

SM and AM were involved in planning the research, study design, analysis, and writing the manuscript; SM, EP and AT were involved in laboratory work and data collection and compiling, preparation of report; SM and AM were involved in analysis, review and editing. All authors read and approved the final manuscript.

Acknowledgements

We sincerely appreciate the visionary efforts and inputs of AASRA Research and Education Academy Counsel for making this study possible. We are also thankful to those individuals who made this study possible through their contribution by any means.

Competing interests

The authors declare that they have no competing interests.

Availability of data and material

All the required data and material of research is given in the manuscript.

Consent for publication

Not Applicable

Funding

No fund/grant was received for the research work.

References

1. Aurelien Bde H, Sylvie B, Alain D, Jerome G, Yves P. Ecotoxicological risk assessment linked to the discharge by hospitals of bio-accumulative pharmaceuticals into aquatic media: The case of mitotane. *Chemosphere*. 2013;93(10):2365–72.
2. Al-Gheethi AA, Efaq AN, Bala JD, NorliM I, Abdel-Monem MO, Ab Kadir MO. *Appl Water Sci*. 2018;8:74.
3. Manyi-Loh CE, Mamphweli SN, Meyer EL, Makaka G, Simon M, Okoh, AI. An Overview of the Control of Bacterial Pathogens in Cattle Manure. *International journal of environmental research and public health*. 2016;13(9):843.
4. Martin NH, Trmčić A, Hsieh TH, Boor KJ, Wiedmann M. The Evolving Role of Coliforms as Indicators of Unhygienic Processing Conditions in Dairy Foods. *Front Microbiol*. 2016;7:1549.
5. Mohameda HSA, Uswege M, Robinson HM. Correlation between Antibiotic Concentrations Genes Contaminations at Mafisa Wastewater Treatment Plant in Morogoro Municipality, Tanzania. *Glob Environ Health Saf*. 2018;2(1):5.
6. Fekadu S, Merid Y, Beyene H, Teshome W, Gebre-Selassie S. Assessment of antibiotic- and disinfectant-resistant bacteria in hospital wastewater, south Ethiopia: a cross-sectional study. *J Infect Dev Ctries*. 2015;9:149-156.
7. Rawat, D., & Nair, D. Extended-spectrum β -lactamases in Gram Negative Bacteria. *Journal of global infectious diseases*, 2010;2(3):263-74.
8. Mahato S, Mahato A, Yadav J. Prevalence and Identification of Uropathogens in Eastern Nepal and Understanding Their Antibigram Due to Multidrug Resistance and Esbl. *Asian Pacific Journal of Microbiology Research*, 2018;2(1):09-17.
9. Cheesbrough, M. Biochemical tests to identify bacteria. In: *District Laboratory Practice in Tropical Countries, Part II*. 2nd ed. New York: Cambridge University Press; 2009. p. 45–58.
10. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing: 26th informational supplement. 2016. Document M100-S26. CLSI, Wayne, USA.
11. Magiorakos AP, Srinivasa A, Carey RB, Carmeli Y, Falagas ME, Giske CG. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. *Clinical Microbiology and Infectious Diseases*. 2011;18:268-281.
12. Kumar D, Singh AK, Ali MR, Chander Y. Antimicrobial Susceptibility Profile of Extended Spectrum β -Lactamase (ESBL) Producing *Escherichia coli* from Various Clinical Samples. *Infect Dis (Auckl)*. 2014;7:1-8.
13. Krümpermann PH. Multiple Antibiotics Resistance Indexing of *E. coli* to Identify High Risks Sources of Faecal Contamination of Foods. *Applied and Environmental Microbiology*. 1983;46 (1):165-170.
14. WHO, Guidelines for Drinking Water Quality, 4th ed., World Health Organization, Geneva, 2017.
15. Abdel-Raouf N, Al-Homaidan AA, Ibraheem IB. Microalgae and wastewater treatment. *Saudi journal of biological sciences*. 2012;19(3):257-75.

16. Korzeniewska E, Korzeniewska A, Harnisz M. Antibiotic resistant *Escherichia coli* in hospital and municipal sewage and their emission to the environment. *Ecotoxicology and environmental safety*. 2013;91. 10.1016/j.ecoenv.2013.01.014.
17. Belachew T, Mihret A, Legesse T, Million Y, Desta K. High level of drug resistance by gram-negative bacteria from selected sewage polluted urban rivers in Addis Ababa, Ethiopia. *BMC research notes*. 2018;11(1):524. doi:10.1186/s13104-018-3622-0
18. Florica M, Luminita M, Ioana S, Veronica L. Antibiotic resistance markers among gram-negative isolates from wastewater and receiving rivers in South Romania. *Roman Biotechnol Lett*. 2015;20(1):10055–10069
19. Delgado-G MCE, Tamez-GP Gomez-FR, Zavala-DS FJ, Gilberto EV, Guadalupe Virginia NM, et al. Multidrug-resistant bacteria isolated from surface water in Bassaseachic Falls National Park, Mexico. *Int J Environ Res Public Health*. 2016;13:597. doi: 10.3390/ijerph13060597.
20. de Sousa JA, Silva-Souza ÂT. Bacterial community associated with fish and water from Congonhas River, Sertaneja, Paraná, Brazil. *Biol Technol Int J*. 2001;44(4):373–381.

Tables

Table 1: Sample collection detail of hospitals from Biratnagar, Nepal

Sample	Date	Location	Code	<i>Klebsiella</i>	<i>E. coli</i>	Code
1	0125	Saptakoshi Hospital	S1LP	+	+	S1P
2	0125	Saptakoshi Hospital	S2LP	+	+	S2G
3	0131	Tulasa Mother and Child Hospital	S3LP	+	+	S3G
4	0131	Max International Hospital	S4	-	-	S4
5	0204	Lifeguard Hospital	S5LP	+	+	S5G
6	0406	Morang Sahakari Hospital	S6	-	-	S6
7	0406	Morang Sahakari Hospital	S7	-	-	S7
8	0408	Koshi Zonal Hospital	S8LP	+	+	S8G
9	0408	Koshi Zonal Hospital	S9	-	+	S9LP
10	0408	Koshi Zonal Hospital	S10LP	+	+	S10LP

Table 2: Antibiotic susceptibility pattern of *Klebsiella* and *E. coli* in percentage

Antibiotics	Resistance Percentage (%)	
	<i>Klebsiella</i>	<i>E. coli</i>
Ceftazidime	66.7	85.7
Cefotaxime	66.7	85.7
Cefoxitin	66.7	57.1
Ceftriaxone	66.7	85.7
Cefpodoxime	66.7	100
Cefuroxime	66.7	85.7
Chloramphenicol	50	14.3
Gentamicin	0	28.6
Amoxicillin/Clavulanate	100	14.3
Ampicillin	100	100
Amoxicillin	100	100
Aztrenoam	50	71.4
Ciprofloxacin	33.3	14.3
Ofloxacin	33.3	14.3
Azithromycin	16.7	0
Nitrofurantoin	66.7	0
Trimethoprim/Sulphamethoxazole	50	57.1

Figures

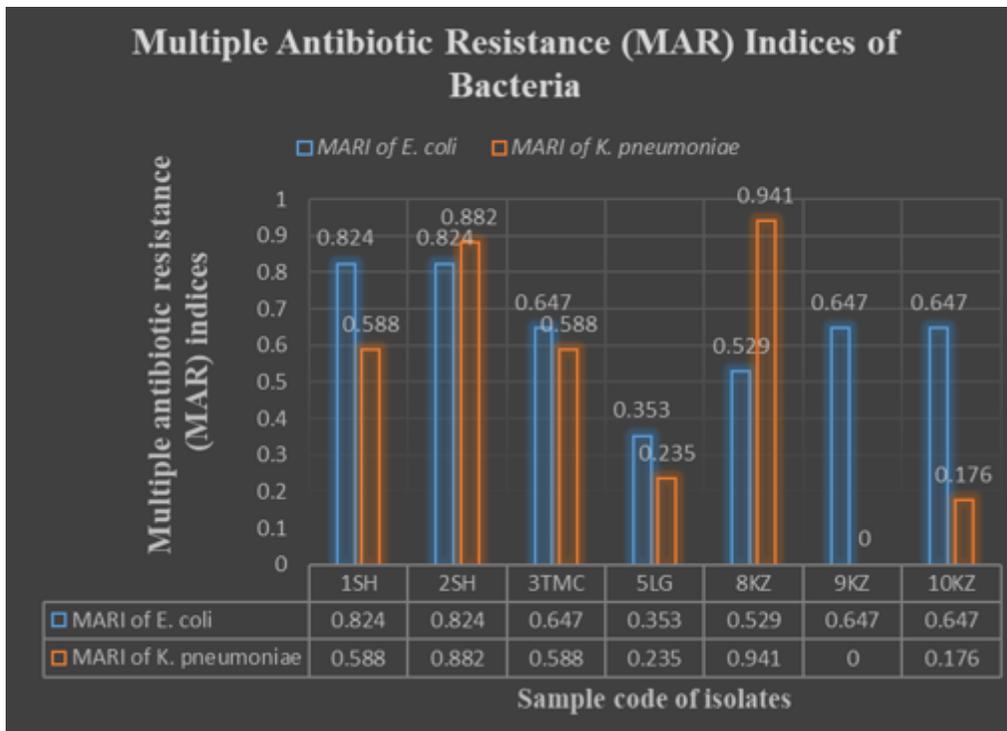


Figure 1

Multiple antibiotic resistance (MAR) indices of bacteria. MAR indices of bacteria revealed that none of E. coli and Klebsiella were susceptible or resistant to all the seventeen tested drugs.