



Phenotypic Identification and Genotypic Characterization of Plasmid-Mediated AmpC β -Lactamase-Producing *Escherichia coli* and *Klebsiella pneumoniae* Isolates in Iran

Saeedeh Robotjazi¹ · Farhad Nikkhahi¹ · Mojtaba Niazadeh¹ · Seyed Mahmoud Amin Marashi¹ · Amir Peymani¹ · Amir Javadi² · Amir Hossein Kashani¹

Received: 16 July 2020 / Accepted: 26 March 2021 / Published online: 10 April 2021
© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2021

Abstract

One of the mechanisms of *Klebsiella pneumoniae* and *Escherichia coli* resistance to β -lactam antibiotics is the production of β -lactamase enzymes. Among these are the AmpC β -lactamases, which confer resistance to a class of antibiotics. However, little is known about the AmpC β -lactamases of *K. pneumoniae* and *E. coli* clinical isolates in Qazvin, Iran. This study was designed to assess the AmpC β -lactamases-producing strains and also identify the prevalence of *AmpC* β -lactamases genes. Antimicrobial susceptibility tests were performed on 435 *K. pneumoniae* and *E. coli* isolates using disk diffusion technique. Plasmid-mediated *AmpC* genes were studied using a multiplex PCR assay. The AmpC β -lactamase-producer isolates were studied by employing cefoxitin disk diffusion test, AmpC induction test, AmpC cefoxitin-EDTA test, and boronic acid disk test. Our results showed that of 46 (18.4%) cefoxitin-insensitive *E. coli* isolates, 10 (21.7%) were positive for *AmpC* β -lactamase genes, among them 4 (8.69%) isolates were positive for *bla*_{DHA} genes and 6 (13%) for *bla*_{CIT} genes. Of 57 (30.4%) cefoxitin-insensitive *K. pneumoniae* isolates, 10 (17.5%) were positive for AmpC gene with 4 (6.34%) and 6 (9.5%) isolates positive for *bla*_{DHA} and *bla*_{CIT} genes, respectively. However, no *MOX*, *ACC*, *FOX*, or *EBC* genes were detected in the isolates. Considering the results of different confirmatory phenotypic tests, the AmpC cefoxitin-EDTA test showed a higher discriminatory power for detecting AmpC β -lactamase-producing strains. The specificity and sensitivity of AmpC cefoxitin-EDTA were 77%, 100% for *K. pneumoniae* and 70%, 90% for *E. coli* higher than the other two tests, respectively. Also, the authors demonstrated high prevalence rate for resistance to certain antibiotics, such as cefuroxime, trimethoprim-sulfamethoxazole, ampicillin, and cefotaxime. In conclusion, our study provided valuable information regarding the plasmid-mediated *AmpC* β -lactamase gene content, antibiotic resistance, and confirmatory phenotypic tests for AmpC β -lactamases in *E. coli* and *K. pneumoniae* isolates from clinical sources.

Introduction

One of the major health problems around the world is the emergence of antibiotic resistance among pathogenic bacteria, which has spread to medical centers and

hospitals [1]. *Escherichia coli* and *Klebsiella pneumoniae* are important bacteria in the family of Enterobacteriaceae and responsible for urinary tract infections (UTIs) and severe conditions, such as bacteremia, pneumonia, and sepsis [2, 3]. β -lactamase is an enzyme with the ability to

✉ Farhad Nikkhahi
Farhadnikkhahi@gmail.com

Saeedeh Robotjazi
robotjazi.1200@gmail.com

Mojtaba Niazadeh
moj.nia@gmail.com

Seyed Mahmoud Amin Marashi
parsmicrob@gmail.com

Amir Peymani
a.peymani@gmail.com

Amir Javadi
javadi_a@yahoo.com

Amir Hossein Kashani
amirhossien_k@yahoo.com

¹ Medical Microbiology Research Center, Qazvin University of Medical Science, Qazvin, Iran

² Department of Biostatistics, Qazvin University of Medical Sciences, Qazvin, Iran