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Research Article

Antimicrobial Resistance Pattern of *Klebsiella pneumoniae* Isolated from UTI Cases in and Around South Trivandrum District, Kerala, India

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Abstract

Background and objectives: Antimicrobial resistance among bacterial strains is an emerging problem. Urinary tract infections are one of the most common bacterial infections in humans, both in the hospital and the community settings. Multidrug resistance is seen in Klebsiella which serves as the most common cause of increased morbidity and mortality. The objective of this study was to isolate and evaluate the antimicrobial resistance pattern of *Klebsiella pneumoniae* from UTI cases in and around southern part of Trivandrum district, Kerala. *Materials and Methods:* This retrospective work was carried out between December 2024 and September 2025, at the Microbiology diagnostic laboratory, Dr. SM CSI Medical College and Hospital, Karakonam, Trivandrum district, Kerala. 200 cases of *Klebsiella pneumoniae* culture positive cases of UTI from both inpatients and outpatients were included in the study. Midstream and catheterized urine were collected with proper precautions, as per their clinical conditions. The isolates were obtained by culturing the samples in conventional media and identified as per CLSI guidelines. Antibiotic susceptibility of each of the isolate was performed in Mueller Hinton agar by disc diffusion test and interpreted as per CLSI standards. For quality control, *Klebsiella pneumoniae* ATCC 13883 strain was utilized. The collected data was entered in MS-Excel and statistical analysis was done using SPSS 17 software and were expressed as percentages. *Results:* Out of the 200 Klebsiella pneumoniae culture positive cases, >70 age group predominated (26.5%). Nearly two third of the cases were male. 62% of the cases were inpatients. Among the 124 inpatients, female medical ward cases predominated (41.9%) over other wards. There were 54 MDR Klebsiella pneumoniae positive cases, of the total 200 positive cases (27%), under study. Overall, 100% of the Klebsiella pneumoniae isolates were susceptible to the lifesaving drugs like, Colistin and Tigecycline, followed by Meropenem (75%), Cefoperazone/sulbactam (66.5%), Amikacin (63.5%) and Piperacillin/tazobactam (62%), in that order. *Conclusion:* Our study revealed emergence of MDR Klebsiella pneumoniae among UTI cases, evident by the finding of 27% of the isolates being resistant to all antibiotics used, except, Colistin and Tigecycline. Another important observation was the emergence of gentamicin, being a first line drug, as a more effective drug than the higher antibiotics, against some of the resistant strains isolated (58%).

Keywords

Antimicrobial Resistance, Klebsiella Pneumoniae, Multidrug Resistance (MDR), UTI

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1. Introduction

The second most prevalent bacterial illness that affects people of all ages globally is urinary tract infection (UTI) [1]. Gram-negative bacteria often cause UTIs and present a major public health challenge due to their ability to acquire antibiotic resistance, compounded by the diminishing prospects of discovering new antibiotics [2]. *Klebsiella pneumoniae* is one of the most prevalent multidrug resistant organisms (MDROs) [3, 4]. Globally, most drug-resistant infections are brought on by extended-spectrum beta-lactamase (ESBL) and carbapenemase-producing *K. pneumoniae* [5-7].

CRKP infections are associated with a higher mortality rate compared to carbapenem-susceptible strains [8]. Carbapenem resistance in *K. pneumoniae* arises through various mechanisms, including the production of Carbapenamase. MDR *K. pneumoniae* develops resistance towards at least one antimicrobial from three different drug classes. PDR (Pan drug resistant) *K. pneumoniae* isolates are resistant to each drug in all antibiotic groups [9-11]. Nowadays, *K. pneumoniae* is one of the leading causes of HAI and CAI [12-16]. Recently, Sharma et al. [17] and Kaur et al. [18] discovered new trends in antimicrobial susceptibility testing (AST) findings of *K. pneumoniae* isolates in India. By keeping all this in mind, we undertook this study, to isolate and identify *Klebsiella pneumoniae* from UTI cases and to evaluate the antibiotic resistance pattern of these isolates, to know the local antibiotic resistance patterns, so as to implement suitable infection control measures and develop a rational antibiotic policy with local recommendations.

2. Materials and Methods

2.1. Study Design

This retrospective work was carried out between December 2024 and September 2025, at the Microbiology diagnostic laboratory, Dr. SM CSI Medical College and Hospital, Karakonam, Trivandrum district, Kerala. The Institutional Ethics Committee has granted us permission to conduct this study.

2.2. Patient Recruitment

We scrutinized the laboratory data of the patients having positive culture reports. Only those patients who had positive *K. pneumoniae* culture reports were analyzed. The AST findings of these isolates were assessed.

2.3. Data Collection

200 cases of *Klebsiella pneumoniae* culture positive cases of UTI from both inpatients and outpatients were included in the study. Midstream and catheterized urine were collected with proper precautions, as per their clinical conditions. The 200 isolates of K. pneumoniae were obtained by culturing the samples in blood agar and MacConkey agar and identified by conventional biochemical tests [19]. Antibiotic susceptibility of each of the isolate was performed in Mueller Hinton agar by Kirby Bauer disc diffusion test and interpreted as per CLSI standards. For quality control, *Klebsiella pneumoniae* ATCC 13883 strain was utilized. After incubation at 37 ℃ for 18-24 hours, the results were read and interpreted as per CLSI guidelines [20]. The antibiotic discs used were, Amoxycillin-clavulanate (20/10 µg), Piperacillin–Tazobactam (100/10 µg), Gentamicin (10 µg), Amikacin (30 µg), Cefazolin (30 µg), Ceftriaxone (30 µg), Cefuroxime (30 µg), Cefepime (30 µg), Cotrimoxazole (1.25/23.75 µg), Cefoperazone-sulbactam (75/30 µg), Tobramycin (10 µg), Meropenem (10 µg), Norfloxacin (10 µg), Nitrofurantoin (100 µg), Colistin (10 µg) and Tigecycline (15 µg).

2.4. Statistical Analysis

The collected data was entered in MS-Excel and statistical analysis was done using SPSS 17 software and were expressed as percentages.

3. Results

The age group of >70 was the predominant group showing the most number of UTI cases, which were positive for *Klebsiella pneumoniae* culture (26.5%) (Table 1, Figure 1). Nearly, two third of the culture positive cases were males (67%), as compared to females (Table 2, Figure 2). Inpatients (62%) were more than outpatients (Table 3, Figure 3). Among inpatients included in the study, female medical ward (FMW) cases were the maximum (41.9%), as compared to other wards (Table 4, Figure 4).

Most of the isolates showed resistance to cefazolin (64.5%), nitrofurantoin (64%), cefuroxime (60.5%), ceftriaxone and amoxiclav (59% each), in the decreasing order (Table 5, Figures 5, 6). On the other hand, 100% of the strains were sensitive to the lifesaving drugs like, colistin and tigecycline. This was followed by meropenem (75%), Cefoperazone-sulbactam (66.5%), amikacin (63.5%) and piperacillin-tazobactam (62%), in the decreasing order. 54 isolates of *Klebsiella pneumoniae* were MDR, out of the total 200 isolates (27%).

Table 1. *Age wise distribution of Klebsiella pneumoniae isolates in UTI cases (n=200).*

Age group	0-10	11-20	21-30	31-40	41-50	51-60	61-70	>70
No. of isolates	2	2	25	8	21	44	45	53
% of isolates	1%	1%	12.5%	4%	10.5%	22%	22.5%	26.5%

Table 2. *Sex wise distribution of Klebsiella pneumoniae isolates in UTI cases (n=200).*

Sex	Male	Female
No. isolates	134	66
% of isolates	67%	33%

Table 3. *Out-patient and in-patient distribution of Klebsiella pneumoniae isolates in UTI cases (n=200).*

	Out-patient	In-patient
No. of isolates	76	124
% of isolates	38%	62%

Table 4. *Ward wise distribution of Klebsiella pneumoniae among in-patients (n=124).*

Ward	MMW	FMW	MSW	FSW	Neuro ward	Ortho ward	Urology ward	Pediatrics ward	Nephrology ward	OBG-W	MICU	CCU	ICU	EM-W
No.	32	52	2	4	4	4	3	1	1	8	7	2	2	2
%	25.8	41.9	1.6	3.2	3.2	3.2	2.4	0.8	0.8	6.4	5.6	1.6	1.6	1.6

Table 5. *Antibiotic susceptibility pattern of Klebsiella pneumoniae isolates (n=200).*

Antibiotic		No. of isolates	% of isolates
Amoxycillin/	S	82	41
Clavulanic acid	R	118	59
Gentamicin	S	116	58
	R	84	42
Cotrimoxazole	S	93	46.5
	R	107	53.5
Norfloxacin	S	101	50.5
	R	99	49.5
Nitrofurantoin	S	72	36
	R	128	64
Cefazolin	S	71	35.5

Antibiotic		No. of isolates	% of isolates
	R	129	64.5
Cefuroxime	S	79	39.5
	R	121	60.5
Ceftriaxone	S	82	41
	R	118	59
Cefepime	S	109	54.5
	R	91	45.5
Tobramycin	S	112	56
	R	88	44
Amikacin	S	127	63.5
	R	73	36.5
Piperacillin/	S	124	62
Tazobactam	R	76	38
Cefoperazone/	S	133	66.5
Sulbactam	R	67	33.5
Meropenem	S	150	75
	R	50	25
Tigecycline	S	200	100
	R	0	0
Colistin	S	200	100
	R	0	0

S- sensitive, R- resistant

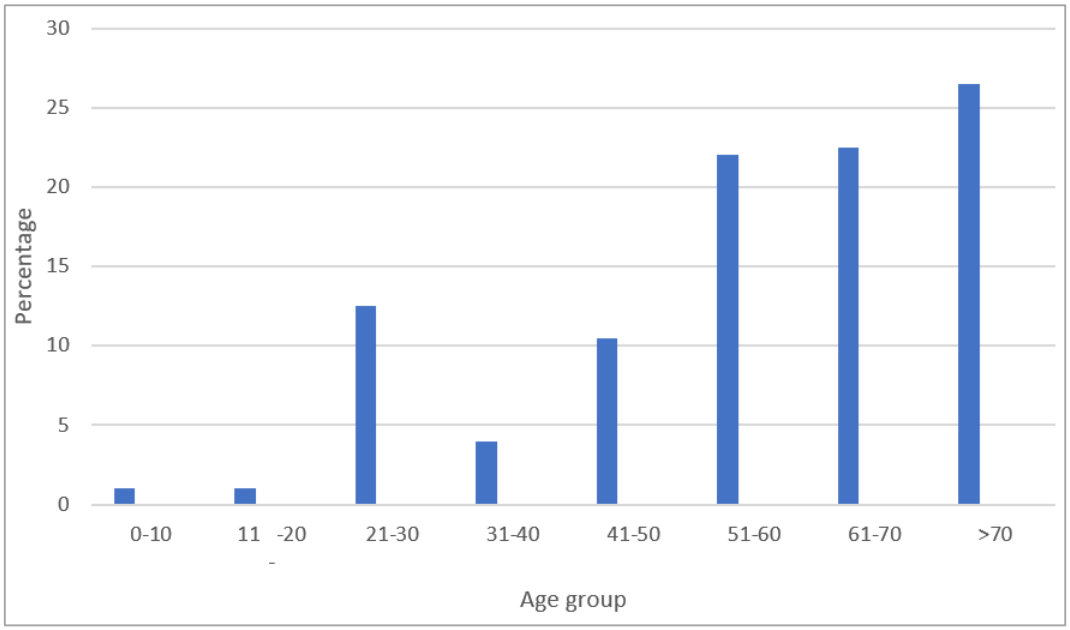

Figure 1. *Age wise distribution of Klebsiella pneumoniae isolates in UTI cases (n=200).*

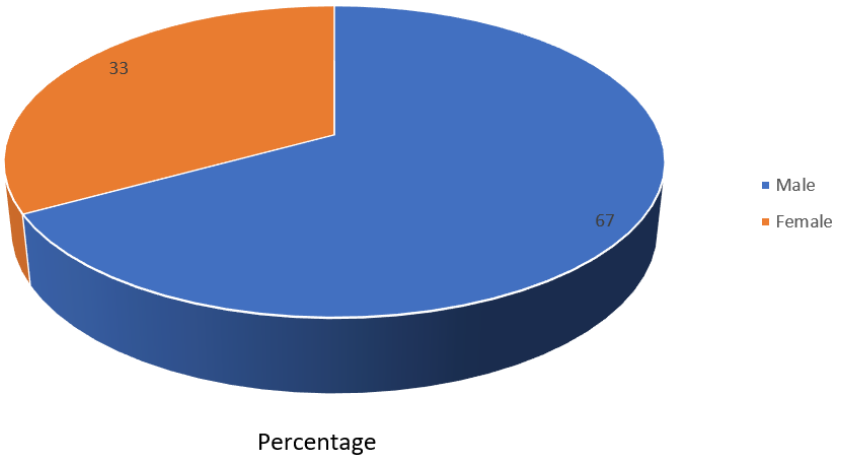

Figure 2. *Sex wise distribution of Klebsiella pneumoniae isolates (n=200).*

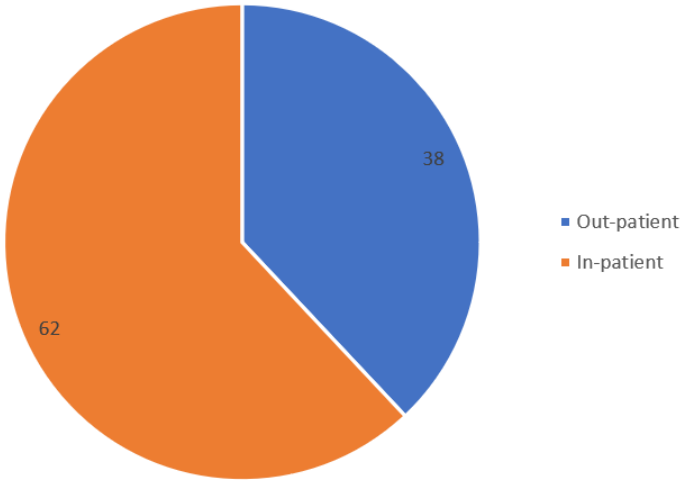

Figure 3. *Out-patient and in-patient distribution of Klebsiella pneumoniae isolates (n=200).*

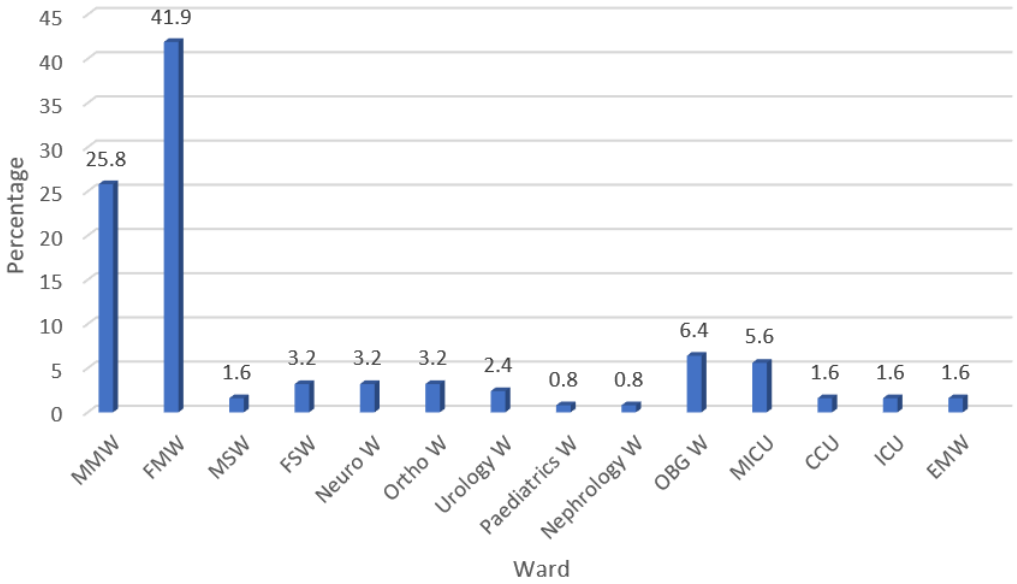

Figure 4. *Ward-wise distribution of Klebsiella pneumoniae isolates among in-patients (n=124).*

MMW- male medical ward, FMW- female medical ward, MSW- male surgical ward, FSW- female surgical ward, EMW- emergency medical ward

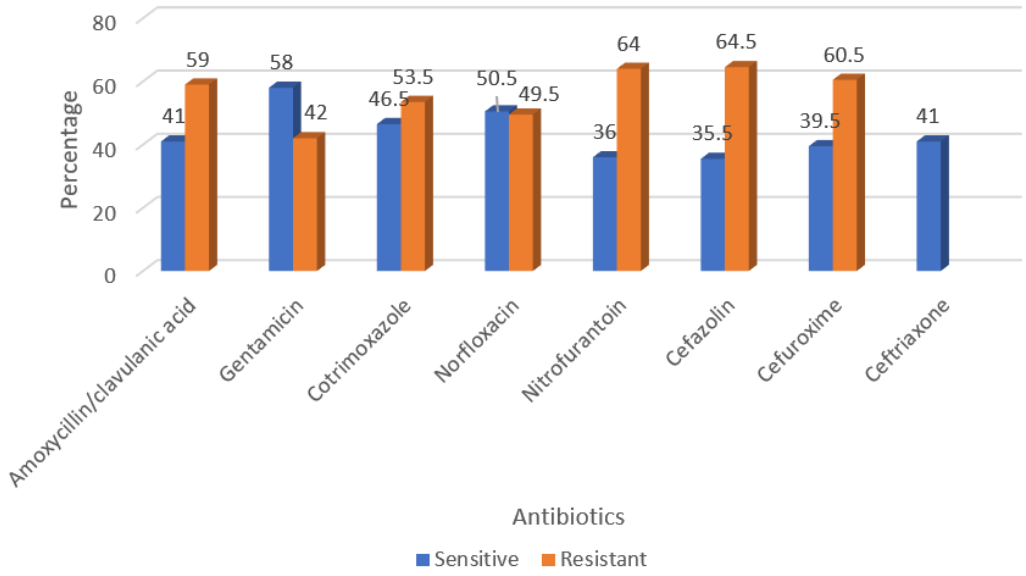

Figure 5. *Antibiotic susceptibility pattern of Klebsiella pneumoniae isolates (n=200).*

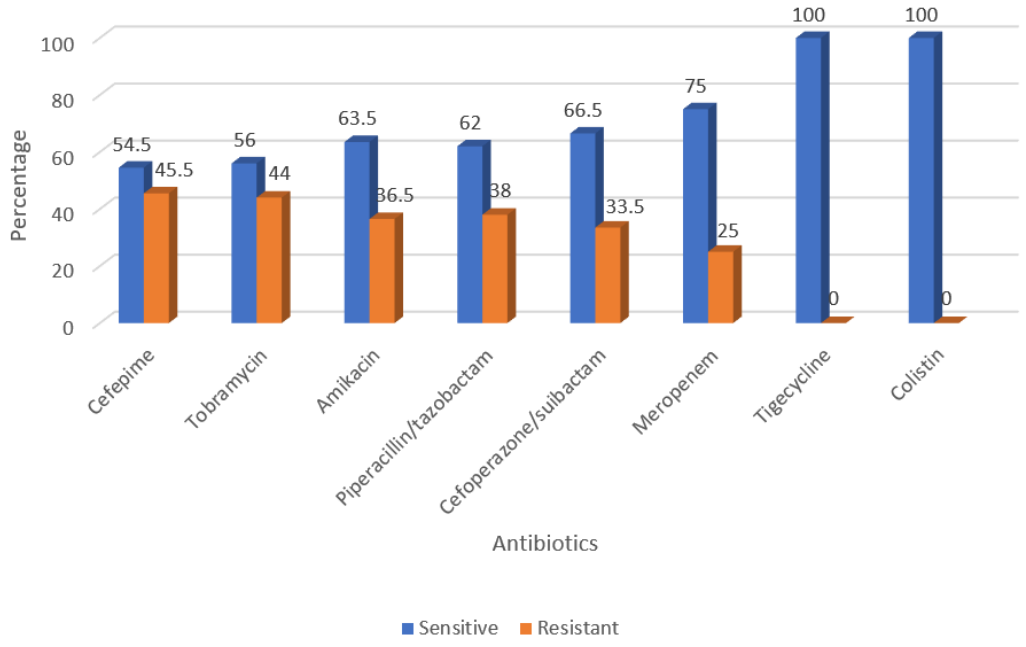

Figure 6. *Antibiotic susceptibility pattern of Klebsiella pneumoniae isolates (n=200).*

4. Discussion

Our study reported >70 age group as the predominant group showing 26.5% distribution of culture positive cases. This observation was different from a study from Bhopal, which recorded 21-40 age group as the dominant group (47.3%) [21]. The predominance of culture positive cases among male in our work (67%), was in accordance with Amandeep Kaur Saini et al 2020, who reported 54.4% cases among male [22]. Our observation of 62% IPD cases among culture positive cases was similar to Punjab study, which reported 60.8% IPD cases [22].

Among the most less effective antibiotics, most of the isolates of *Klebsiella pneumoniae* were resistant to cefazolin (64.5%), nitrofurantoin (64%), cefuroxime (60.5%), ceftriaxone and amoxiclav (59% each). 68.2% of the isolates were resistant to cefuroxime in a study from Trivandrum [24]. In one of our earlier studies [26], and another research work from Bhopal [21], the patterns were 43.7% and 55% respectively. 57.1% of the strains were resistant to ceftriaxone in the work from Trivandrum [24]. There was a dip in the number of strains resistant to amoxiclav from 87.5% in our earlier study

[26] to 59% in the current work. This may be attributed to adhering to antibiotic stewardship program in our institution. On the contrary, the resistance rate has jumped from 33.6% to 74.1% between a gap of 10 years in a study by Jalal NA et al 2023 [23]. There were 54 MDR strains of *Klebsiella pneumoniae* isolates (27%). This is attributable to the inappropriate, inadvertent and irrational use of antibiotics.

There was definitely a dip in the susceptibility pattern of isolates against drugs like amikacin, piperacillin-tazobactam, Cefoperazone-sulbactam and even meropenem, evident from this work, which stood at 63.5%, 62, 66.5 and 75%, respectively, as compared to earlier works [21, 24, 25] or [26], which were above 80%.

5. Conclusion

The presence of 54 (27%) MDR strains of *Klebsiella pneumoniae* and also due to the drastic reduction in the susceptibility of the isolates against 1st, 2nd, 3rd and even 4th generation (cefepime) cephalosporins and gradual dip in the effectiveness of normally stronger antibiotics like, amikacin, beta lactam/beta-lactamase combination drugs like, piperacillin-tazobactam, Cefoperazone-sulbactam and even carbapenems like, meropenem, is a concern, which warrants adhering to strict infection control measures and to educate the clinicians for judicial use of antibacterials. Discovering or inventing newer antibiotics is beyond the scope of the researchers, due to rampant AMR in the community as well as health care setup.

6. Recommendations

By keeping all these findings in this work, in mind, we authors recommend a future work in continuation of this research, by including test parameters for detecting, ESBLs, AmpC beta lactamases and carbapenemase produced by *Klebsiella pneumoniae*, so as to have a broad understanding of its resistance pattern, as it the most predominant species producing frequent multi-drug resistant strains. A questionnaire can also be included, to know the adherence of antibiotic stewardship program in our institution.

Abbreviations

UTI	Urinary Tract Infection
MDR	Multidrug Resistant
MDROs	Multidrug Resistant Organisms
ATCC	American Type Culture Collection
CLSI	Clinical and Laboratory Standards Institute
AST	Antimicrobial Susceptibility Testing
PDR	Pan Drug Resistant
HAI	Healthcare Associated Infection
CAI	Community Acquired Infection
CRKP	Carbapenem Resistant Klebsiella Pneumoniae
ESBL	Extended Spectrum Beta Lactamase
K. pneumoniae	*Klebsiella pneumoniae*
µg	Microgram
MMW	Male Medical Ward
FMW	Female Medical Ward
MSW	Male Surgical Ward
FSW	Female Surgical Ward
OBGW	Obstetrics and Gynecology Ward
MICU	Medical Intensive Care Unit
CCU	Critical Care Unit
ICU	Intensive Care Unit
EMW	Emergency Medicine Ward

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Author Contributions

Suresh Babu: Conceptualization, Data curation, investigation, methodology, project administration, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares no conflicts of interest.

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