ORIGINAL ARTICLE

TRENDS IN CARBAPENEM RESISTANCE FROM 2018-2023 IN HOME HEALTH CARE: THE BOTTOM OF THE ICEBERG

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Abstract

Introduction: There has been a shift in the care of older patients from hospital settings to home healthcare. Older patients are more susceptible to infections, and infections associated with home healthcare are often understudied. This study aimed to investigate the changing trends in carbapenem resistance in these infections over time.

Materials and Method: Microbiological data of home healthcare patients between 2018 and 2023 were analyzed using hospital records.

Results: The rate of carbapenem resistance increased significantly from 4.17% to 19.53% between 2018 and 2023, particularly in Klebsiella spp. and Pseudomonas spp. Additionally, an increase in the number of respiratory and wound tissue samples was observed.

Conclusion: Carbapenem resistance is a growing problem not only in hospitals but also in home healthcare settings. Effective infection prevention and control measures should be implemented, given the complexities of managing these infections, especially in geriatric populations.

Keywords: Home Care Services; Carbapenem-Resistant Enterobacteriaceae; Pseudomonas Aeruginosa; Acinetobacter Baumannii.

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INTRODUCTION

Healthcare-associated infections (HAI) are among the most common adverse events and serious public health threats. This results in prolonged hospitalization, expensive diagnostic methods, increased treatment costs, and reduced quality of life (1,2). The geriatric population is disproportionately affected by HAIs owing to predisposing factors such as age-related changes, geriatric syndromes, and comorbidities (3). Additionally, non-hospital HAIs are frequently overlooked (2). In recent years, there has been a shift from inpatient to home care in Europe. Home care involves healthcare workers taking care of individuals to provide a range of services, from routine checkups to post-mortem care. While home care offers benefits such as an improved quality of life and reduced healthcare costs, it also carries risks such as the potential for infection (2,4). Studies on infections linked to home healthcare services are limited. Infections that arise 48 hours after hospital discharge are defined as home HAI (5).

Patients receiving home healthcare services include those with various underlying medical conditions, invasive procedures, frequent hospitalizations, and intensive care admissions. Bacterial colonization, including that of resistant bacteria, is frequently observed in these patients. Consequently, they are more susceptible to infections caused by resistant bacteria (6, 7). One of these is carbapenem-resistant Gram-negative bacteria such as *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* (8). In cases of non-hospitalized infections selecting an appropriate antibiotic can be challenging because of bacterial resistance (9). In cases of serious infections requiring hospitalization, empirical antibiotics should be initiated with a broader spectrum for this population than for other patients (7).

The objective of this study was to investigate changes in carbapenem resistance rates in samples collected from patients followed up at home healthcare clinics. Additionally, this study analyzed the types of samples and changes in the microbiological epidemiology of these patients over time. The data from our study can aid in determining empirical treatment approaches for patients, both at home and during hospitalization. In addition, it can facilitate the rapid implementation of infection control measures during hospitalization.

MATERIALS AND METHOD

This retrospective study analyzed the microbiological samples of patients who were followed up in the home healthcare clinics of Yildirim Beyazit University Yenimahalle Training and Research Hospital between August 15, 2018, and August 15, 2023. Data were obtained from the electronic medical records of the hospital.

Patients who were followed up at the Home Health Care Clinic and whose samples were sent to the microbiology laboratory were included in this study. Isolates from these samples were identified using an automated microbial identification system (Vitek 2, Biomerieux, France) and conventional methods, such as oxidase, catalase, indole, methyl red, citrate, mobility, citrate, and urease tests. Susceptibility testing was performed using the disc diffusion method and interpreted according to current EUCAST guidelines (10).

All samples collected from the patients were retrospectively examined for microorganisms without distinguishing between infection and colonization. Microorganisms and their resistance status were analyzed, with a focus on carbapenem resistance. Sample types were recorded. Microorganisms and their carbapenem resistance statuses were classified annually, and differences in species and resistance statuses were compared.

SPSS 29.00 software was used for statistical analysis. Descriptive statistics is used to demonstrate the study population, clinical sample, and bacterial distribution. Differences in bacterial species,

carbapenem-resistant bacteria, and culture types over the years were analyzed using the Chi-Square test. The Kruskal -Wallis test was used to analyze the relationship between age and carbapenem resistance rates.

RESULTS

A total of 1243 samples taken from patients followed up at home health care clinics at Yenimahalle Training and Research Hospital were analyzed in this study. No microbial growth was detected in any of the 321 samples. The mean patient age was 71.3 ± 14.8 (26-102) years.

Of the 922 samples containing growing microorganisms, 119 showed carbapenem resistance.

The incidence of carbapenem-resistant bacteria increased in parallel with age (p 0.02). Specifically, there were 77 urine cultures, 15 pressure ulcers, 26 tracheal aspirates, and one sputum sample. Changes in carbapenem resistance rates and microorganisms are shown in Table 1. The samples were grouped into five periods in Figure 1: August 2018-2019, August 2019-2020, August 2020-2021, August 2021-2022, and August 2022-2023. Carbapenem resistance rates showed a statistically significant increase over the years ($p < 0.01$).

Table 1. The change in carbapenem resistance rates between 2018 and 2023.

Date	Carbapenem resistance rate n (%)	*Klebsiella* spp. n (%)	*Pseudomonas* spp. n (%)	*Acinetobacter* spp. n (%)
2018-2019	4 (4,17)	1 (1,04)	2 (2,08)	1 (1,04)
2019-2020	1 (2,32)	1 (2,32)	-	-
2020-2021	4 (7,14)	1 (1,18)	3 (5,36)	-
2021-2022	61 (12,68)	28 (5,94)	23 (4,88)	10 (2,12)
2022-2023	49 (19,53)	33 (12,89)	15 (5,86)	1 (0,39)
Total	119	64	43	12

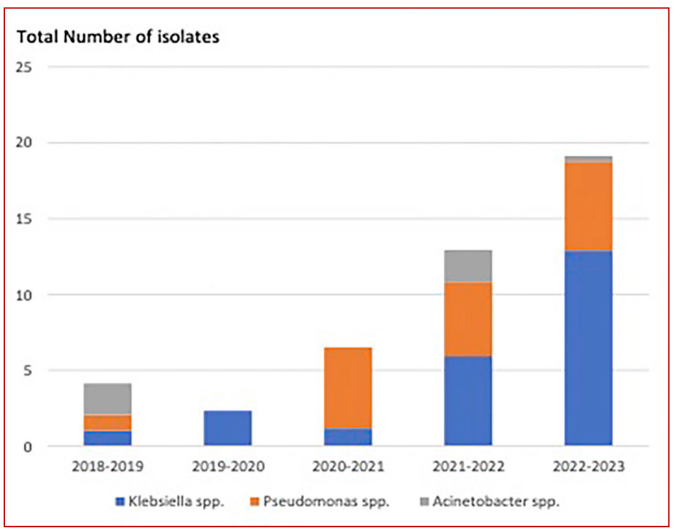

Figure 1. Change in carbapenem resistance over time.

Table 2. The change in sample types between 2018 and 2023.

Date	Urine n (%)	Wound n (%)	Aspirate n (%)	Sputum n (%)	Total n (%)
2018-2019	104 (97.20)	1 (0.93)	0	2 (1.87)	107
2019-2020	84 (96.55)	1 (1.15)	1 (1.15)	1 (1.15)	87
2020-2021	76 (90.48)	7 (8.33)	1 (1.19)	0	84
2021-2022	482 (81.97)	65 (11.05)	40 (6.80)	1 (0.17)	588
2022-2023	259 (82.48)	34 (10.83)	20 (6.37)	1 (0.32)	314
Total	1005 (85.17)	108 (9.15)	62 (5.25)	5 (0.42)	1180*

* other samples (n=63) were not included in the table

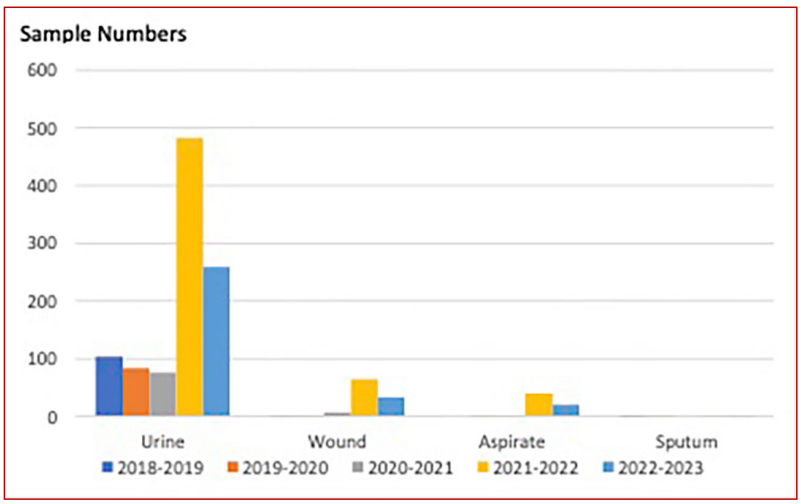

Figure 2. Change in sample types over time.

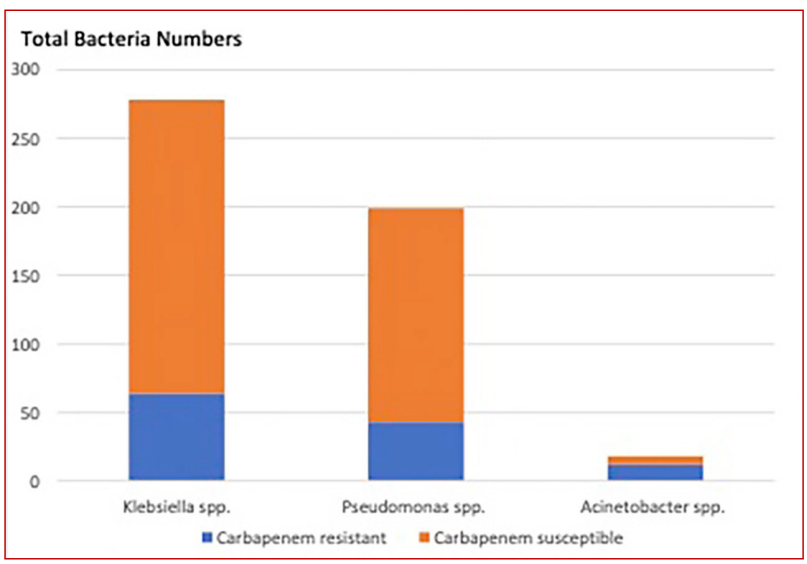

Figure 3. Carbapenem resistance rates in home health care patients.

Table 2 and Figure 2 summarize the distribution of samples received by the laboratory and their changes over the years. The majority of the samples from home healthcare patients sent to the microbiology laboratory were urine cultures (85.17%). The rest of the samples were wound (9.15%), tracheal aspirated (5.25%), sputum (0.42%), and other (n=63). Wound and tracheal aspirate samples showed an increasing trend over time $p < 0.01$.

The resistance rates are summarized in Figure 3. Carbapenem resistance rates were 23.02 % (64/278) for *Klepsiella spp.*, 66.67 % (12/18) for *Acinetobacter spp.*, and 21.60 % (43/199) for *Pseudomonas spp.* in all samples. Distribution of the carbapenem-resistant bacteria type between the years wasn't statistically significant *p* 0.09.

DISCUSSION

Our study detected an increase in carbapenem resistance, particularly in *Klebsiella* and *Pseudomonas* spp. in-home HAI. We also observed a significant change after the COVID-19 pandemic and an increase in the number of pressure ulcers and tracheal aspirate samples. This increase could be attributed to an increase in the number of bedridden and intubated patients receiving home healthcare services. The worldwide incidence and prevalence of carbapenem-resistant Gram-negative bacteria have increased alarmingly over the past decade. In Europe, in 2015, population-weighted means of carbapenem resistance for *P. aeruginosa, K. pneumonia,* and *A. baumanii* were 17.8%, 8.1%, and 0.1%, respectively (11). The national healthcare-associated infection surveillance report for 2022 reveals that the carbapenem resistance rate in *A. baumanii* was 92.18%, *K. pneumonia* was 66.56%, and *P. aeruginosa* was 67.60% among HAI (12). In 2018, the *A. baumanii* rate was 70.90% and the *P. aeruginosa* rate was 33.99% (13). As seen in these two reports, there has been a very significant increase in the incidence of carbapenem-resistant bacteria in HAIs over the past several years. A study reported even higher rates of carbapenem resistance than reported for 2018; carbapenem resistance was *A. baumanii* 93%, *K. pneumonia* 78%, and *P. aeruginosa* 76% (14). Another study examined bloodstream infections in the ICUs of 24 hospitals in Turkey in 2021, highlighting the rise in carbapenem-resistant bacteria and high mortality rates despite the initiation of appropriate treatment (15). A simulation study reported that carriers of carbapenem-resistant Gram-negative bacteria had a 1.8-fold higher possibility of re-admission within 1 year. Additionally, 30% of carriers sustain life-long infections. Implementing contact precautions can reduce transmission risk by 40%, yet only 10% of carriers adhere to these precautions (16).

Older people are much more likely to suffer from infectious diseases than younger people. Organ dysfunctions that increase with age, changes in the immune system, nutritional problems, and underlying diseases that increase over the years lead to an increased risk of infection among older patients. Infections in older people are one of the primary causes of death (17). A very large proportion of home healthcare patients are geriatric patients with multiple hospitalizations and even ICU stays (18). Previous studies have shown that advanced age is an important risk factor for carbapenem-resistant bacteria. Some studies reported a 20–30% mortality rate increase with carbapenem-resistant bacteria infections (17, 19). Our study, like other studies, observed a significant increase in carbapenem resistance with increasing age.

These results suggest that carbapenem resistance is a growing problem not only in hospital settings but also in long-term care facilities. Older adults are particularly susceptible to colonization by carbapenem-resistant Gram-negative bacteria because of extended hospital stays, catheter or mechanical ventilation use, and comorbidities (3,19). Following discharge, these colonizing bacteria can cause outbreaks in long-term care facilities. A report

from West Virginia identified a long-term care facility as the primary source of a carbapenem-resistant *K. pneumoniae* outbreak (20). Furthermore, the rates of carbapenem-resistant Gram-negative bacteria were found to be significantly higher in long-term care facilities than in communities and hospitals (21). However, despite the lack of research on patients followed up in home healthcare settings, our study highlights the need for epidemiological studies on these infections as well as infection prevention and control strategies.

Infection rates among patients who received home healthcare have been reported to range from 5% to 80%. Common infections reported in these patients include respiratory tract infections, urinary tract infections, skin and soft tissue infections, and those associated with intravenous catheters (6). The samples analyzed in our study were predominantly from the urinary system, with respiratory tract samples obtained through tracheal aspiration being less frequent. This discrepancy may stem from the possibility patients with tracheostomies were more prone to having respiratory tract specimens collected, whereas other patients might not have undergone sputum culture assessments. However, an increase in the number of respiratory and wound samples was observed in this study. Infections are the leading cause of hospitalization in these patients, with respiratory tract infections being the most common. Infection was detected in 45% of patients who required admission in a previous study (6, 22). The rise in respiratory and wound infections over time is noteworthy for home healthcare patients, considering the need for re-admission because of these infections.

This study found a significant increase in the rate of carbapenem-resistant bacteria in the samples, particularly after the COVID-19 pandemic. Post-pandemic era studies have demonstrated an increase in carbapenem-resistant Gram-negative bacteria due to impaired infection prevention and control practices resulting from a high workload (23-26). It is worth noting that the significant rise in the use of polymixin antibiotics, particularly in empirical cases, may have exerted selection pressure on these species (26-28). The high antibiotic use rates, the highest among the region, at hospitals and outpatients caused one of the highest resistance rates in the region, especially carbapenem resistance (29, 30).

Treatment options for carbapenem-resistant bacterial infections are limited, particularly in cases that do not require hospitalization and can be managed on an outpatient basis (31). Therefore, when considering empirical treatment options, it is crucial to be aware of the resistance profile, particularly the likelihood of carbapenem-resistant bacteria in patients being managed at home, when considering empirical treatment options (9,31). Data on the epidemiology of home healthcare infections are scarce, and this study highlights the need for epidemiological research on home healthcare infections to develop better management strategies.

Owing to the increasing rates of resistance in these patients, it is crucial for the healthcare staff to implement precautionary measures to prevent infection transmission among patients. Additionally, they should monitor the growth of resistant bacteria and the onset of infections in patients. Healthcare personnel should demonstrate equal vigilance to inpatients in isolating patients, separating equipment, practicing hand hygiene, and using protective gear (32,33). Home healthcare workers must receive training in infection control procedures to prevent outbreaks among patients (22,32). However, in cases where patients are admitted to a hospital without prior information on their bacterial growth, such as those transferred from another hospital, it is advisable to place them in contact isolation until culture results are available. This measure helps ensure infection control within the hospital. Additionally, upon discharging patients with nosocomial infections to home healthcare facilities, there should be a mechanism in place to

promptly notify home healthcare workers about infection control measures (33,34).

The limitations of this study include the absence of patient clinical data and the lack of differentiation between infection and colonization as the cause in our laboratory data. However, we aimed to demonstrate changes in carbapenem resistance trends among home healthcare patients, regardless of whether the microorganism was a cause of infection or colonization, or if it was clinically relevant. This is because infection prevention and control practices should be implemented regardless of the clinical relevance to prevent the spread of these microorganisms.

This study showed an increasing trend in carbapenem resistance rates among home healthcare patients, particularly after the COVID-19 pandemic. The incidence of carbapenem resistance increases in parallel with age. The negative contribution of this increasing prevalence to morbidity and mortality in older patients has also increased. Therefore, prevention and control strategies should be implemented in home healthcare settings to manage these infections. These infections are challenging to manage, especially in geriatric patients, and may cause hospital readmission or outbreaks in vulnerable older patients.

Conflict of Interest: The authors declare no conflict of interest regarding this manuscript.

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Ethics approval: This study was approved by the Yildirim Beyazit University Clinical Studies Ethical Committee with the registration number E-2023-40.

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