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REVIEW

Antimicrobial resistence of Escherichia coli in urinary tract infections

Resistencia antimicrobiana de Escherichia coli en infecciones del tracto urinario

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ABSTRACT

Urinary tract infection (UTI) is a microbial invasion of the urinary tract that overwhelms the host's defense mechanisms. UTIs are a common cause of consultations and hospitalizations worldwide at all ages, with the impact on kidney function varying depending on associated risk factors and age. The increasing use of antimicrobials has resulted in increased resistance among microorganisms. A narrative literature review was conducted that included various texts, articles, and printed and digital materials related to urinary tract infections caused by Escherichia coli (E. coli) and their resistance patterns. The aim was to analyze the literature that supports the growing antimicrobial resistance of E. coli in urinary tract infections. The study concluded that antimicrobial resistance is an issue that globally affects public health and has been increasing. E. coli has specifically developed special resistance to fluoroquinolones and carbapenems, a situation of increasing concern. Faced with this global emergency, we must work together to mitigate the situation. Otherwise, the outlook for the near future will be very bleak if this health threat continues to be ignored.

Keywords: Antimicrobial Resistance; Urinary Tract Infection (UTI); *Escherichia Coli (E. Coli)*.

RESUMEN

La infección del tracto urinario (ITU) es la invasión microbiana del aparato urinario que sobrepasa los mecanismos de defensa del huésped. En el mundo las ITU son causa frecuente de consultas y hospitalización en cualquier edad, repercusión sobre la función renal varia en dependencia de los factores de riesgo asociados y la edad. El creciente consumo de los antimicrobianos ha traído como consecuencia un aumento de la resistencia de los microorganismos. Se realizó una revisión bibliografía de tipo narrativa que incluyó diversos textos, artículos y materiales impresos y digitales relacionados con las infecciones del tracto urinario por *Escherichia coli (E. coli*) y los patrones de resistencia de ellas con el objetivo de analizar bibliografía que sustenten la creciente resistencia a los antimicrobianos que presenta *E. coli* en infecciones del tracto urinario. Al finalizar el estudio se concluyó que la resistencia de antimicrobianos es un tema que afecta de forma global a la salud pública, la misma ha ido en aumento. *E. coli* taxativamente ha desarrollado especial resistencia a fluoroquinolonas y carbapenémicos situación cada vez más preocupante, ante esta emergencia mundial debemos integrarnos para mitigar dicha situación de lo contrario el escenario en un futuro próximo será muy poco alentador si se sigue ignorando esta amenaza de salud.

Palabras clave: Resistencia Antimicrobiana; Infección Del Tracto Urinario (ITU); *Escherichia Coli (E. Coli)*.

INTRODUCTION

Urinary tract infections (UTI) are one of the most frequent infections in the hospital setting and primary health care; they are defined as an inflammatory process involving the invasion and multiplication of microorganisms in the urinary tract, presenting with dysuria, urgency, suprapubic pain, fever, and urinary urgency. However, their asymptomatic form is quite common.[1]

These infections are classified based on different criteria: according to their location, they can be upper or lower urinary tract; by epidemiology, they are divided into community- or hospital-acquired; by associated factors and severity, into complicated or uncomplicated; and by clinical presentation, into symptomatic or asymptomatic.[2]

The leading aetiological agent of UTIs and the one most associated with recurrence is the bacterium Escherichia coli (E. coli). It has become increasingly resistant through multiple mechanisms related to the massive and irrational use of antibiotics, making it difficult to treat in medical practice.[3,4]

From 1928, when Fleming discovered penicillin, the so-called antibiotic era began, and from that date onwards, in the following decades, there was an exponential increase in the creation of new classes of these agents, especially in developed countries.[5]

In recent years, the production of new antibiotics has declined considerably, and antibiotic resistance has emerged as a problem with unpredictable consequences due to the emergence of defensive mechanisms in bacteria, viruses, fungi, and protozoa to evade the destructive action of these substances.[5]

Concern about this problem is demonstrated, for example, by the UK House of Lords Science and Technology Committee, which expresses concern about the overuse and misuse of antibiotics and the loss of their effectiveness against multiple micro-organisms.[5]

The speed with which multidrug-resistant microorganisms emerge is not matched by the speed with which new antibiotics emerge, so it is conceivable that soon, there will be no new antibiotics to treat patients with severe sepsis.[5]

It is essential to know what resistance means, as it is simply the mechanism by which bacteria can diminish the action of antimicrobial agents. From a clinical point of view, a bacterium is considered sensitive to an antibacterial when the concentration of the antibacterial at the site of infection is at least 4 times the minimum inhibitory concentration (MIC). A concentration below the MIC qualifies the bacteria as resistant, and intermediate values as moderately sensitive. The concepts of sensitivity and resistance are highly relative and depend both on the value of the site of infection and on the dose and route of administration of the antibiotic.[5]

The social significance of identifying antimicrobial resistance patterns in E. coli bacteria is that it is recognized as having an alarming pattern of antimicrobial resistance,[1,3] including carbapenems. This situation was noted by the World Health Organization when it was included in a list of bacteria for which new antibiotics are needed rapidly.[7]

Given the above, the present review analyzed the literature to support the level of E. coli antimicrobial resistance in urinary tract infections.

METHOD

Information on microbial resistance (E. coli urinary tract infections and their antimicrobial resistance patterns) was searched in different databases, such as Scielo, Google Scholar, Medline, and the PAHO, FAO, and OIE websites.

Original and review articles were consulted between 2019 and 2024. Keywords related to the topic were used in Spanish and English. Once the articles to be included in the review had been selected, critical reading and analysis of the information necessary for the drafting of the manuscript were carried out to discuss the current problem of antimicrobial resistance.

DEVELOPMENT

For a long time, the terms infection and sepsis have been used alternatively; the current tendency is to refer to infection as a germ-dependent bacterial process, while sepsis is the body's immunological response to the presence of the causative agent.[8]

Urinary tract infection (UTI) is a microbial invasion of the urinary tract that overcomes the host's defense mechanisms, produces an inflammatory reaction, and eventually, morphological and functional alterations such as local deformation of the ureterovesical junction, thus allowing bacteria to ascend unhindered into the upper urinary tract.[8]

Urinary tract infection is one of the causes of bacterial infection in outpatients and hospitalized patients. In the pediatric age group, 8-10 % of girls and 2-3 % of boys will have a symptomatic infection before the age of 7 years. Approximately 2,4 to 2,8 % of annual UTI medical visits in the USA account for about 1 million emergency department visits.[9] UTIs in puberty (between 15 and 19 years of age) represent the third leading cause of morbidity, with 297,831 cases. In children under 15 years of age, they cause 360 220 cases. The prevalence in

children under 1 year is 20 300 cases per year.[10,11]

The microbial agent causing UTI is primarily associated with the gram-negative, facultative anaerobic bacillus Escherichia coli, with a 60-70 % prevalence in this pathology. This bacterium colonizes the intestine within hours after birth and is considered a commensal flora microorganism.[12,13]

In the United States, about 11 % of women aged 18 years have a UTI event each year, while in women aged 18-24 years, five events occur per year. In healthy women aged 18-39 years, after a first event, 24 % recur in the next six months, and 5 % of women with an initial event have multiple episodes in a year. Today, people over 65 years of age represent one-sixth of the general population, with one in three outpatients seen in this population group.[8]

In addition, older people are at increased risk of bacterial infection, which increases morbidity, mortality, and hospital care rates. Urinary tract infection is one of the most common infections, and if not treated promptly, it progresses to severe sepsis. Each year in England, there are 150000 cases of sepsis in the population, causing 44000 deaths. In the elderly, urinary tract infection is one of the most common and reports 33 % of deaths from severe sepsis in hospitalized patients in this age group. In the United States, sepsis is the tenth leading cause of death in patients over 65 years of age. UTI is the leading cause of emergency room admissions that can be effectively treated in the community. The annual costs per hospitalization in both England and the United States represent significant figures.[8]

The incidence of urinary tract infections (UTIs) varies with age, gender, and associated risk factors. The incidence is higher in females, with an estimated 10-20 % of women experiencing at least one episode in their lifetime; prevalence rises from 1 % at school age to 5 % by the age of 20, which coincides with the onset of sexual intercourse and pregnancy. After this age, prevalence continues to increase at a rate of 1 to 2 % per decade of life so that by the age of 70, more than 10 % of women have asymptomatic bacteriuria.[8]

The current emergence of bacterial resistance to antibiotics is causing significant problems in hospitals worldwide. To survive within the host, bacterial pathogens exploit different mechanisms to prevent identification and elimination by the immune system. Microbiology laboratories enable clinicians to understand the causative agents of this infection, as well as the in vitro behavior of existing antimicrobial resistance. This phenomenon is constantly changing and requires systematic evaluation.[8]

The burden of antimicrobial resistance in gram-negative bacilli, especially E. coli, is a daily challenge in dealing with E. coli infections.[14]

Alarming resistance rates are reported worldwide, and increasing trends may raise concerns for the coming years.[14]

Almost exclusively restricted to the hospital setting until the turn of the century, this problem increasingly applies to patients with community-acquired infections.[14]

A study showed that the most frequently isolated micro-organisms were Staphylococcus aureus and Escherichia coli. The highest resistance patterns were found in amoxicillin +sulbactam, being most striking against Escherichia coli and, to a lesser extent, against Staphylococcus aureus. Cefepime showed high resistance to both microorganisms.[14]

The issue of germ resistance is vital for the treatment of both community-acquired and hospital-acquired infections, and the joint work of microbiologists and pharmacologists in selecting the appropriate drug will help mitigate antimicrobial resistance.

In a study conducted in the Community Health Sector of Huesca in the period 2016-2018, a significant linear trend was observed in the decrease of E. coli susceptibility during the three years of the study. Despite this overall increase in resistance, some drugs such as fosfomycin, nitrofurantoin, cefotaxime, gentamicin, and piperacillin-tazobactam maintain good activity in community and hospital strains. Cefuroxime and amoxicillin-clavulanic acid showed a significant increase in resistance in hospital strains compared to community strains in the period studied. The mean percentage of tobramycin resistance was 20 % in hospital strains; at the community level, although the first year of the study showed significant levels of resistance, sensitivity increased in the following two years. The highest resistance levels (above 20 %) were found in orally administered antibiotics frequently indicated for uncomplicated urinary tract infections: trimethoprim-sulfamethoxazole, ciprofloxacin, and amoxicillin.[3]

These results show that the sensitivity patterns obtained are similar to those found in other studies, so it is reasonable to use the data provided in the antibiograms to indicate that empirical treatments should not be used.

In a study conducted in Lima, Peru, in 2022, 35 beta-lactamase-producing E. coli (BLEE) samples were isolated. Most isolates were resistant to cefotaxime (25/35), no carbapenem-resistant isolates, and only two (2/35) isolates were resistant to cefoxitin. In addition to beta-lactam resistance, it could be observed that the isolates showed extensive resistance to ciprofloxacin in 82,9 % (29/35) of the cases.[15]

A study carried out in Colombia showed that of the Escherichia coli isolates, 12,1 % (n= 27) were resistant to extended-spectrum beta-lactamases (BLEE positive), and 4,9 % (n= 11) were resistant to carbapenemics.[16]

Regular and up-to-date knowledge of antibiotic sensitivity and resistance patterns favors the choice of effective treatment, reduces the emergence of resistance, and contributes to a more rational and appropriate use of antimicrobials.[16] In Matanzas, between 2000 and 2005, the number of antimicrobial resistance cases in the country increased by 1000.

In Matanzas between 2001 and 2006, according to statistical reports from the urology services of Matanzas, a high incidence of UTI has been noted, either in patients admitted with this diagnosis or in those operated on for urological pathologies who suffer from septic complications that considerably increase morbidity and hospital stay, without the existence of a protocol for the control and follow-up of each patient treated.[8]

In that province of the country in 2015 and published in 2017, a study was carried out in which it became evident that the most significant resistance patterns were to amoxicillin + sulbactam, being more striking. Cefepime showed high resistance to both E. coli and gram-positive germs.[14]

Awareness of the serious problem of antimicrobial resistance is essential to urgently changing how antibiotics are prescribed and used. The discovery of new antibiotics will not be the solution to contain antimicrobial resistance if we do not alter current behaviors. Hence, it is essential to adhere to standards or treatment protocols. All efforts made will not have a valuable impact if we do not join forces to mitigate this major global health problem.

CONCLUSIONS

Antimicrobial resistance represents a serious threat to global health. Although advances in medical research are promising in prevention and treatment, international action is needed to reduce the spread and mitigate the effects of AMR.

And mitigate its adverse effects. Inappropriate prescribing of antimicrobials, increased immunization against pathogens, implementation of infection prevention and control measures, and strengthened surveillance of resistant pathogens in human medicine are key factors that need to be addressed to make this a strength rather than a challenge.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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