Original article

Multidrug resistant Enterococci as a community acquired infection in diarrheal cases of children

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Background and Objectives: Enterococci causes many serious and life-threatening infections. Enterococci may be the cause of diarrhea in children. Multidrug-resistant (MDR) Enterococci limits treatment options. So, the aim of our study was to detect the frequency and the antibiotic resistance profile, both phenotypically and genotypically, of MDR Enterococci isolated from the stools of children suffering from gastroenteritis who needed hospitalization.

Materials and Methods: Enterococci were isolated from stool samples from children. One hundred ten (110) infants (in patients) with typical signs of gastroenteritis (nausea, vomiting, abdominal pain, diarrhea). The Vitek 2 Compact System is used for identification and antimicrobial susceptibility testing. Drug resistance genes (ermB, aph(3′)IIIa, and tetM) and virulence genes (esp) were identified using molecular techniques.

Results: Thirty-six isolates of Enterococci were diagnosed phenotypically by routine lab examination and Vitek2 followed by genotypic characterization by multiplex PCR for three resistant genes: ermB (100%), aph(3′)IIIa (63.9%) and tetM (91.7%) and one virulence gene (esp (25%)). The frequency of Enterococci among studied patients was 32.7% (36/110). Most of the Enterococci isolated from stool were Enterococcus faecium (86.1%). MDR Enterococci was found to be 94.4% (34/36) in total isolates.

Conclusion: MDR Enterococci was isolated in community acquired diarrhea in young aged (less than 24 months) children. More than one resistance gene: ermB, aph(3′)IIIa, tetM and virulence gene (esp) were detected in isolates. The presence of MDR strains is risky at a young age as it limits treatment options. Drug-resistant genes may be transmitted to a child through a carrier mother or cross infection from the hospital.

Introduction

Enterococci are Gram-positive, catalase-negative, non-spore-forming, facultative anaerobic bacteria that live in the human digestive tract [1]. After birth, Enterococci are the first bacteria to enter the neonate’s gastrointestinal tract. They can also enter through a mother’s breast milk or intimate touch [2]. Even though Enterococcus spp. cohabit in the intestinal tract, it can still cause diarrhea in elderly people, kids, and people with impaired immune systems [3].
Enterococci, one of the most common nosocomial infections, is now well-established and is growing more resistant to antibiotics. All nosocomial enterococcal infections are currently caused by either Enterococcus (E.) faecalis or E. faecium [4]. Despite the fact that E. faecalis is the most harmful of the group, E. faecium is growing in importance as a result of its greater antibiotic resistance [5]. Infections that arise in hospitals are frequently brought on by these bacteria, including meningitis, endocarditis, bacteraemia, infant sepsis, surgical and burn wound infections, and urinary tract infections (UTIs) associated with catheters [5].

Enterococci are typically harmless in healthy people. They become opportunistic pathogens by infecting people in intensive care units, with severe underlying conditions, or who are immunocompromised. As a result, extended hospitalization and/or indiscriminate antibiotic use can directly correlate with disease severity and immune suppression, and these are important risk factors for nosocomial drug-resistant Enterococci acquisition [6].

Macrolides are bacteriostatic antibiotics that bind to the 50S ribosomal subunit and impede protein synthesis [7]. The ermB gene, which is found in multiple transposons and plasmids in Enterococcus, Streptococcus, Staphylococcus, and Clostridium spp., is the most widely distributed gene in Enterococci that confers resistance to macrolides [8].

Tetracyclines suppress protein synthesis by binding to the ribosome and preventing tRNA linking, which has a bacteriostatic effect on cells [9]. The Enterococci that have been linked to the tet(K) and tet(L) efflux pump genes or the tet(M), tet(O), and tet(s) ribosome protection genes have shown significant resistance to this family of antibiotics [8]. Out of the five human Enterococci strains, tetM seems to be the gene that is isolated from them the most frequently [8, 10]. This gene can be located on the chromosome or be transmitted via a plasmid [11].

Aminoglycosides attach to the aminocyl-tRNA recognition site (A-site) of the 16S rRNA, inhibiting polypeptide synthesis and causing cell death. Resistance to aminoglycosides can emerge through numerous methods, including a. enzymatic modification and inactivation of the aminoglycosides, which is often reported in Gram-positive and Gram-negative bacteria and is mediated by aminoglycoside acetyltransferases, nucleotidyl transferases, or phosphotransferases. b. increased efflux; c. lower permeability; and d. changes to the 30S ribosomal subunit that interferes with aminoglycoside binding [12, 13].

Aminoglycosides bind to the aminocyl-tRNA recognition site (A-site) of the 16S rRNA of the 30S ribosomal subunit, blocking polypeptide synthesis and triggering cell death. Resistance to aminoglycosides can occur via a variety of mechanisms, including a. enzymatic modification and inactivation of the aminoglycosides, which is frequently observed in Gram-positive and Gram-negative bacteria and is mediated by aminoglycoside acetyltransferases, nucleotidyl transferases, or phosphotransferases. Changes to the 30S ribosomal subunit that interferes with aminoglycoside binding [12, 13].

So, the aim of our study was to detect the frequency and the antibiotic resistance profile, both phenotypically and genotypically, of MDR Enterococci isolated from the stools of children suffering from gastroenteritis who needed hospitalization.

Materials and methods
Design of the study
A cross-sectional study was conducted from October 2022 to February 2023 on 110 infants showing signs of typical gastrointestinal.

Study setting
Microbiology & Immunology Department, Faculty of Medicine, Assiut University. Stool samples were collected from all studied patients (inpatients children) with sterile swabs and cultured on the different culture media. The samples were collected from Children Hospital, Gastroenterology and Hepatology unit, Faculty of Medicine, Assiut University.

Sample size calculation
Sample size was calculated using statcalc program of EPI-info version 7.2 using population survey or descriptive study calculation, according to the prevalence of Enterococci from stool, prevalence of enterococcus species in stool was 11 % [12], acceptable margin of error was 5%, confidence interval 90 %, and the minimum required sample size will be 106 sample of stool to detect presence of Enterococci in it.
Ethical statement

The study was approved by the Ethical Committee of the Faculty of Medicine at Assiut University in Assiut, Egypt, following Declaration of Helsinki number 17101901 of the World Medical Association.

Isolation of Enterococci

Samples were cultured for 24 hours at 37°C on blood agar plates (Himedia), which were poured using 5% defibrinated sheep blood. Non-hemolytic white colonies with clean edges that were Gram positive cocci arranged in pairs or short chains [14].

Identification of Enterococci isolates

Separate purified colonies were identified by catalase test, Gram stain, and culturing on bile esculin agar.

Vitek 2 Compact System

Enterococcal colonies were confirmed by using Gram positive identification card which held 43 different biochemical tests applied on each sample [15].

Testing for antimicrobial susceptibility

Minimum inhibitory concentrations (MICs) were determined by Vitek 2 Compact (BioMerieux Inc., France) for the following antibiotics: ampicillin, benzylpenicillin, high level streptomycin, high level gentamycin, ciprofloxacin, levofloxacin, erythromycin, quinupristin/dalfopristin, linezolid, nitrofurantoin, vancomycin, tetracycline and tigecycline [16]. A category interpretation will be reported along with a MIC, according to the interpretations defined by CLSI (2021) [17]. The result was interpreted as either sensitive, intermediate, or resistant as per guidelines. MDR Enterococci identified as Multidrug resistance (defined as resistant to at least one agent in three or more antimicrobial categories) [18].

PCR for genotypic characterization of Enterococci isolates

DNA of bacterial isolates was extracted by boiling method [19]. For four genes: ermB, aph (3')IIIa, tetM and esp genes, the Multiplex PCR was conducted for all isolated Enterococci. The primers used for detection of both resistant genes and virulence gene were showed in the following table (Table 1).

PCR assays

Two separate multiplex PCR assays for each two gene sets (ermB and esp) and (aph (3') IIIa and tetM). PCR was performed in a 25 μl reaction mixture containing 0.5 μl each of forward and reverse specific primer pairs (0.5 μl x 4), 12.5 μl of PCR master mix (Thermo Fisher Scientific, United States), 5.5 μl of nuclease free water, and 5.0 μl of DNA template.

ErmB and esp genes

Initial denaturation at 95°C for 5 minutes, 40 cycles, each cycle consisting of: denaturation at 95°C for 40 seconds, annealing at 55°C for 50 seconds, extension at 72°C for 50 seconds and final extension at 72°C for 5 minutes [10].

TetM and aph (3')-IIIa genes

Initial denaturation at 95°C for 5 minutes, 40 cycle, each cycle consisting of: denaturation at 95°C for 40 seconds, annealing at 50°C for 50 seconds, extension at 72°C for 50 seconds and final extension at 72°C for 5 minutes [20, 21].

Detection of the amplified products

After being stained with ethidium bromide and examined for 60 to 70 minutes. Under UV light at 80 volts, the resulting PCR amplicons were screened on a 1.5% agarose gel. As a negative control, distilled water was used in each PCR cycle [22].

Statistical analysis

Data analysis was performed using statistical package for the social science (IBM-SPSS) version 26.0 software. Categorical data was presented in the form of frequencies and percentages. Numerical variables as age presented by mean ± SD. Chi square (χ2) test was used to compare proportion between groups as the difference in antibiotic resistance according to age groups. independent Sample T test compare mean age between positive and negative cases to Enterococci. The level of significance was considered at p value < 0.05.
Table 1. Primers used in detection of drug resistance and virulence genes.

<table>
<thead>
<tr>
<th>Target gene</th>
<th>Sequence of primers</th>
<th>Size of amplified product(bp)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virulence gene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>esp</td>
<td>F AGATTTCTCTTGGATCTTG 510bp R AATTGATTTTTAGCATCTGG</td>
<td>510bp</td>
<td>10</td>
</tr>
<tr>
<td>Resistance genes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ermB</td>
<td>F CCGAACACTAGGGTTGCTC 139bp R ATCTGGAACATCTGTGGTATG</td>
<td>139bp</td>
<td>10</td>
</tr>
<tr>
<td>tet(M)</td>
<td>F ACAGAAAGCTATTATATAAC 170bp R TGCGTGCTATGATGTTAC</td>
<td>170bp</td>
<td>20</td>
</tr>
<tr>
<td>Aph (3′)-IIIa</td>
<td>F GGCTAAAAATGAGAATACCCGG 523bp R CTTAAAAATCATAACGCTGCC</td>
<td>523bp</td>
<td>21</td>
</tr>
</tbody>
</table>

Results
Out of 110 studied samples collected from infants suffering from gastroenteritis, about 36 (32.7%) isolates were found to be Enterococci. The distribution of isolated Enterococci among different age and sex groups is represented (Table 2).
Identification of bacterial isolates was done by Vitek 2 compact system. Most of the Enterococci isolated from stool were E. faecium (86.1%), followed by E. avium and E. gallinarum with percentages of 11.1% and 2.8%, respectively.

Antimicrobial susceptibility pattern for Enterococci.
β-lactams (ampicillin and benzylpenicillin) had the similar highest resistance with a percentage of 94.4%. The resistance to high level of streptomycin, tetracycline, and erythromycin were 88.9%, 66.7 %, and 100 %, about 41.7% had resistance to both (Ciprofloxacin and Levofloxacin) and nitrofurantoin, similarly, followed by high level gentamycin 30.5%, quinupristin /dalfopristin was 11.1%. Only 8.3% of the isolated Enterococci had vancomycin-resistance. Linezolid resistance was 2.8%. No resistance was found to tigecycline. The relationship between resistance to different antibiotics and children's age is illustrated in table (3).

Molecular detection
PCR assay which was conducted on the studied Enterococci from stool showed that ermB was found in 100% of all samples, tetM with the percentage of 91.7% and aph (3′)IIIa with the percentage of 63.9% (Figure 1, 2). The esp gene (virulence gene) was found with 25% frequency in stool samples. The coexistence of three drug resistance genes and virulence esp gene in stool isolates was shown in figure (1, 2) and table (4).

Relation between phenotypic and genotypic detection of Enterococci isolated from stool isolates. Thirty-six isolates (100%) of erythromycin-resistant strains carried ermB. Tetracycline-susceptible strains harbored the tetM resistance gene at a rate of 25% (9/36), while 66.7% (24/36) of tetracycline-resistant strains carried tetM. High-level streptomycin-resistant strains carried aph(3′)IIIa with a percentage of 63.9%.
Table 2. Distribution of *Enterococci* isolates in stool of children according to some demographic variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total (n=110)</th>
<th>Positive (No=36)</th>
<th>Negative (No=74)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>11.43±8.43 (2-31)</td>
<td>11.27±8.50 (4-30)</td>
<td>10.24±7.24 (2-31)</td>
<td>0.891</td>
</tr>
<tr>
<td>&lt;6 months</td>
<td>37 (33.6%)</td>
<td>9 (24.3%)</td>
<td>28 (75.7%)</td>
<td>0.445</td>
</tr>
<tr>
<td>6-&lt;12 months</td>
<td>43 (39.1%)</td>
<td>16 (37.2%)</td>
<td>27 (62.8%)</td>
<td></td>
</tr>
<tr>
<td>12-24 months</td>
<td>22 (20.0%)</td>
<td>7 (31.8%)</td>
<td>15 (68.2%)</td>
<td></td>
</tr>
<tr>
<td>&gt;24 months</td>
<td>8 (7.3%)</td>
<td>4 (50.0%)</td>
<td>4 (50.0%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>59 (53.6%)</td>
<td>19 (32.2%)</td>
<td>40 (67.8%)</td>
<td>0.899</td>
</tr>
<tr>
<td>Male</td>
<td>51 (46.4%)</td>
<td>17 (33.3%)</td>
<td>34 (66.7%)</td>
<td></td>
</tr>
</tbody>
</table>

No statistically significant difference between positive and negative cases to *Enterococci* regarding age, mean age of positive cases was 11.27±8.50 and ranged from 4-30 months and for negative cases was 10.24±7.24 and ranged from 2 to 31 months. Moreover, there was no statistically significant difference between different age groups regarding *Enterococci* presence (24.3%, 37.2%, 31.8% and 50.0% in <6 months, 6-<12 months, 12-24 months and >24 months respectively).

Table 3. Relationship between antibiotics resistance and age of children.

<table>
<thead>
<tr>
<th>Antimicrobial Agent/ total no. (36)</th>
<th>Age groups/month</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 6 months (9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrolide: Erythromycin</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Tetracycline: Tetracycline</td>
<td>5 (55.6%)</td>
<td>10 (62.5%)</td>
<td>5 (71.4%)</td>
</tr>
<tr>
<td>β – lactams:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ampicillin</td>
<td>9 (100%)</td>
<td>16 (100%)</td>
<td>5 (71.4%)</td>
</tr>
<tr>
<td>Benzylpenicillin</td>
<td>9 (100%)</td>
<td>16 (100%)</td>
<td>5 (71.4%)</td>
</tr>
<tr>
<td>Fluoroquinolones:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levofoxacin</td>
<td>3 (33.3%)</td>
<td>8(50%)</td>
<td>2(28.6%)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>3 (33.3%)</td>
<td>8(50%)</td>
<td>2(28.6%)</td>
</tr>
<tr>
<td>Nitrofuran: Nitrofurantoin</td>
<td>5 (55.6%)</td>
<td>5(31.3%)</td>
<td>3(42.9%)</td>
</tr>
<tr>
<td>Aminoglycoside:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Level Streptomycin</td>
<td>9 (100%)</td>
<td>12(75.0%)</td>
<td>7(100%)</td>
</tr>
<tr>
<td>High level Gentamicin</td>
<td>2 (22.2%)</td>
<td>5(31.3%)</td>
<td>2(28.6%)</td>
</tr>
<tr>
<td>Streptogramin: Quinupristin/Dalfopristin</td>
<td>0(0.0%)</td>
<td>1(6.3%)</td>
<td>1(14.3%)</td>
</tr>
<tr>
<td>Glycopeptide: Vancomycin</td>
<td>1(11.1%)</td>
<td>0(0.0%)</td>
<td>1(14.3%)</td>
</tr>
<tr>
<td>Oxadiazoles: Linezolid</td>
<td>(0.0%)</td>
<td>(0.0%)</td>
<td>(0.0%)</td>
</tr>
<tr>
<td>Glycylcycline: Tigecycline</td>
<td>(0.0%)</td>
<td>(0.0%)</td>
<td>(0.0%)</td>
</tr>
</tbody>
</table>

R: resistant. NA (non-applicable to calculate the significance between groups). There were statistically significant differences between resistance to β-lactams drugs (Ampicillin and Benzylpenicillin) and age group distribution, as the lower resistance to the drugs was among 12-24 months groups (71.4%) and the other age groups the resistance was 100.0%. Moreover, there was statistically significant no resistance to linezolid among all age groups (0.0%) except > 24 months, the resistance was 25.0%. No statistically significant difference between resistance to other drugs and age distribution. In the current study, MDR *Enterococci* was found to be 94.4% (34/36) in total isolates, which were resistant to more than 3 classes of antibiotics.
Table 4. Coexistence of drug resistance genes and esp gene in stool isolates.

<table>
<thead>
<tr>
<th>No. of genes</th>
<th>Genes</th>
<th>No. of isolates (36)</th>
<th>No. of MDR Enterococci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two genes</td>
<td>ermB, tetM</td>
<td>17</td>
<td>15/17 (88.2%)</td>
</tr>
<tr>
<td>Three genes</td>
<td>eEsp, ermB, tetM</td>
<td>1</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>Three genes</td>
<td>ermB, tetM, aph(3′)IIIa</td>
<td>10</td>
<td>10 (100%)</td>
</tr>
<tr>
<td>Four genes</td>
<td>esp, ermB, tetM, aph(3′)IIIa</td>
<td>8</td>
<td>8 (100%)</td>
</tr>
</tbody>
</table>

Figure 1. Agarose gel electrophoresis of the products of PCR to detect ermB (139 bp) and esp (510 bp) genes. Lane (M) shows the DNA (100-1500bp) standard marker, All lanes (1 to 9) show ermB and esp positive isolates. Lane (10) is negative.

Figure 2. Agarose gel electrophoresis of the products of PCR to detect tetM (170 bp) and aph(3′)IIIa (523 bp) genes. Lane (M) shows the DNA standard marker (100-1500bp), All lanes (1 to 8) show tetM and aph(3′)IIIa positive isolates. Lane (9) is negative.
Discussion

With significant morbidity and death, Enterococci have become a major factor in a number of illnesses. Treatment of enterococcal infections is difficult due to their ability to acquire resistance as well as innate resistance to several antimicrobials [20]. Previously thought to be benign intestinal commensals with little clinical importance, Enterococci has developed into a significant nosocomial pathogen [2].

In the current study, 32.7% (36/110) of children with gastroenteritis had Enterococcus species. In a similar study conducted in Iran, Alebouyeh et al. [23] found the percentage of Enterococcus species isolated from rectal swabs to be 34.6% which comes in accordance with our results. A study from Iraq (2019) found that 48.3% of children with diarrhea were infected with Enterococci [3].

In the present study, different species were isolated from children. Enterococcus faecium was the most predominant isolate in the samples with a prevalence of 86.1% (31/36), followed by E. avium and E. gallinarum with prevalence of 11.1% (4/36) and 2.8% (1/36), respectively. No detection of other species of Enterococcus was found in the current study. Ngah et al. [24] found that the prevalence of E. faecalis was 10.5% and that E. faecium was 36.9% in the stool in another study done in Cameroon.

Prevalence of antibiotic resistance was highest in the β-lactam group (ampicillin and benzylpenicillin), at 94.4% (34/36), similarly. The high resistance of β-lactams group may be due to the frequent use of unictam (combination of sulbactam and ampicillin) in treatment of gastroenteritis in children hospital. In a similar study conducted in Korea, So et al. [25] discovered an 82.9% prevalence of β-lactam resistance. This was nearly in agreement with our results. Our finding was higher than the prevalence detected by Jannati et al. [26], who detected the percentage of β-lactams resistance was 41.3%. Al-Dahmoshi et al. [3], found the prevalence of β-lactam resistance was 53.6%. According to Subramanya et al. [27], this resistance is due to the organism’s inherent resistance to various antibiotics, including β-lactams.

Our research revealed that a significant portion of isolated samples were high resistant to high-level aminoglycoside antibiotics, with a percentage of 88.9% (32/36) being resistant to high-level streptomycin, about 30.5% (11/36) being resistant to high-level gentamycin. The highest resistance to aminoglycoside may be due to the use of amikacin in the treatment of gastroenteritis. The results of our research were higher than those discovered by So et al. [25], who reported that 46.8% of high-level aminoglycosides were resistant (streptomycin was 13.2% and gentamycin was 33.7%). This was less than that of our results. In contrast to our findings, a study conducted in Iran found that the high-level gentamycin resistance was 2.7% and the high-level streptomycin resistance was 17.4% [26].

The high rate of tetracycline resistance observed in the present study was 66.7% (24/36). This is in accordance with Jannati et al. [26], who detected the resistance of tetracycline at 66.7%. Tetracycline resistance was shown to be 87.5% in an Iranian study, according to Yadegarynia et al. [28]. In a study done in Iraq, Al-Dahmoshi et al. [3] found that the prevalence of tetracycline resistance was 57.14%.

In our study, the rate of erythromycin resistance was 100% (36/36). Al-Dahmoshi et al. [3] and Yadegarynia et al. [28] revealed the high resistance rate of erythromycin, as their results were 85.71% and 95.8%, respectively. In a study established in Iran, the prevalence of erythromycin resistance was 41.3%, which was lower than our results [26].

Resistance to fluoroquinolones (ciprofloxacin and levofloxacin) was obviously marked in our results with a 41.7% (15/36), equally. Another study done in Iraq, it was found that the frequency of fluoroquinolones was 60.7% [3]. Jannati et al. [26] detected the low resistance rate of fluoroquinolones, that is 15.9%. In the absence of antibiotic exposure, the presence of antibiotic-resistant genes in bacteria present in the infant’s gut may indicate that these strains were transferred from a carrier mother to the child, as suggested by Patangia et al. [32].

Our findings showed a prevalence of nitrofurantoin resistance of 41.7%, which was more than that reported by Jannati et al. [26], who found a prevalence of nitrofurantoin resistance of 19.3%. Al-Dahmoshi et al. [3] found the prevalence to be 64.29%, which is greater than the data we found, and so found that this rate of nitrofurantoin resistance was the highest.
The lowest resistance rates in the current study were found for quinupristin/ dalfopristin, Vancomycin, and Linezolid, with respective rates of 11.1%, 8.3%, and 2.8%. So et al. [25] and Subramanya et al. [27] found no resistance to linezolid in their studies. The three VRE strains isolated were multi drug resistant, two of them were E. faecium and the other one was E. avium. Vancomycin resistance was found at 44.4% and 46.4%, respectively, by Alebouyeh et al. [23] and Dahmoshi et al. [3], which was more than our values. Vancomycin resistance was reported to be 17.1% according to a study by So et al. [25], although no Vancomycin resistant Enterococci were observed, according to Jannati et al. [26].

Vancomycin Resistant Enterococci (VRE) sepsis is emerging as a significant problem in the intensive care setting. The infection can be acquired from the carrier mother or as cross infection from the hospital [29]. Vancomycin resistant Enterococcus faecium (VRE-fm) was first reported in 1988, a time point when it had rarely been isolated in neonates. Its prevalence has significantly increased globally during the following decades [30]. Almost any surface can become contaminated with VRE, which can also persist in the environment for lengthy periods of time (more than one week). Healthcare workers can also spread these organisms from one patient to another. This highlights the urgent need for effective measures to control the spread of these pathogens [23].

The high prevalence of MDR Enterococci in infant stool may be due to vertical antibiotic transmission across the mother-baby axis via lactation or during birth.

Natural resistance to a variety of antibiotics exists in Enterococci, and they are also capable of transferring resistance genes to other microbes via plasmid conjugation mechanisms [33]. Ben Braiek et al. [34] mentioned that intrinsic antibiotic resistance of Enterococci includes resistance to cephalosporins, sulphonamides, lincosamides, β-lactams, and aminoglycosides, located in the chromosomes.

The erythromycin-resistant gene (ermB) was found to be present in 100% of isolates. The prevalence of the ermB resistant gene was determined to be 33.3% in research by Mišić et al. [35], which is much lower than our findings. According to Tian et al. [36] and Ben Sallem et al. [37], there were 67.7% and 84.6%, respectively, of ermB-positive clinical isolates.

Aph(3′)IIIa gene was detected in 63.9% (23/36) of isolated strains. Approximately 63.9% of all high-level streptomycin resistant strains carried aph(3′)IIIa, while 25% (9/36) of the high-level streptomycin resistant strains detected did not carry the aph(3′)IIIa gene. This could be due to the existence of unknown resistance mechanisms, as suggested by Ben Sallem et al. [37]. According to Tian et al. [36], 64.9% of isolated samples carried the aph(3′)IIIa gene, which is consistent with our findings. With rates of 32%, and 54.5%, respectively, Moussa et al. [38], and Jannati et al. [26] indicated the low prevalence of the aph(3′)IIIa-resistant gene. In contrast, the percentage of aph(3′)IIIa was very high in a study conducted in Egypt by Diab et al. [39], as they detected 86.5% of resistant strains carrying the aph(3′)IIIa-resistant gene.

The tetM gene was found in isolated strains with 91.7% (33/36) percentage. Surprisingly, a tetracycline resistance gene was present in 25% (9/36) of tetracycline-susceptible strains while 66.7% (24/36) was the percentage of tetracycline-resistant strains harboring tetM resistant gene. Said et al. [20] and Ben Sallem et al. [37] stated that the percentage of tetM was found to be 50% and 70% in the isolated strains, respectively. In another study conducted in China, Tian et al. [36] documented the prevalence of tetM was 100% which comes nearly to our finding and reported that there was no tetracycline susceptible strain carrying tetM found in their study.

The esp virulence gene was found in 25% (9/36) of stool samples. Both Ben Sallem et al. [37] and Sattari-Maraji et al. [31] found the prevalence of the esp virulence gene to be 17.5% in their studies.

Thirty-four of the thirty-six multidrug resistant bacteria included the four genes that were the subject of the study in Enterococci isolates, and they were distributed as follows: fifteen MDR strains carried two resistance genes (ermB and tetM). Eleven MDR strains carried three different genes; 10 of them carried the ermB, tetM and aph(3′)IIIa genes, and the other one carried the esp, ermB, and tetM genes. Eight isolates of multi drug-resistant bacteria carried the four genes (esp, ermB, tetM and aph(3′)IIIa).
The emergence of clinical infection is mostly correlated with high colonization pressure and risk factors, the most significant of which are: young age, use of invasive devices, administration of antimicrobial drugs, immunosuppression, low birth weight, and underlying malignancy [30].

Conclusion

MDR Enterococci were isolated in community acquired diarrhea in young aged children. More than one resistance genes: ermB, aph(3′)IIIa, tetM and virulence gene (esp) were detected in isolates. The presence of MDR strains is risky at a young age as it limits treatment options.

Study limitation

1- No financial fund for more molecular work
2- We don’t collect from healthy children beside diseased ones and compare between them.

Disclosure of potential conflicts of interest

The authors report no conflicts of interest.

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