Prevalence and antibiotic susceptibility of ear pathogenic isolated from patients in Tripoli, north of Lebanon

Monzer Hamze¹, Marwan Osman¹, Hassan Mallat¹, Marcel Achkar²

- 1 Laboratoire Microbiologie Santé et Environnement (LMSE), Ecole Doctorale des Sciences et de Technologie, Faculté de Santé Publique, Université Libanaise, Tripoli, Lebanon.
- 2 Clinical Laboratory, Nini Hospital, Tripoli, Lebanon

Abstract

Background: Ear infection is one of the most widespread illness usually caused by bacteria or viruses, and which can be extremely painful. They are the most common reason for parents to bring their children to clinicians. The aim of this study is to determine the prevalence and antibiotic susceptibility pattern of common bacterial ear pathogens isolated from patients in Tripoli, North Lebanon during the period of 7 years.

Methods: A total of 481 bacterial ear pathogens were isolated from deep ear swab specimens of patients who came to Nini hospital clinical laboratory in Tripoli, North Lebanon. Culture, identification and antibiotic susceptibility of suspected isolates were carried out through conventional tests. API identification and serotyping were performed according to standard protocols proposed by the Référentiel en Microbiologie Médicale and the recommendations of the European Committee on Antimicrobial Susceptibility Testing.

Results: Out of 481, non-*Enterobacteriaceae* Gram negative rods were predominant (36.4%) followed by *Staphylococcus aureus* (24.8%), *Enterobacteriaceae* (16.8%), *Haemophilus influenzae* (10%), β -hemolytic streptococci (6.2%), *Streptococcus pneumoniae* (5.4%) and *Moraxella catarrhalis* (0.4%). Susceptibility testing showed the prevalence rate of methicillin-resistant *S. aureus* was 18.5% and of penicillin-non-susceptible pneumococci was 30.8%. *Enterobacteriaceae* and *H. influenzae* had susceptibilities of 18.5% and 80% to ampicillin, respectively. *P. aeruginosa* susceptibility to piperacillin-tazobactam and imipenem were very low, with 9.4% and 6.6%, respectively. Overall, *H. influenzae* and *S. pyogenes* isolates were also among the more susceptible isolates to antibiotics.

Corresponding author:

Prof. Monzer Hamze

mhamze@monzerhamze.com

Conclusion: This study revealed widely different antibiotic resistance rates of bacterial ear pathogens among the examined patients in Tripoli, North Lebanon. These findings provide useful information to physicians to select the proper antibiotic for treatment of ear infections in North Lebanon. Also, allow health authorities to develop effective program to combat antibiotic resistance in Lebanon.

Keywords: Bacterial ear pathogens, Antibiotic susceptibility, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Haemophilus influenzae*, Lebanon

Introduction

Ear infection is one of the most common illness which can be extremely painful because of inflammation and fluid buildup in the ear [1,2]. Its illness can affect the ear canal, the eardrum, or the middle ear. Ear infections are mostly observed in babies and young children, although it can occur in people of any age. Most children will have had at least one acute ear infection episode before three years of age. The main symptoms are ear pain, feeling unwell, fullness in the ear, hearing loss, ringing in the ear, discharge from the ear, nausea, vomiting and vertigo. Symptoms may follow a respiratory infection such as the common cold [1,2]. In addition, acute otitis externa (AOE), also known as 'swimmer's ear', is an inflammation or infection of external auditory canal, the auricle, or both which found often in adults[3]. However, otitis media with effusion (OME) is defined as a buildup of fluid in the middle ear but without symptoms and signs of infection, but this fluid can become occasionally infected, leading to acute otitis media (AOM). Numerous etiology of OME were described including allergies, irritants, previous respiratory infections, drinking while laying on your back and changes in air pressure [2,3].

Both features of AOE and AOM can be painful. They are often caused by bacteria, but can

also be caused by viruses. Although the etiological diagnosis is rarely discovered, bacterial infections are the most common cause of AOE and AOM [3]. Analgesics and fever-reducing drugs are the main treatment but also antibiotics are prescribed by clinicians for the cure of ear infections. The clinicians' decision will consider several factors for an ear infection such as age, illness severity, certainty a bacterial infection is present, and options for follow-up [4]. According to these factors, the decision will be either treat with antibiotics or waited a few days before prescribing antibiotics. Ear infections usually clear up on their own within a few days, and serious complications are rare. It has been noted that when an ear infection is caused by a virus, antibiotics will not help to get better and may even cause harm in both children and adults [4]. Nevertheless, ear infections are a leading cause for antibiotic prescriptions.

In Lebanon, numerous recent studies reported an increasing high rates of resistant bacteria isolates from clinical and commensal sources to most antimicrobials [5-21]. However, few data about the bacterial ear pathogens in Lebanon is available. For this reason, this investigation aimed to determine the occurrence of pathogens causing ear infections and its antibiotic susceptibility patterns in Tripoli, North Lebanon during the period of 7 years.

Material and methods

This study was conducted at clinical microbiology laboratory of Nini hospital in Tripoli, North Lebanon over the period from January 2009 to December 2015. Deep ear swab specimens were obtained by clinicians from both ears of 463 patients (235 males and 228 females, ranging in age from 1 month to 85 years, with a mean age of 20 years) with presenting ear illness symptoms. All collected samples were transported immediately using Amies agar gel (Oxoid®, United Kingdom) to the microbiology laboratory.

Culture of specimens was performed according to standard protocols proposed by the Référentiel en Microbiologie Médicale (REMIC) using four different media including Columbia blood agar, Columbia CNA blood agar with 5% sheep blood, Drigalski and Chocolate agar with bacitracin [22]. The identification of *Enterobacteriaceae*, non-*Enterobacteriaceae* Gram negative rods and *Haemophilus* spp. was carried out through the use of API-20E, API-20NE and API-NH (bioMérieux® - France), respectively. The identification of β -hemolytic streptococci belonging to Lancefield groups A, C, and G was performed by agglutination techniques (Bio-Rad®, France). The detection of α -hemolytic *S. pneumoniae* was carried out using the test of optochin susceptibility and latex agglutination tests (Bio-Rad®, France). The identification of *S. aureus* was realized using catalase test and Pastorex™ Staph Plus kit (Bio-Rad®, France).

The antibiotic susceptibility testing was performed by disk diffusion method on Mueller Hinton agar for *S. aureus*, *Enterobacteriaceae* and non-*Enterobacteriaceae* Gram negative rods (Bio-Rad®, France), and on Mueller Hinton agar supplemented with 5% blood and 20 mg/l β -NAD (MHF) for *H. influenzae*, *M. catarrhalis*, *S. pneumoniae* and β -hemolytic streptococci according to the recommendations of the European Committee on Antimicrobial Susceptibility Testing (EUCAST).

Statistical analyses were performed with Graph-Pad Prism 6.0 (GraphPad Software Inc., San Diego, CA) using the Fisher's exact test to explore the association between bacterial infections and age of patients (≤ 10 years and > 11 years). The general significance level was set at a P-value below 0.05.

Results

A total of 481 non-duplicated isolates were recovered from patient's specimens. **Table 1** shows the distribution of isolates based on age of patients. Out of 481, non-*Enterobacteriaceae* Gram negative rods were the most frequently isolates (175/481; 36.4%) followed, by *S. aureus* (119/481; 24.8%), *Enterobacteriaceae* (81/481; 16.8%), *H. influenzae* (48/481; 10%), β -hemolytic streptococci (30/481; 6.2%), *S. pneumoniae* (26/481; 5.4%) and *M. catarrhalis* (2/481; 0.4%).

Furthermore, approximately half of infected patients were children aged ≤ 10 years old (236/481; 49%). *H. influenzae* (47/48; 98%), *S. pneumoniae* (25/26; 96%) and *S. pyogenes* (20/24; 83%) were almost present in ear infection of this children group (**Table 1**).

The majority of cases occurred mostly during the winter season (158/481; 32.8%) followed by spring season (126/481; 26.2%) and fall season (110/481; 22.9%). However, the lowest number of cases was found in summer season (87/481; 18.1%) (**Figure 1**). The results of antimicrobial susceptibility tests of all tested isolates are presented in **Tables 2-4**.

Discussion

According to our laboratory records, the majority of ear infection cases were due to *P. aeruginosa*, *S. aureus*, *H. influenzae* and *S. pneumoniae* with an average number of 19.4, 17, 6.9 and 3.7 cases per year over the last 7 years, respectively. *H. influenzae*,

Table 1. Distribution of bacterial ear pathogens strains according to age of patients.

Age of patients	Number of strains							Total
	[0;10]	[11;20]	[21;30]	[31;40]	[41;50]	[51;60]	[61;90]	
<i>P. aeruginosa</i>	49	29	10	9	12	17	10	136
<i>Pseudomonas</i> spp.	6	8	3	1	1	1	0	20
<i>Alcaligenes</i> spp.	4	2	5	1	1	1	0	14
<i>Acinetobacter baumannii</i>	1	0	2	1	0	1	0	5
<i>E. coli</i>	8	6	1	0	3	2	4	24
<i>Proteus</i> spp.	7	6	1	2	0	2	1	19
<i>Enterobacter</i> spp.	4	8	2	0	0	0	0	14
<i>Klebsiella pneumoniae</i>	0	3	1	1	2	2	2	11
<i>Citrobacter</i> spp.	0	4	0	0	0	1	0	5
<i>Morganella morganii</i>	3	1	0	0	0	0	1	5
<i>Providencia</i> spp.	1	2	0	0	0	0	0	3
<i>H. influenzae</i>	47	1	0	0	0	0	0	48
<i>M. catarrhalis</i>	2	0	0	0	0	0	0	2
<i>S. aureus</i>	54	16	11	9	10	10	9	119
<i>S. pneumoniae</i>	25	0	0	0	0	1	0	26
<i>S. pyogenes</i>	20	2	1	1	0	0	0	24
Group C & group G streptococci	5	0	0	0	0	1	0	6
Total	236	88	37	25	29	39	27	481

S. pneumoniae and *S. pyogenes* infections were significantly predominant (p -value<0.001) in children aged less than 10 years. These three bacteria remain a leading cause of serious illness among babies and young children worldwide and are a frequent cause of ear infections [23]. However, *P. aeruginosa* was significantly prevalent in patients aged more than 10 years (p -value<0.001). *P. aeruginosa* ear infections are more prevalent in older population and often more difficult to treat [24]. No significant difference was found concerning the distribution of other reported bacteria species.

Otherwise, although ear infections occurred all year round, they were more common during the winter season when people spend more time in close contact indoors, children attending daycare and climate become colder.

This study confirms the wide range rates of an-

tibiotic resistance among the majority of bacterial ear pathogens isolates in Tripoli, North Lebanon. Regarding *P. aeruginosa*, several Lebanese investigation showed the emergence of multidrug resistance strains. Al Bayssari *et al.* [25] reported the emergence of *P. aeruginosa* producing IMP-15 and VIM-2 carbapenemases and the disruption of the *oprD* gene. Moreover, Chamoun *et al.* [5] showed a trend of increasing resistance of antibiotics in Lebanon between 2011 and 2013, with the highest resistance being found to imipenem (27.2%) followed by aztreonam (23.7%) and ciprofloxacin (22.7%). Another report showed mean resistant rates of 8.7% to imipenem, 13% to aztreonam and 8.7% to ciprofloxacin [19]. In our study, *P. aeruginosa* resistance to aztreonam and ciprofloxacin was 16.3% and 10.3%, respectively, and within range of the respective rates reported previously. A slight decrease

Figure 1. The seasonal distribution of ear infection cases in Lebanese patients.

in carbapenem resistance (6.6%) was observed in the present study, while susceptibility to ticarcillin and ticarcillin-clavulanate was maintained at around 80% and to piperacillin and piperacillin-tazobactam at around 85%.

Concerning *H. influenzae*, antibiotic resistance is more diverse and widespread than is commonly expected. *H. influenzae* isolates in our study revealed no-resistance to amoxicillin-clavulanate, cephalosporins, gentamicin, rifampicin and chloramphenicol. However, we note an emergence of resistance to kanamycin (2%), fluoroquinolones (3.4%), and tetracycline (4.2%). Higher resistant rate of *H. influenzae* was found against ampicillin (20%). No BLNAR isolates were found which suggest that all ampicillin-resistant bacteria were producer of β -lactamase. Two recent studies conducted in Tripoli, North Lebanon described that all β -lactamase producing *H. influenzae* were TEM-1, which is the most frequent resistance mechanism reported for this species [18,26].

Among the *Enterobacteriaceae*, *E. coli* was the predominant species. Various previous studies conducted in Lebanon showed a high prevalence of extended-spectrum beta-lactamases (ESBL)-producing *E. coli* with a mean rate of 20% [7,15] to 32% [5]. In addition, several reports described the emergence of carbapenemase-producing *E. coli* isolates, particularly OXA-48 [class D β -lactamases] [13,15,27-29]. In the present study, ESBL-producing *E. coli* was in the range of the previous reports since ertapenem, imipenem and meropenem resistance rates were about 6%, 0% and 0%, respectively. Ciprofloxacin resistance was about 30%, which is lower than that lately reported in the nationwide study [5], but in the range of that recently reported in Tripoli, North Lebanon [7,15,21].

S. aureus is a major pathogen for both hospital and community-acquired infections. Of the 119 isolated strains in our study, 21 (18%) MRSA. The high rate of MRSA observed in our study may result that *S. aureus* ear infections is becoming more difficult to treat. A

Table 2. Percentage of antibiotic susceptibility of major *Enterobacteriaceae* isolates.

	<i>E. coli</i> N=24 (%)	<i>Proteus</i> spp. N=19 (%)	<i>Enterobacter</i> spp. N=14 (%)	<i>Klebsiella pneumoniae</i> N=11 (%)	<i>Enterobacteriaceae</i> * Total N=81 (%)
AMP	20.8	47.4	0	0	18.5
AMC	70.8	89.5	0	81.8	59.3
TIC	37.5	57.9	92.9	0	50.6
TCC	79.2	94.7	92.9	81.8	88.9
PIP	37.5	57.9	92.9	0	50.6
PPT	94.1	100	92.9	81.8	96.6
CFX	58.3	57.9	0	81.8	46.9
CXM	70.8	89.5	71.4	81.8	75.3
FOX	83.3	100	0	90.9	76.5
CFM	79.2	89.5	92.9	81.8	86.4
CTX	79.2	89.5	92.9	81.8	87.7
CAZ	79.2	89.5	92.9	81.8	87.7
FEP	79.2	89.5	100	81.8	88.9
ATM	79.2	89.5	92.9	81.8	87.7
ERT	94.1	100	100	87.5	94.8
IMP	100	78.9	85.7	90.9	88.9
MEM	100	100	91.7	87.5	94.8
GMN	66.7	78.9	100	81.8	81.5
TMN	60.9	84.2	85.7	81.8	76.2
NET	75	78.9	92.9	81.8	84.0
AKN	95.8	100	100	100	98.8
OFX	66.7	73.7	85.7	72.7	72.8
CIP	70.8	78.6	92.9	72.7	76.5
TET	58.3	0	57.1	70	46.2
MNO	66.7	0	57.1	80	51.2
TGC	95.8	0	85.7	90.9	77.8
CS	100	0	100	100	65.4
FSF	100	89.5	78.6	63.6	85.2
SXT	58.3	57.9	92.9	72.7	69.1

AMP, ampicillin (10 µg) ; AMC, amoxicillin/clavulanate (20/10 µg) ; TIC, ticarcillin (75 µg) ; TCC, ticarcillin/clavulanate (75/10 µg) ; PIP, piperacillin (30 µg) ; PPT, piperacillin/tazobactam (30/6 µg) ; ATM, aztreonam (30 µg) ; IMP, imipenem (10 µg) ; MEM, meropenem (10 µg) ; ERT, ertapenem (10 µg) ; CFX, cefalexin (30 µg) ; CXM, cefuroxime (30 µg) ; FOX, cefoxitin (30 µg) ; CFM, cefixim (5 µg) ; CTX, ceftaxime (5 µg) ; FEP, cefepime (30 µg) ; CAZ, ceftazidime (30 µg) ; GMN, gentamicin (10 µg) ; TMN, tobramycin (10 µg) ; AKN, amikacin (30 µg) ; NET, netilmicin (10 µg) ; OFX, ofloxacin (5 µg) ; CIP, ciprofloxacin (5 µg) ; TET, tetracycline (30 µg) ; MNO, minocycline (30 µg) ; TGC, tigecycline (15 µg) ; CS, colistin (50 µg) ; FSF, fosfomycin (200 µg) ; SXT, trimethoprim/sulfamethoxazole (1,25/23,75 µg).

**Enterobacteriaceae* isolates include 24 *E. coli*, 19 *Proteus* spp., 14 *Enterobacter* spp., 11 *K. pneumoniae*, 5 *Citrobacter* spp., 5 *Morganella morganii* and 3 *Providencia* spp.

Table 3. Percentage of antibiotic susceptibility of major non-*Enterobacteriaceae* Gram negative rods isolates.

	<i>P. aeruginosa</i> N=136 (%)	<i>Pseudomonas</i> spp. N=20 (%)	<i>Alcaligenes</i> spp. N=14 (%)	<i>Acinetobacter baumannii</i> N=5 (%)
TIC	79.4	88.9	100	100
TCC	80.9	90	100	80
PIP	85.3	95	100	100
PPT	90.6	100	100	100
CAZ	91.9	85	85.7	20
FEP	89	60	64.3	100
ATM	83.7	50	21.4	0
IMP	93.4	85	92.9	100
MEM	97.6	100	100	100
GMN	79.4	65	35.7	80
TMN	88.2	60	35.7	80
NET	79.1	60	42.9	100
AKN	89.7	70	42.9	100
OFX	64.7	60	35.7	80
CIP	89.7	65	57.1	80
CS	100	90	85.7	100
FSF	68.4	45	21.4	0

recent nationwide study revealed an increase in the prevalence of MRSA in Lebanese hospitals [5]. This prevalence was two times higher than that reported in healthy schoolchildren in the same region [30]. In addition, the study found that *S. aureus* isolates are still susceptible to vancomycin, teicoplanin and linezolid.

With regard to *Streptococcus* group, *S. pneumoniae* was the predominant species followed by *S. pyogenes*. Of the 26 *S. pneumoniae* isolates, 30.8% were penicillin non-susceptible *S. pneumoniae* (PNSP), and 34.6% were resistant to both erythromycin and cotrimoxazole. A national prospective study reported that resistance rates to penicillin, erythromycin and cotrimoxazole were 17.4%,

29.3% and 54%, respectively [31]. However, higher level of resistance to penicillin (53.8%), erythromycin (41.3%) and cotrimoxazole (56.7%) was reported in another nationwide retrospective survey [5]. However, all *S. pneumoniae* isolates were susceptible to vancomycin, teicoplanin, linezolid, pristinamycin, tigecycline, gentamicin, streptomycin and fluoroquinolones. Penicillin, erythromycin and cotrimoxazole high resistance in *S. pneumoniae* has been incriminated due to antibiotic misuse and overuse of these antibiotics in Lebanon, since all oral antibiotics are easily available over the counter. While *S. pyogenes* remained sensitive to the majority of antibiotics during the study period.

Table 4. Percentage of antibiotic susceptibility of *S. aureus*, *S. pneumoniae*, *S. pyogenes* and *H. influenzae*.

	<i>S. aureus</i> N=119 (%)	<i>S. pneumoniae</i> N=26 (%)	<i>S. pyogenes</i> N=24 (%)	<i>H. influenzae</i> N=48 (%)
P	-	-	100	80
AMP	-	-	-	80
AMC	-	-	-	100
OX	-	69.2	-	-
FOX	81.5	-	-	-
CFX	-	-	-	100
CXM	-	-	-	100
CTX	-	-	-	100
VAN	100	100	100	-
TEI	100	100	100	-
S	-	100	100	-
KMN	78.2	-	-	-
TMN	89.1	-	-	-
GMN	90.8	100	100	-
C	93.3	100	100	100
TET	94.1	76.9	87.5	95.8
MNO	100	-	-	-
TGC	100	100	100	-
E	85.7	65.4	95.8	-
CD	95.8	69.2	95.8	-
PTN	100	100	100	-
LZD	100	100	100	-
FUS	79.8	-	-	-
NA	-	-	-	93.1
OFX	-	-	-	96.6
CIP	-	-	-	96.6
LVX	87.7	100	100	-
MOX	87.7	100	100	-
RIF	98.3	96.2	95.8	100
SXT	95	65.4	45.8	64.6
FSF	95.8	-	-	-
NOV	82.8	-	-	-

P, penicillin G (1 UI) ; AMP, ampicillin (2 µg) ; AMC, amoxicillin/clavulanate (2/1 µg) ; CFX, cefalexin (30 µg) ; CXM, cefuroxime (30 µg) ; CTX, cefotaxime (5 µg); OX, oxacillin (1 µg) ; FOX, ceftioxin (30 µg); S, streptomycin (300 µg); KMN, kanamycin (30 µg); TMN, tobramycin (10 µg), GMN, gentamicin (10 µg for *S. aureus* and 500 µg for *Streptococcus* spp.), C, Chloramphenicol (30 µg); TET, tetracycline (30 µg) ; MNO, minocycline (30 µg); TGC, tigecycline (15 µg); E, erythromycin (15 µg); CD, clindamycin (2 µg); PTN, pristinamycin (15 µg); LZD, linezolid (10 µg); TEI, teicoplanin (30 µg); VAN, vancomycin (5 µg); FUS, fusidic acid (10 µg); NA, nalidixic acid (30 µg); OFX, ofloxacin (5 µg) ; CIP, ciprofloxacin (5 µg) ; LVX, levofloxacin (5 µg); MOX, moxifloxacin (5 µg); RIF, Rifampicin (5 µg) ; SXT, trimethoprim/sulfamethoxazole (1,25/23,75 µg); FSF, fosfomicin (200 µg); NOV, novobiocin (5 µg).

In conclusion, this study indicates that the antibiotic resistance rates of pathogens causing ear infection are widely varied among bacterial isolates in Tripoli, North Lebanon. These findings are probably correlated with the high spread of counterfeit medicines and the misuse and overuse of antibiotics. Therefore, cultures and antibiotic susceptibility testing of bacterial ear pathogens are very important to determine bacterial causes and to guide appropriate treatment.

References

1. Rovers MM, Schilder AG, Zielhuis GA, Rosenfeld RM. Otitis media. *Lancet*. 2004;363(9407):465-73.
2. Hui CP, Canadian Paediatric Society ID, Immunization C. Acute otitis externa. *Paediatrics & child health*. 2013;18(2):96-101.
3. Minovi A, Dazert S. Diseases of the middle ear in childhood. *GMS Curr Top Otorhinolaryngol Head Neck Surg* 2014;13:Doc11.
4. Qureishi A, Lee Y, Belfield K, Birchall JP, Daniel M. Update on otitis media - prevention and treatment. *Infect Drug Resist* 2014;7:15-24.
5. Chamoun K, Farah M, Araj G, Daoud Z, Moghnieh R, Salameh P, et al. Surveillance of antimicrobial resistance in Lebanese hospitals: retrospective nationwide compiled data. *Int J Infect Dis*. 2016;46:64-70.
6. Hamze M, Osman M, Achkar M, Mallat H, Dabboussi F. Alarming increase in prevalence of *Neisseria gonorrhoeae* infections associated with a high level of antibiotic resistance in Tripoli, Lebanon. *Int J Antimicrob Agents*. 2016.
7. Hamze M, Osman M, Mallat H, Achkar M. Antibiotic Susceptibility of *Salmonella* spp., *Shigella* spp. and enteropathogenic *Escherichia coli* strains isolated from diarrheic children in Tripoli, North Lebanon. *IAJAA* 2016;6(2:2).
8. Al Bayssari C, Dabboussi F, Hamze M, Rolain JM. Emergence of carbapenemase-producing *Pseudomonas aeruginosa* and *Acinetobacter baumannii* in livestock animals in Lebanon. *J Antimicrob Chemother*. 2015;70(3):950-1.
9. Rafei R, Hamze M, Pailhories H, Eveillard M, Marsollier L, Joly-Guillou ML, et al. Extrahuman Epidemiology of *Acinetobacter baumannii* in Lebanon. *Appl Environ Microbiol* 2015;81(7):2359-67.
10. Rafei R, Pailhories H, Hamze M, Eveillard M, Mallat H, Dabboussi F, et al. Molecular epidemiology of *Acinetobacter baumannii* in different hospitals in Tripoli, Lebanon using bla OXA-51-like sequence based typing. *BMC Microbiol* 2015;15(1):103.
11. Rafei R, Dabboussi F, Hamze M, Eveillard M, Lemarie C, Mallat H, et al. First report of blaNDM-1-producing *Acinetobacter baumannii* isolated in Lebanon from civilians wounded during the Syrian war. *Int J Infect Dis* 2014;21:21-3.
12. El Ayoubi MD, Hamze M, Mallat H, Achkar M, Dabboussi F. Glycopeptide intermediate *Staphylococcus aureus* and prevalence of the luk-PV gene in clinical isolates, in Northern Lebanon. *Medecine et maladies infectieuses* 2014;44(5):223-8.
13. Beyrouthy R, Robin F, Dabboussi F, Mallat H, Hamze M, Bonnet R. Carbapenemase and virulence factors of *Enterobacteriaceae* in North Lebanon between 2008 and 2012: evolution via endemic spread of OXA-48. *J Antimicrob Chemother* 2014;69(10):2699-705.
14. Moghnieh R, Rafei R, Husni-Samaha R, Hamze M. Genetic and antibiotic susceptibility profiles of drug-resistant *Acinetobacter baumannii* from various parts of Lebanon *IAJAA* 2014;4(1):1-9.
15. Amrieh S, Hamze M, Mallat H, Achkar M, Dabboussi F. Detection of *Escherichia coli* O157:H7 and O104:H4 in patients with diarrhea in Northern Lebanon and characterization of fecal *E. coli* producing ESBL and carbapenemase genes. *IAJAA* 2014;4(3:4).
16. Dabboussi F, Allouche S, Mallat H, Hamze M. Prevalence of first-step mutants among levofloxacin-susceptible isolates of *Streptococcus pneumoniae* in north Lebanon. *J Chemother* 2013;25(6):328-31.
17. Salma R, Dabboussi F, Kassaa I, Khudary R, Hamze M. gyrA and parC mutations in quinolone-resistant clinical isolates of *Pseudomonas aeruginosa* from Nini Hospital in north Lebanon. *J Infect Chemother* 2013;19(1):77-81.
18. Kassaa I, Hamze M, Dabboussi F. Molecular Characterization and resistance of *H. influenzae* isolated from Nasopharynx of Students in North Lebanon. *IAJAA* 2012;2(1:5):1-6.
19. Hamze M, Mallat H, Dabboussi F, Achkar M. Antibiotic susceptibility and serotyping of clinical strains of *Pseudomonas aeruginosa* isolated in northern Lebanon. *IAJAA* 2012; 2(4:2):1-6.
20. Osman M, Al Nasbeh A, Rafei R, Mallat H, Achkar M, Dabboussi F, et al. Characterization of resistance genes to macrolides, lincosamides and streptogramins (MLS) among clinical isolates of *Staphylococcus aureus* in North Lebanon. *IAJAA* 2015;5(4:3):1-8.
21. Tabbouche S, Al Khudary R, Beyrouthy R, Dabboussi F, Achkar M, Mallat H, et al. Detection of genes TEM, OXA, SHV and CTX-M in 73 clinical isolates of *Escherichia coli* producers of extended spectrum Beta-lactamases and determination of their susceptibility to antibiotics. *IAJAA* 2011;1:1-6.
22. SFM. Référentiel en Microbiologie Médicale (REMIC). 5ème édition ed. Paris: Société Française de Microbiologie; 2015.
23. Rodrigues F, Morales-Aza B, Turner KM, Sikora P, Gould K, Hinds J, et al. Multiple *Streptococcus pneumoniae* serotypes in aural discharge samples from children with acute otitis media with spontaneous otorrhea. *J Clin Microbiol*. 2013;51(10):3409-11.
24. Gellatly SL, Hancock RE. *Pseudomonas aeruginosa*: new insights into pathogenesis and host defenses. *Pathog dis* 2013;67(3):159-73.
25. Al Bayssari C, Diene SM, Loucif L, Gupta SK, Dabboussi F, Mallat H, et al. Emergence of VIM-2 and IMP-15 carbapenemases and inactivation of oprD gene in carbapenem-resistant *Pseudomonas aeruginosa* clinical isolates from Lebanon. *Antimicrob Agents Chemother*. 2014;58(8):4966-70.
26. Kassaa I, Hamze M, Dabboussi F, Mallat H, Achkar M, Hlais S. Prevalence of type b *Haemophilus influenzae* and antibiotic resistance in 52 clinical isolates in north Lebanon. *East Mediterr Health J*. 2014;19 Suppl 3:S105-10.

27. Al Bayssari C, Olaitan AO, Dabboussi F, Hamze M, Rolain JM. Emergence of OXA-48-producing *Escherichia coli* clone ST38 in fowl. *Antimicrob Agents Chemother* 2015;59(1):745-6.
28. Beyrouthy R, Robin F, Cougnoux A, Dalmasso G, Darfeuille-Michaud A, Mallat H, et al. Chromosome-mediated OXA-48 carbapenemase in highly virulent *Escherichia coli*. *J Antimicrob Chemother* 2013;68(7):1558-61.
29. Beyrouthy R, Robin F, Delmas J, Gibold L, Dalmasso G, Dabboussi F, et al. IS1R-mediated plasticity of IncL/M plasmids leads to the insertion of bla OXA-48 into the *Escherichia coli* Chromosome. *Antimicrob Agents Chemother* 2014;58(7):3785-90.
30. Beyrouthy R, Hamze M, Hleis S, Mallat H, Dabboussi F. Pantone-Valentine leukocidin producing *Staphylococcus aureus* nasal carriage, in North-Lebanon. *Medecine et maladies infectieuses* 2013;43(9):386-90.
31. Hanna-Wakim R, Chehab H, Mahfouz I, Nassar F, Baroud M, Shehab M, et al. Epidemiologic characteristics, serotypes, and antimicrobial susceptibilities of invasive *Streptococcus pneumoniae* isolates in a nationwide surveillance study in Lebanon. *Vaccine* 2012;30 Suppl 6:G11-7.

Comment on this article: <http://medicalia.org/>

Where Doctors exchange clinical experiences, review their cases and share clinical knowledge. You can also access lots of medical publications for free. **Join Now!**

Publish with iMedPub<http://www.imed.pub>

The Journal is an open access peer-reviewed journal that publishes scientific papers about all aspects of antimicrobials. The journal will publish original research articles, reviews, brief reports and case reports dealing with basic and clinical antibacterial agents, antiviral, antiprotozoals, antituberculous, antifungal and antihelminthes agents.

All manuscripts must be prepared in English, and are subject to a rigorous and fair peer-review process. Accepted papers will immediately appear online.

The journal aims to advance the knowledge, attitude and the research of chemotherapy in the Arabic world in cooperation with international, national scientific and public societies as well as research centers with similar aims and objectives.