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Microbiological Study On Respiratory Tract Infections In Libya

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Abstract

Introduction: Recent reports revealed that 10% of the worldwide burden of morbidity and mortality relates to respiratory tract infection.

Patient and methods: Five hundreds and fifty nine clinical strains were isolated and identified from 322 patients suffering from respiratory tract infections. Patients represented different ages, sexes, and types of infections. Out of the 322 patients, 204 were suffering from upper respiratory tract infections and 118 patients were suffering from lower respiratory tract infections. Patients of upper respiratory tract infections were suffering from chronic suppurative otitis media (63 patients), tonsillitis (50 patients), pharyngitis (48 patients), and sinusitis (43 patients).

Results: Out of the total isolates, *Staphylococcus aureus* was the most prevalent organism, followed by *Streptococcus pyogenes* and *Klebsiella pneumoniae* (17.71, 12.34, and 11.27% respectively). *Pseudomonas aeruginosa* represented 6.26%. *Serratia marcescens* and *Morganella morganii* were the least isolated organisms. The results revealed that 52.42% of the strains were isolated from males and 47.58% from females. *Staphylococcus aureus* was the most prevalent organism in males (21.16%) while in females *Strept. pyogenes* was the most prevalent organism (14.29%). Also, the study revealed that Staphylococcus aureus was the most frequent isolate in age groups between 1-20, 21-40 and 41-60 years old (20.85%, 17.02% and 16.67% respectively). However, both *Staphylococcus aureus* and *Klebsiella pneumoniae* were isolated with equal incidences, 12% each, in elder patients (more than 60 years). The susceptibility pattern of the isolated bacteria to different antimicrobial agents was studied. Both levofloxacin and gatifloxacin showed the highest activity (100%), followed by ofloxacin and ciprofloxacin (96.44% and 93.39%, respectively). Those are followed by amikacin (91.86%), cefotaxime (89.31%), cefoperazone (86.26%), gentamicin (84.22%), ampicillin-sulbactam (70.48%), amoxycillin-clavulanic (62.34%), cefuroxime (62.09%), lincomycin (61.83%), vancomycin (61.07%), chloramphenicol (57%), cephalexin (48.35%), cephapirin (45.29%), erythromycin (44.78%), and trimethoprim-sulphamethoxazole (43%). Amoxycillin and tetracycline were the least active ((36.64% and 32.06% respectively). *Staphylococcus aureus* strains resistant to amoxycillin were tested for *B*-lactamase production. Out of the tested strains, 62.5% were *B*- lactamase producers and it may be responsible for the resistance to amoxycillin.

In conclusion, the study revealed that evaluation of respiratory tract infections and antimicrobial susceptibility is still in need for more studies. This is due to the continuous development of newly resistant strains and the relatively little number of isolates in some species. Moreover, the differences in the previous antimicrobial treatment, the history of subclinical infections and the immune status of patients involved in each study have increased the difficulty in evaluation.

Itroduction

Recent reports revealed that 10% of the worldwide burden of morbidity and mortality relates to respiratory tract infections as they kill an estimated 10 million people annually. The majority of these cases are children under five years old in developing countries (Ball *et al*., 2002). Upper respiratory tract infections account

for more visits to physicians than any other type of infectious disease. Lower respiratory tract infection is a common cause of hospital admission (Chan *et al*., 1995 ; Caroll and Reimer, 1996).

Upper respiratory tract infections may move downwards and result in more severe infections of the lower respiratory tract, such as pneumonia or bronchioitis (Sleigh and Timbury, 1998). This progression towards more severe respiratory tract infection is of significant concern in developing countries where pneumonia contributes substantially to childhood death (Wald, 1991).

Different microorganisms are recognized as important etiologic agents of upper respiratory tract infections. *S. aureus, Proteus, Klebsiella,* and *Pseudomonas* were reported to be the most important causes of chronic suppurative otitis media (Black, 2002). *S. pneumoniae, H. influenzae*, group *A Streptococci and S.aureus* are often isolated from cases of sinusitis (Ferranti *et al*., 1998). *S. pyogenes* is by far the most clinically important etiologic agent of bacterial pharyngitis (Zwart *et al*., 2001). Infecting organisms of tonsillitis are identical in type and incidence to those causing pharyngitis with the addition of *Staphylococci, S. pneumoniae* and *Haemophilus* species (Brillman and Quenzer, 1992). *S. pneumoniae* is the most common bacterial pathogen in lower respiratory tract infections (Caroll, 2002).

The problem of increasing antimicrobial resistance of bacterial species commonly isolated from community-acquired respiratory tract infections is of growing concern to microbiologists and infectious disease physicians (Mandell, 1995; Goldstein *et al*., 1998). The infecting pathogen is often unknown during the acute phase of the infection and therapy is thus empirical. The choice of therapy should reflect the local resistance profile (Felmingham *et al*., 2000).

The aim of the present work is to study the important microorganisms responsible for respiratory tract infections in Libya to evaluate the anti-bacterial activities of some antimicrobial agents against the isolated strains, and to study the possible mechanisms of resistance of the resistant strains.

Materials And Methods

Patients, Specimens, and Media:

Three hundreds and twenty two patients suffering from respiratory tract infections were included in this study and were colleced from outpatient clinics. Out of the 322 patients, 204 patients were suffering from upper respiratory tract infections and 118 patients were suffering from lower respiratory tract infections. Patients of upper respiratory tract infections were complaining from chronic suppurative otitis media (63 patients), tonsillitis (50 patients), sinusitis (43 patients) and pharyngitis (48 patients).

Sterile cotton-tipped swabs were used for collection of upper respiratory tract specimens. Sputum samples were collected in sterile wide-necked and leak proof containers. The collected samples were cultured on blood agar, nutrient agar, MacConkey agar and mannitol salt agar plates. The plates were incubated aerobically at 37°C for 24 hours. Sputum samples were spread on slide surfaces for preparation of smears for acid fast stain. The produced colonies were examined morphologically, microscopically and biochemically.

The culture media used were nutrient agar, mannitol salt agar, sulphide indole motility, DNase agar, eosin methylene blue, methyl red-Voges Proskauer (MR-VP) medium and nutrient broth (all are products of Oxoid laboratories). MacConkey agar, triple sugar iron, Christensen's urea agar, Simmons citrate agar and blood agar base (products of Britania laboratories). In addition, brain-heart infusion broth (Biolife) and phenylalanine deaminase agar (Difco) were also used. All media were prepared according to the instructions of the manufacturers. In addition, other media including blood agar, crystal violet blood agar, brain heart infusion with cooked meat particles, cetrimide agar, sugar fermentation medium, nitrate reduction medium and phenolphthalein phosphate agar were prepared in laboratory.

Biochemical activities including catalase, coagulase, DNase, phosphatase production, bacitracin sensitivity, optochin sensitivity, bile solubility, oxidase, urease, nitrate, indole production, H_2S production, methyl red, Voges-Proskauer, citrate utilization, amino acid decarboxylation and sugars fermentation tests were performed for identification of each isolate. Biochemical reactions were carried out according to the standard methods of Cruickshank *et al*., 1975; Koneman *et al.*, 1994 and Collee *et al.*, 1996.

Antimicrobial susceptibility patterns for the isolated strains were studied using Bauer and Kirby method (Bauer *et al*., 1966). The antimicrobial disks used were amoxycillin (25µg), amoxycillin/clavulanic acid (20µg/10µg), ampicillin/sulbactam (20µg/10µg), cephalexin (30µg), cephapirin (30µg), cefuroxime (30µg), cefotaxime (30µg), cefoperazone (30µg), vancomycin (30µg), gentamicin (10µg), amikacin (30µg), lincomycin (2µg), erythromycin (15UI), chloramphenicol (30µg), tetracycline (30UI), ciprofloxacin (5µg), ofloxacin (5µg), levofloxacin (5µg), gatifloxacin (5µg), trimethoprim/sulpha-methoxazole (1.25µg+23.75µg). All were products of Oxoid Laboratories. In addition, Bacitracin (10µg) was supplied by Bio-adwic.

Results

In this study, 559 different clinical strains were isolated from 322 patients suffering from respiratory tract infections (166 male and 156 female) representing different age groups. Out of the 322 patients, 204 were suffering from upper respiratory tract infections and 118 patients were suffering from lower respiratory tract infections. Patients of upper respiratory tract infections were suffering from chronic suppurative otitis media (63 patients), tonsillitis (50 patients), sinusitis (43 patients) and pharyngitis (48 patients). Distribution of the patients according to their age, sex and site of the infection were shown in table (1) and Figure (1).

**Percentage was correlated to the total number of isolates.

The prevalence of microorganisms isolated from the patients in relation to sex was shown in table (3). Data in the table show that 52.42% (293/559) of the strains were isolated from males while 47.58% (266/559) were isolated from females. *S. aureus* was the most prevalent organism in males (21.16%) while in females *S. pyogenes* was the most prevalent organism (14.29%).

Table (4) shows the prevalence of microorganisms isolated from the patients according to the type of infection. Of the isolated strains, *Staphylococcus aureus* was the most frequent in otitis media (24/106, 22.64%), tonsillitis (19/88, 21.59%), and Sinusitis (18/82, 21.95%) followed by *Pseudomonas aeruginosa* in otitis media (18/106, 16.98%), *Streptococcus pyogenes* in tonsillitis (17/88, 19.32%), and *Staphylococcus* albus in sinusitis (11/82, 13.41%). Data in the table show that 559 different strains were isolated. *S. aureus* was the most prevalent organism (17.71%) followed by *S. pyogenes* (12.34%), *K. pneumoniae* (11.27%), *Strept. viridans* (10.73%), *Staph. albus* (10.38%), *C. albicans* (9.3%), *Ps. aeruginosa* (6.26%), *S. pneumoniae* (5.37%), *Proteus mirabilis* (4.47%), *Diphtheroids spp*. (3.22%), E.coli (2.5%), *Sarcina spp*. (1.97%), Bacillus spp. (1.79%), *Mycobacterium tuberculosis* (1.43%), *Proteus vulgaris* (0.72%), *Serratia marcescens* (0.36%), and *Morganella morganii* (0.18%).

Table (5) shows the susceptibility patterns of the isolated microorganisms against different antimicrobial agents. Both levofloxacin and gatifloxacin showed the best activity (100%). Ofloxacin and ciprofloxacin exhibited activities of 96.44% and 93.39% respectively. The activities of the other antimicrobials were in the following order: amikacin (91.86%), cefotaxime (89.31%), cefoperazone (86.26%),

gentamicin (84.22%), ampicillin-sulbactam (70.48%),amoxycillin-clavula-nic (62.34%), cefuroxime (62.09%), lincomycin (61.83%), vancomycin (61.07%), chloramphenicol (57%), cephalexin (48.35%), cephapirin (45.29%), erythromycin (44.78%), trimethoprim/sul-phamethoxazole (43%), amoxycillin (36.64%) and tetracycline (32.06%).

Table (1): Distribution of patients according to their age, sex, and type of infection:

Type of Infection	Age in years								Total
	1-20		21-40		41-60		Above 60		
	Male	Female	Male	Female	Male	Female	Male	Female	
Otitis Media	21	20	6	7	3	3	3	0	**63**
Tonsillitis	15	10	5	3	6	5	4	2	**50**
Pharyngitis	12	9	6	11	4	3	1	2	**48**
Sinusitis	8	14	10	4	2	2	0	3	**43**
LRT infections	9	10	15	18	19	19	17	11	**118**
Total	**65**	**63**	**42**	**43**	**34**	**32**	**25**	**18**	**322**

* LRT = lower Respiratory Tract.

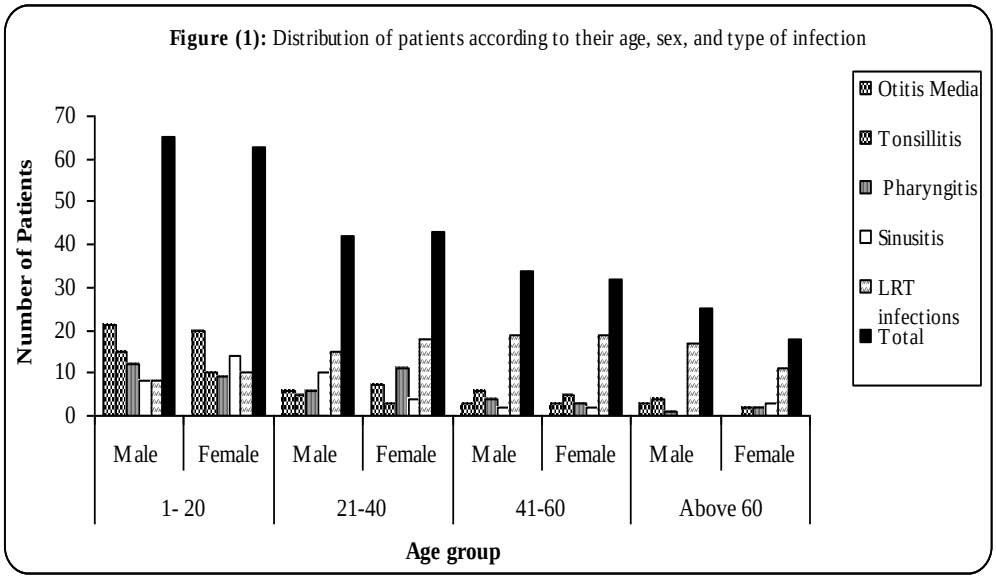

Figure (1): Distribution of patients according to their age, sex, and type of infection

Table (2): Prevalence of microorganisms isolated from the patients in relation to age

Microorganisms	Age in years									
	1-20		21-40		41-60		> 60		Total	
	No	%*	No	%*	No	%*	No	%*	No	%*
Staphylococcus aureus	44	20.85	24	17.02	22	16.67	9	12	99	17.71
Staphylococcus albus	23	10.9	18	12.77	10	7.58	7	9.33	58	10.38
Streptococcus pyogenes	27	12.8	21	14.89	14	10.61	7	9.33	69	12.34
Streptococcus viridans	23	10.9	12	8.51	19	14.39	6	8	60	10.73
Streptococcus pneumoniae	7	3.32	10	7.09	6	4.55	7	9.33	30	5.37
Pseudomonas aeruginosa	16	7.58	10	7.09	7	5.3	2	2.67	35	6.26
Proteus mirabilis	11	5.21	4	2.84	7	5.3	3	4	25	4.47
Proteus vulgaris	4	1.9	0	0	0	0	0	0	4	0.72
Escherichia coli	7	3.32	4	2.84	2	1.52	1	1.33	14	2.5
Klebsiella pneumoniae	22	10.43	14	9.93	18	13.64	9	12	63	11.27
Serratia marcescens	0	0	2	1.42	0	0	0	0	2	0.36
Morganella morganii	0	0	0	0	1	0.76	0	0	1	0.18
Mycobacterium tuberculosis	0	0	1	0.71	4	3.03	3	4	8	1.43
Candida albicans	16	7.58	14	9.93	13	9.85	9	12	52	9.3
Bacillus spp.	1	0.47	2	1.42	2	1.52	5	6.67	10	1.79
Sarcina spp.	4	1.9	0	0	3	2.27	4	5.33	11	1.97
Diphtheroids spp.	6	2.84	5	3.55	4	3.03	3	4	18	3.22
Total	211	100	141	100	132	100	75	100	559	100

* Percentage was correlated to the number of isolates in each age group.

Table (3): Prevalence of microorganisms isolated from the patients in relation to sex

Microorganisms	Male		Female		Total	
	No	%*	No	%*	No	%**
Staphylococcus aureus	62	21.16	37	13.91	99	17.71
Staphylococcus albus	33	11.26	25	9.4	58	10.38
Streptococcus pyogenes	31	10.58	38	14.29	69	12.34
Streptococcus viridans	28	9.56	32	12.03	60	10.73
Streptococcus pneumoniae	11	3.75	19	7.14	30	5.37
Pseudomonas aeruginosa	19	6.48	16	6.02	35	6.26
Proteus mirabilis	10	3.41	15	5.64	25	4.47
Proteus vulgaris	4	1.37	0	0	4	0.72
Escherichia coli	6	2.05	8	3.01	14	2.5
Klebsiella pneumoniae	33	11.26	30	11.28	63	11.27
Serratia marcescens	1	0.34	1	0.38	2	0.36
Morganella morganii	1	0.34	0	0	1	0.18
Mycobacterium tuberculosis	7	2.39	1	0.38	8	1.43
Candida albicans	28	9.56	24	9.02	52	9.3
Bacillus spp.	3	1.02	7	2.63	10	1.79
Sarcina spp.	5	1.71	6	2.26	11	1.97
Diphtheroids spp.	11	3.75	7	2.63	18	3.22
Total	293	100	266	100	559	100

*Percentage was correlated to the number of isolates of each sex.

Table (4): Prevalence of microorganisms isolated from the patients according to the type of infection

Microorganisms	Type of infection											
	Otitis media		Tonsillitis		Pharyngitis		Sinusitis		LRT infections		Total	
	no	%*	no	%*	no	%*	no	%*	no	%*	no	%**
Staphylococcus aureus	24	22.64	19	21.59	15	17.24	18	21.95	23	11.73	99	17.71
Staphylococcus albus	17	16.04	7	7.95	5	5.75	11	13.41	18	9.18	58	10.38
Streptococcus pyogenes	7	6.6	17	19.32	24	27.59	8	9.74	13	6.63	69	12.34
Streptococcus viridans	3	2.83	16	18.18	18	20.69	5	6.1	18	9.18	60	10.73
Streptococcus pneumoniae	0	0	1	1.14	2	2.3	4	4.88	23	11.73	30	5.37
Pseudomonas aeruginosa	18	16.98	0	0	0	0	5	6.1	12	6.12	35	6.26
Proteus mirabilis	11	10.38	0	0	0	0	7	8.54	7	3.57	25	4.47
Proteus vulgaris	2	1.89	0	0	0	0	0	0	2	1.02	4	0.72
Escherichia coli	7	6.6	0	0	0	0	5	6.1	2	1.02	14	2.5
Klebsiella pneumoniae	8	7.55	13	14.77	11	12.64	9	10.98	22	11.22	63	11.27
Serratia marcescens	0	0	0	0	0	0	0	0	2	1.02	2	0.36
Morganella morganii	0	0	0	0	0	0	0	0	1	0.51	1	0.18
Mycobacterium tuberculosis	0	0	0	0	0	0	0	0	8	4.08	8	1.43
Candida albicans	9	8.49	7	7.95	9	10.34	7	8.54	20	10.2	52	9.3
Bacillus spp.	0	0	0	0	0	0	0	0	10	5.1	10	1.79
Sarcina spp.	0	0	3	3.41	2	2.3	1	1.22	5	2.55	11	1.97
Diphtheroids spp.	0	0	5	5.68	1	1.15	2	2.44	10	5.1	18	3.22
Total	**106**	**100**	**88**	**100**	**87**	**100**	**82**	**100**	**196**	**100**	**559**	**100**

LRT: lower respiratory tract,

- Percentage was correlated to the number of isolates in each type of infection.
- **Percentage was correlated to the total number of isolates.

Discussion

Prevalence of the isolated strains:

Respiratory tract infections are the most common causes of childhood morbidity and mortality worldwide, accounting for about 30% of all childhood deaths in the developing countries (Dixon, 1985 ; Hinman, 1998).

Five hundreds and fifty nine different clinical strains were isolated from 322 patients suffering from different respiratory tract infections. Patients were suffering from chronic suppurative otitis media (63 patients), follicular tonsillitis (50 patients), pharyngitis (48 patients), sinusitis (43 patients) and lower respiratory tract infections (118 patients).

Otitis media is one of common diseases, for which infants and children seek health care. Children who have otitis media in the first year of life are more likely to suffer from chronic infection (Klein *et al*., 1989; Middleton, 1991). In this study, 106 clinical strains were isolated and identified from 63 patients suffering from chronic suppurative otitis media. *Staph. aureus* was the most prevalent organism (22.64%). *Ps. aeruginosa* was the second (16.98%) followed by Staph. albus (16.04%), *Proteus mirabilis* (10.38%), *C. albicans* (8.49%), *K. pneumoniae* (7.55%), *Strept. pyogenes* (6.6%), *E. coli* (6.6%), *Strept. viridans* (2.83%) and *Proteus vulgaris* (1.89%). In a study carried out by Abd-Elrehim *et al*. (1988), 32 clinical strains were isolated from 25 cases of chronic suppurative otitis media. *S. aureus* was the most prevalent organism (28%) followed by *Pseudomonas spp*. (24%), *Proteus spp*. (20%), *E. coli* and *Bacteroides fragilis* (12% each), *Klebsiella, anaerobic Streptococcus, Diphtheroids* and *Bacteroides melaninogenicus* (8% for each). El-Daly *et al*. (1990) found that Staph. aureus was the most prevalent organism (39%) followed by *Pseudomonas spp*. (29%), *Proteus spp*. (21%), *Pneumococci* (17%), *Bacteroides* and anaerobic *Streptococci* (12% each), *E. coli* and *Strept. pyogenes* (10% for each), *H. influenzae* and *Klebsiella spp*. (9% each). Al-Saadawy and El-Tawy (1990) and Del Beccaro *et al.* (1992) reported higher prevalence for *S. aureus* (37.5% and 47.7% respectively).

Okasha *et al*. (1995) isolated 28 strains from 24 cases of chronic suppurative otitis media. *S. aureus* was the most frequent organism (28.6%) followed by *Ps. aeruginosa* (21.4%), *Proteus mirabilis* (14.3%), *Strept. pneumoniae* and *Aspergillus niger* (10.7% for each), *S. pyogenes* (7.2%), *C. albicans* and *Aspergillus flavus* (3.6% for each). In a study carried out by Radosz-Komoniewska (1997), *S. aureus* was the most prevalent organism isolated (45%) followed by *Ps. aeruginosa* (34%) and **Proteus mirabilis** (16%). Kuczkowski *et al*. (2000) investigated 150 patients with chronic otitis media. The most frequently observed bacteria were *S. aureus*, *Ps. aeruginosa* and *Proteus mirabilis*.

Results of the mentioned studies agree with the present study in having *S. aureus* the most common organism. The predominance of *S. aureus* and *Ps. aeruginosa* in chronic suppurative otitis media was also reported by Brook and Burke (1992) and Shaheen *et al*. (1994). The high prevalence of *S. aureus* could be explained on basis of increased resistance of *S. aureus* to the commonly used antibiotics (Eiff *et al*., 2001). It could be also attributed to the fact that Staph. aureus is one of the normal flora of the respiratory system and colonizing strains may serve as endogenous reservoirs for overt clinical infections or may spread to other patients (Waldvogel, 1999).

In other studies *P. aeruginosa* was found to be the commonest organism causing chronic suppurative otitis media. Jonsson *et al*. (1986) reported that *P. aeruginosa* was the most prevalent organism (31.91%) followed by *S. aureus* and *S. albus* (29.79% each), Diphtheroids spp. (25.53%), Proteus spp. (21.28%), β-haemolytic streptococci (10.64%), *Branhamella catarrhalis* (4.26%) and *H. influenzae* (2.13%). The results obtained by Giebink (1989) showed a high importance

of *Ps. aeruginosa* in the pathogenesis of chronic suppurative otitis media, where it was isolated in 67% of ear discharge samples and in 31% of the cases it was the only isolate. Ibrahim *et al.* (1992) isolated *P. aeruginosa* at a high rate (32%) followed by Proteus spp. (20%), H. influenzae and Strept. pneumoniae (8% each), *S. Aureus*, *S. pyogenes* and *E. coli* (5% each).

The study of Altuntas *et al*. (1996), on chronic suppurative otitis media, revealed that the most common aerobic isolates were *Pseudomonas* spp., *Proteus* spp., and *S. aureus* with recovery rates of 40.7%, 21.6% and 19.1% respectively. Ghosh et al. (2000) reported that the principal organisms isolated from patients with chronic otitis media were *Ps. aeruginosa* and *Staph. aureus*. Zaki (2000) reported a high incidence of *P. aeruginosa* (16.39%), followed by *S. aureus* (14.75%), *Proteus mirabilis* (12.29%), *Staph. albus* (10.66%), *E. coli* (9.02%), *Bacillus* spp. (7.38%), *Strept. pyogenes* and *S. viridans* (6.56% for each) and *C. albicans* (4.92%).

The high prevalence of *P. aeruginosa* could be attributed to the fact that *P. aeruginosa* is intrinsically resistant to most commonly used antimicrobial agents. To a considerable extent this resistance is due to outer membrane porins that restrict the entry of antimicrobial agents to the periplasmic space (Talaro and Talaro, 2002 and Abdel-Salam *et al*., 2003).

The difference in the results may be attributed to that organisms responsible for chronic suppurative media vary from one place to another depending on socioeco-nomic conditions, which are considered important predisposing etiological factors (Okafor, 1984). Also, the age of patient, the habits of the population as well as the season, during which the study is carried out, may influence the incidence of different organisms (Abd-Elrehim *et al.*, 1988).

Throat infections are common illnesses, for which patients visit primary care physicians (Bisno, 2001). Eighty eight clinical strains were isolated from 50 patients suffering from follicular tonsillitis. Staph. aureus was the most common organism (21.59%) followed by *St. pyogenes* (19.32%), Strept. viridans (18.18%), K. pneumoniae (14.77%), *S. albus* (7.95%), *C. albicans* (7.95%), *Diphtheroids* spp. (5.68%), *Sarcina* spp. (3.41%) and *S. pneumoniae* (1.14%).

El-Maraghy (1985) reported that *S. aureus* was the most common orga-nism isolated from chronic tonsillitis cases (48%) followed by *S. pyogenes* (30%) and Staph. albus (4%). Badr (1991) reported that *S. aureus* was the most common organism (76%) followed by *S. pyogenes* (52%), *S. albus* (30%), *C. albicans* (30%), Klebsiella spp. (16%), Strept. pneumoniae and *Diphtheroids* spp. (14% for each) *Bacillus* spp. and *Neisseria* spp. (8% for each). Ali (1991) revealed that *S. aureus* was the most prevalent organism in recurrent tonsillitis (56%) followed by *S. pyogenes* (44%), *Diphtheroids* spp. (28%), *Neisseria* spp. (20%), *S. albus* (16%) and *S. pneumoniae* (12%).

The previous studies agree with the present one in having *S. aureus* the most prevalent organism in tonsillitis followed by *S. pyogenes*.

Group A streptococcus is by far the most common bacterial cause of acute pharyngitis, accounting for approximately 15% to 30% of cases in children and 5% to 10% in adults (Uhl *et al.*, 2003). In this study, 87 strains were isolated from 48 patients suffering from pharyngitis. *S. pyogenes* was the most common organism (27.59%). *S. viridans* was the second (20.69%) followed by *S. aureus* (17.24%), *K. pneumoniae* (12.64%), *C. albicans* (10.34%), Staph. albus (5.75%), *S. pneumoniae* (2.3%), Sarcina spp. (2.3%) and *Diphtheroids* spp.(1.15%). The high prevalence of *S. pyogenes* (27.59%) among patients of pharyngitis was also reported by other studies carried out by Roos *et al.* (1985); Fluckiger *et al*. (1998) and Zwart *et al*. (2001). In these studies, the rate of *S. pyogenes* isolation agrees more or less with that reported by the present study. Epidem-iological factors and difference in selection of patients might account for some of these differences.

S. viridans was isolated at high rates in both follicular tonsillitis and phary-ngitis (18.18% and 20.69% respectively). *Strept.*

pneumoniae was also isolated but at much lower rates (1.14% and 2.3% respectively). Ibrahim (1978) and Brook *et al*. (1980) reported that α-haemolytic streptococci were the most commonly isolated organism (74% and 86.96% respectively). Ali (1991) also reported the isolation of α-haemolytic streptococci but at a much lower rate (12%). Mansy and Al-Saadawy (1990) reported the isolation of *S. viridans* from both severe and moderate cases of acute tonsillitis (3.3% and 7.1% respectively). *S. albus* was isolated at an incidence of 7.95% from follicular tonsillitis cases and 5.75% from pharyngitis cases. Similar isolation rates were reported by Brook *et al*. (1980) and Lachin (1989) (8.7% and 6% respectively).

Eighty two different strains were isolated from 43 patients suffering from sinusitis. Staph. aureus was the most prevalent organism (21.95%). Staph. albus was the second (13.41%) followed by *K. pneumoniae* (10.98%), *S. pyogenes* (9.74%), *C. albicans* and *Proteus mirabilis* (8.54%). *S. viridans*, *E. coli* and *P. aeruginosa* came next with the same frequency percentage (6.1%) followed by Strept. pneumoniae (4.88%), Diphtheroids spp. (2.44%) and finally *Sarcina* spp. (1.22%). Middleton (1991) found that 40% of cases of sinusitis were caused by Strept. *pneumoniae,* 15% by *H. influenzae* and 15% by *M. catarrhalis*.

Montgomery *et al*. (1990) found *S. aureus* and *S. pneumoniae* to be the most common organism isolated from sinusitis cases (11%) followed by H. influenzae (8.3%), K. pneumoniae (1.8%), E. coli (1.2%) and *Proteus* spp. (1%). Zaki (2000) reported a high prevalence of Staph. aureus (26%) followed by Staph. albus (14%), *K. pneumoniae* (12%), *E. coli* (11%), and *S. viridans* (8%). The two mentioned studies agree with the present study in having *S. aureus* the most common organism isolated.

Jousimies-Somer *et al*. (1988) found *H. influenzae* to be the most common organism isolated from sinusitis cases (67%) followed by *S. pneumoniae* (27%), *S. pyogenes* (8%), Staph. albus (8%), *S. aureus (2%), Branhamella catarrhalis* (2%), *S. viridans* and *E. coli* (1% each). The results obtained by Attia (1992) showed that H. influenzae was the most common organism (26%) followed by Staph. aureus (24%), Strept. pneumoniae (22%), Strept. pyogenes (8%), Strept. viridans, Klebsiella spp. and Ps. aeruginosa (4% each). The high prevalence of H. influenzae among patients of sinusitis was also reported by Ferranti *et al*. (1998). Ito *et al*. (1995) reported that the most common organism in patients suffering from sinusitis was non-haemolytic streptococci (20%) followed by *S. albus* (10%), *Micrococcus* spp. (10%) and *Pseudomonas* spp. (10%). The present study showed similar isolation rate of *S. albus* (13.41%).

Lower respiratory tract infections are common and potentially serious infections that afflict children and elderly people throughout the world (McIntosh, 2002). In this study, 196 different strains were isolated from 118 patients suffering from lower respiratory tract infections. Both *S. aureus* and *S. pneumoniae* had the highest frequency (11.73% each). K. pneumoniae was the second (11.22%) followed by *C. albicans* (10.2%), *S. albus* (9.18%), *S. viridans* (9.18%), *S. pyogenes* (6.63%), Ps. aeruginosa (6.12%), Diphtheroids spp. (5.1%), *Bacillus* spp. (5.1%), *Mycobacterium tuberculosis* (4.08%), *Proteus mirabilis* (3.57%), and *Sarcina* spp. (2.55%). E. coli, Proteus vulgaris and *Serratia marcescens* came after that with the same incidences (1.02% each) and finally *Morganella morganii* (0.51%). The high prevalence of *S. aureus* among patients suffering from lower respiratory tract infections was reported by others (Torres *et al*.,1989; Rouby *et al.*, 1992; and Kayser, 1992). The study performed by Hawan (2000) illustrated that the highest rate of isolation was for *S. aureus* (34.33%) followed by *P. aeruginosa* (32.84%) and *M. pneumoniae* (10.4%). For Strept. pneumoniae and *C. albicans* the total isolation rate was 9% each.

Caroll (2002) found that *S. pneumoniae* to be the major cause of community acquired lower respiratory tract infections. Porath *et al*. (1997) reported a high isolation rate of *S. pneumoniae*

(42.8%). The present study showed much lower isolation rate (11.73%), which was close to those obtained by Cosentini *et al*. (1996) (10%). The high prevalence of *S. pneumoniae* among patients suffering from lower respiratory tract infections was also reported in other studies (Douglas *et al*., 1995 and Felmingham *et al*., 2000). *K. pneumoniae* was isolated at a rate of 11.22%. Balid (1999) reported a similar isolation rate (14%). Merchant et al. (1998) and Badawy (2002) reported much higher isolation rates (34% and 32.8% respectively).

The present study showed relatively a high rate of *C. albicans* isolation (10.2%). Youssef *et al*. (1980) found *C. albicans* to be the most commonly isolated fungi from sputum of patients suffering from lower respiratory tract infections. Torres *et al*. (1989) reported much lower isolation rate (4.5%).

The present study showed 4.08% isolation rate of *Mycobacterium tuberculosis*. This rate is close to that reported by Grange (1993). The difference between isolation rates might be due to the preexisting medical diseases.

Antimicrobial susceptibility patterns:

Overuse of antibiotics and the emergence of resistant bacteria continue to be the subject of many debates. The isolated bacteria were tested for the antimicrobial susceptibility pattern. For *S. Aureus*, ofloxacin, levofloxacin, gatifloxacin, amikacin and gentamicin were the most active antibiotics showing 100% activity followed by ciprofloxacin (98.98%). Both vancomycin and lincomycin showed equal activities (95.95% each). El-Daly et al., (1990) reported 84% activity for gentamicin. Diekema *et al*. (1999) reported 100% for vancomycin. Zaki (2000) reported 100% activity for ofloxacin, ciprofloxacin, amikacin and gentamicin followed by 98.88% for vancomycin. Hawan (2000) showed that 64.1% of tested strains were susceptible to ciprofloxacin and 76.92% to vancomycin. Badawy, (2002) reported 100% activity for ofloxacin but he reported only 28.6% for amikacin. Results of the mentioned studies agree with those of the present in having quinolones the most active antibiotics against Staph. aureus. Martin, (2001) recommended the use of ciprofloxacin as an empiric therapy of presumed *S. aureus* infections. Amoxycillin showed a decreased activity (23.23%). The production of β-lactamases was the main mechanism of resistance to amoxycillin as 62.5% of resistant strains were β-lactamases producers. New types of plasmid-mediated resistant mutants have been characterized that are capable of producing extended-spectrum β-lactamases (ESBLs). Strains producing ESBLs are able to inactivate third-generation cephalosporins and monobactams and may only be susceptible to amikacin, quinolones (Murthy, 2001).

Levofloxacin and gatifloxacin showed the greatest activities (100%) against *S. pneumoniae* followed by ofloxacin and ciprofloxacin (90% each), cefotaxime and cefoperazone (86.67% each), lincomycin and vancomycin (83.33% each), cefuroxime (70%) and amikacin (63.33%). Ampicillin/sulbactam and amoxicillin /clavulanic came next (53.33% each) followed by amoxycillin, and gentamicin (50% each). Cephalexin, cephapirin and erythromycin showed equal activities (46.67% each) followed by chloramphenicol (43.33%), trimethoprim/ sulphamethoxazole (33.33%) and tetracycline (30%).

The results obtained by Diekema *et al*. (1999) showed 85.8% activity for vancomycin. This result is close to that obtained in the present study. Hawan (2000) reported 94.74% activity for ciprofloxacin and 84.2% for vancomycin. These results agree with that obtained by the present work. The present study also agree with that of Felmingham *et al*. (2000) where it showed significant resistance to erythromycin and β-lactam antibiotics while the resistance to quinolones was uncommon.

The present study showed 50% activity for amoxycillin and 46.67% for erythromycin. All strains that were amoxycillin resistant were also erythromycin resistant. The prevalence of penicillin resistance in Pneumococci has risen steeply over the past years in some countries.

Macrolide resistance among Pneumococci has increased dramatically in most countries. Because of the local spread of multi resistant clones, a relationship has been suggested between the prevalence of resistance to macrolides and penicillin (Dagan *et al*., 2001).

Levofloxacin, gatifloxacin, and vancomycin had the greatest activity (100%) against *S. pyogenes* followed by ofloxacin (98.55%), lincomycin (97.1%), cefotaxime (95.65%), ciprofloxacin and cefoperazone (91.3% each), cefuroxime (85.5%), amikacin (84.06%), ampicillin/ sulbactam and gentamicin (82.61% each), amoxycillinclavulanic(79.71%), cephalexin (78.26%), amoxycillin (75.36%), erythromycin (73.91%), cephapirin (69.57%), chloramphenicol (65.21%), trimethoprim/ sulphamethoxazole (62.32%), and tetracycline (50.72%).

El-Daly *et al*. (1990) investigated the antimicrobial activity of different antimicrobial agents against isolates of *S. pyogenes*. The study reported 25%, 50%, 25% and 25% for erythromycin, amoxycillin, chloramphenicol and tetracycline respectively. The present study showed higher activities for the same antibiotics. Baquero *et al*. (1999) reported that the susceptibility of Strept. pyogenes was 73% for erythromycin and 90% for ciprofloxacin. The high activity of ofloxacin (100%) was demonstrated by Badawy (2002).

Levofloxacin and gatifloxacin showed the best activity against *S. albus* (100%) followed by amikacin (98.28%), lincomycin (96.55%) and ofloxacin (94.83%). Ciprofloxacin showed high activity against the tested strains (91.38%) followed by vancomycin (87.93%) and ampicilln/sulbactam (86.21%), cefotaxime (84.48%),amoxycillinclavulanic (81.03%), cefoperazone (80.03%), erythromycin (72.41%), cefuroxime (70.69%), chloramphenicol (68.97%), trimethoprim/sulphamethoxazole (67.24%). Cephalexin and cephapirin came next (55.17% and 51.72% respectively) followed by amoxycillin (48.28%) and tetracycline (43.1%). Zaki (2000) reported 100% activity for ofloxacin, 96.36% for gentamicin, 94.55% for amikacin, 92.73% for ciprofloxacin, and 85.45% for vanco-mycin. Murray *et al*. (2002) declared that *S. albus* was sensitive to quinolones, vancomycin and trimethoprim/-sulphamethoxazole.

Ps. aeruginosa showed the following susceptibility pattern: levofloxacin, gatifloxacin, ofloxacin and ciprofloxacin showed the greatest activity (100%) followed by amikacin (97.14%), gentamicin (94.28%), cefoperazone (85.71%), cefotaxime (82.86%), amoxycillin/ clavulanic (37.14%), amoxycillin (28.57%), tetracycline (17.14%) and chloramphenicol (11.43%). Wilkie *et al*. (1992) reported that new quinolones such as norfloxacin and ciprofloxacin had a broad spectrum of activity and were effective against gram-positive and gram-negative bacteria including *Pseudomonas* spp.. Gebreel *et al*. (2000) reported in their study on Ps. aeruginosa isolates that sensitivity to ciprofloxacin, ofloxacin and ampicillin was 100%, 100%, and 0%, respectively.These results are in agreement with those obtained in the present study. Only 28.57% of *P. aeruginosa* isolates were susceptible to amoxicillin. The low susceptibility of Ps. aeruginosa to β-lactam antibiotics like amoxycillin was also reported by Abdel-Salam *et al*. (2003).

Proteus mirabilis showed the following susceptibility pattern: levofloxacin, gatifloxacin and cefotaxime showed 100% activity. Ofloxacin showed an activity of 96% followed by ciprofloxacin and amikacin (92% each), cefoperazone (88%), gentamicin (84%), ampicillin/ sulbactam (64%), amoxycillin-clavulanic (52%), chloramphenicol (48%), amoxycillin (44%), trimethoprim/ sulphamethoxazole (40%), cefuroxime (32%), tetracycline (16%), cephalexin (8%), cephapirin (4%).

These results were consistent with the results of other studies that showed the high activity of aminoglycosides and quinolones against Proteus mirabilis (Abou-Sayed, 1988; Zaki, 2000).

Levofloxacin and gatifloxacin showed 100% activity against K. pneumoniae isolates. Ofloxacin, ciprofloxacin and amikacin also showed high activities (92.06%, 90.48% and 90.48% respectively).

The activities of the other of antimicrobials were in the following order: cefoperazone (88.89%), cefotaxime (87.3%), gentamicin (82.54%), chloramphenicol (73.02%), ampicillin-sulbactam (50.79%), cefuroxime (47.62%), tetracycline (39.68%), cephalexin (33.33%), cephapirin (28.57%), trimethoprim/sulphamethoxazole (22.22%), amoxycillin-clavulanic (20.63%), and amoxycillin (4.76%).

Baron *et al*. (1994) found that *K. pneumoniae* was susceptible to aminoglycosides, quinolones and third generation cephalosporins. The present study showed good activities for aminoglycosides, quinolones and for third generation cephalosporins. El-Daly *et al*. (1990) reported 100% activity for gentamicin. Kamal (1999) found that amikacin and ciprofloxacin were the most potent antimicrobials against *Klebsiella* spp.

For *E. coli*, levofloxacin, gatifloxacin and amikacin showed the best activity (100%). Ofloxacin and ciprofloxacin showed 92.86% and 85.71% respectively followed by gentamicin (78.57%), cefotaxime (71.43%), cefoperazone (64.29%) and ampicillin-sulbactam (50%), amoxycillin-clavulanic (35.72%), chloramphenicol (28.57%), and cefuroxime (21.43%). Amoxycillin, Cephalexin and trimethoprim/ sulphamethoxazole came next (14.29% each) followed by both tetracycline and cephapirin (7.14% each). Baron *et al*. (1994) recommended the use of aminoglycosides and quinolones for treatment of E. coli infections. The present study declared that the highest activity was obtained by aminoglycosides and quinolones. Oteo *et al*. (2002) investigated the susceptibility of E. coli. The study reported 82.81% activity for ciprofloxacin and 93.61% for gentamicin. The present study showed similar activity for ciprofloxacin.

The present study showed decreased activity of amoxycillin (14.29%) against E. coli isolates. High antibiotic consumption selects for resistance in microorganisms of commensal flora. Most *E. coli* infections involve organisms originating from the patient's own gut flora, and the resistance of these is very likely to reflect previous patterns of prescribing in a community. This could be the cause of more prevalent resistance to amoxycillin in children, who probably consume more of this class of antibiotics than adults (Osterblad *et al*., 2000).

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دراسة ميكروبيولوجية لعدوى الجهاز التنفسى فى الجماهيرية الليبية

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أجريت هذه الدراسة للتعرف على نوعية الميكروبات المسببة لعدوى الجهاز التنفسى وكذلك لمعرفة أكثر الميكروبات مقاومة للمضادات الحيوية و ميكانيكية هذه المقاومة

أسفرت الدراسة عن عزل 559 سلالة ميكروبية مختلفة تم عزلهم والتعرف عليهم من 322 مريض كانوا يعانون من عدوى الجهاز التنفسى منهم 204 كانوا يعانون من عدوى الجهاز التنفسى العلوى و 118 كانوا يعانون من عدوى الجهاز التنفسى السفلي. مرضى الجهاز التنفسى العلوى كانوا يعانون من الالتهاب المزمن فى الأذن الوسطي(63 مريض) ، التهاب اللوزتين(50 مريض) ، التهاب الجيوب الأنفية(43 مريض) والتهاب الحلق (48 مريضا) ولقد اظهرت الدراسة ان استافيلوكوكاس اوريوس *(Staphylococcus aureus)* هو الميكروب الأكثر شيوعا (17.71%) يتبعه ستربتوكوكاس بيوجيناس *(Streptococcus pyogenes)* (12.43%) ، كلبسيلا نيومونيا (*Klebsiella pneumoniae*) (11.27%) ، ستربتوكوكاس فريدانس (*Streptococcus viridans*) (10.73%) ، استافيلوكوكاس البـاس (*Staphylococcus albus*) (10.38%) ، كانديدا ألبيكانس (*Candida* albicans) (9.3%) ، سودوموناس ايروجينوزا (*Pseudomonas aeruginosa*) (6.26%) ، ستربتوكوكاس نيومونيا (*Streptococcus pneumoniae*) (5.37%) ، بروتياس ميرابيليس (*Proteus mirabilis*) (4.47%) ، دفتيرويدز (*Diphtheroids* spp.) (3.22%) ، إيشيريشيا كولاي (*Escherichia coli*) (2.5%) ، سرسينا (Sarcina spp.) (1.97%) ، باسيلس (*Bacillus spp.*) (1.79%) ، ميكوبكتريم تيوبركلوزس (*Mycobacterium tuberculosis*) (1.43%) ، بروتياس فولجاريس*(Proteus vulgaris)* (0.72%) ، سراشيا مارسينس (*Serratia marcescens*) (0.36%) ثم مورجانيللا مورجانى(*Morganella* morganii) (0.18%) .

وقد تم أجراء أختبار حساسية المضادات الحيوية المختلفة على 393 سلالة بكتيرية. وقد كان كلا من الليفوفلوكساسين و الجاتيفلوكساسين الأكثر فاعلية (100%) يليهم أوفلوكساسين و سيبروفلوكساسين (96.44% و93.39% على التتابع). هذا وقد تم ترتيب المضادات الحيوية الأخرى المستخدمة حسب مدى فاعليتها كالاتى: أميكاسين (91.86%) ، سيفوتاكسيم (89.31%) ، سيفوبيرازون (86.26%) ، جنتاميسن (84.22%) ، أمبيسلين-سالبكتام (70.48%) ،

أموكساسلين-كلافيولانك أسد (62.34%) ، سفيوروكسيم (62.09%) ، لنكومايسين (61.83%) ، فانكومايسن (61.07%) ، كلورامفنيكول (57%) ، سيفاليكسين (48.35%) ، سيفابيربن (45.29%) ، أريثرومايسين (44.78%) ، ترای میثوبریم-سالفامیسوکسازول (43%) ، أموكساسلين (36.64%) و تتراسيكلين (32.06%).