Bacterial and Antimicrobial Sensitivity Patterns in Bahrain

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ABSTRACT

A restrospective analysis of the most common bacterial isolates in Bahrain from January 1982 till December 1983 and their antimicrobial drug sensitivity patterns is presented and discussed. The rational approach to the choice of chemotherapeutic agents is also discussed.

INTRODUCTION

In the treatment of bacterial infections, the selection and choice of antimicrobial agents must always be based on the bacteriological results of culture and sensitivity. However, although in a large number of infections, it is possible to delay the therapy until the results of culture and sensitivity are available, not infrequently the severity of certain infections requires the initiation of antibiotic therapy before the bacteriological results are available. In such cases, the selection of the most appropriate antibiotic should be guided by knowledge of the most common bacterial organisms isolated in a particular geographical area. The aim of the present work is to study the bacterial pattern in Bahrain and suggest a rational approach to the choice of antibiotic based on clinical considerations and bacteriological results.

METHODS

The study was based on the review of 129,884 samples of culture and sensitivity tests received at the Department of Pathology, Salmaniya Medical Centre, Bahrain between January 1982 and December 1983. This is the largest such institution in the islands and its catchment area includes all Government hospitals and clinics as well as the private clinics. The specimens examined were blood (14803), CSF (1699), throat swabs (15547), sputum (3718) ear swabs (5375), urine (62034), faeces (17290), urethral discharge (1706) and other miscellaneous sites excluding vaginal swabs (7712).

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Standard methods were applied for isolation and identification of organisms and antimicrobial drug sensitivity (4,6,16). The technical procedures involved in the collection, transportation and culture of the above specimens were as follows:

1. *Blood :* These were drawn under aseptic conditions and immediately inoculated into taurocholate broth and cooked meat medium. The specimens were subcultured aerobically and anaerobically 24 and 48 hours after incubation. Cooked meat medium was held for 7 days and a third subculture was carried out.

2. *CSF :* Collected by lumbar puncture and immediately transported in sterile tubes. Inoculation was carried out from centrifuged sediment.

3. *Urine :* The majority of these samples were voided mid-stream samples and few were collected by catheterisation. The specimens were transported in sterile disposable containers and tested for colony count. A count of 100, 000 per ml. or more was considered as significant growth.

4. *Urethral discharge :* Collected in the Bacteriology Laboratory by sterile ready-made cotton-wool swabs and immediately processed.

5. *Sputum and faeces :* Collected and transported in sterile disposable containers.

6. *Ear, throat and swabs from miscellaneous sites :* Collected by sterile ready-made cotton-wool swabs and transported in modified Stuart's transport medium.

RESULTS

Out of 129884 samples only 21568 (17%) showed significant growth on bacterial culture. Tables 1 - 5 show the common isolates from various sites and their antibiogram.

1. *Blood :* (Table 1) The highest incidence of isolates from blood was *Sal.typhi* accounting for 32% of the total positive blood culture. Most isolates of this organism were sensitive to ampicillin, cephaloridine, chloramphenicol, co-trimoxazole and gentamicin. Most of the *Klebsiella* were resistant to ampicillin whereas more than half of *E. Coli* isolates were sensitive to it. All isolates of *Strept. pneumoniae* were sensitive to penicillin and all *Staph. aureus* were resistant. Most *Ps. aeruginosa* isolates were gentamicin-sensitive and nearly half were carbenicillin-resistant.

TABLE 1

Organisms	Isolates		Percentage sensitive to												
	No.	%	Ampicillin	Carbenicillin	Cephaloridine	Chloramphenicol	Cloxacillin	Colistin	Co-trimoxazole	Erythromycin	Fusidic acid	Gentamicin	Neomycin	Penicillin	Tetracycline
Sal. typhi	271	32	100		100	99			99			100			
Klebsiella	114	13	13		70	88			77			89			
E. coli	85	10	63		82	92			89			89			
Strept. pneumoniae	93	11							75	99			6	100	88
Staph. aureus	49	6					98		82	75	97		79	X	70
Ps. aeruginosa	42	5		45		4		100				98			
Others(*)	195	23													

Table 1. Frequency of isolates and antibiogram from blood. Other organisms (*) include *Sal. paratyphi A,* other salmonellae, *H. Influenzae, N. meningitidis, Strept. viridans, B-haem streptococci, Proteus, Strept. faecalis, Acinobacter, Citrobacter, Enterobacter, Alkaligenes, Aeromonas hydrophila* and *Candida albicans.* X indicates total antibiotic resistance.

2. *CSF:* (Table 2) Shows 54 isolates and their antibiogram belonging to 35 patients with pyogenic meningitis; 3 of which had mixed infection. From one of these patients *Ps. aeruginosa, Klebsiella, Enterobacter* and *Prot. Mirabilis* were isolated at various times during a 5 week period. The second patient had *H. influenzae* and *Strept. Pneumoniae* and the third had *H. influenzae* and *non-haem Streptococci.* However, the main isolates were *Strept. pneumoniae* and *H. influenzae* accounting to 20% and 19% respectively of all CSF positive cultures.

All the isolates *Strept. pneumoniae* and *N. meningitidis* were sensitive to penicillin and only 10% of *H. influenzae* isolates were resistant to ampicillin.

The age distribution of the 35 patients with pyogenic meningitis was as follows : 32 patients (91%) were children below the age of 9 years and 3 patients (9%) above the age of 30 years.

TABLE 2

Organisms	Isolates		Percentage sensitive to								
	No.	%	Ampicillin	Cephaloridine	Chloramphenicol	Co-trimoxazole	Erythromycin	Gentamicin	Neomycin	Penicillin	Tetracycline
Strept. pneumoniae	11	20				64	100		X	100	100
H. influenzae	10	19	90	80	100	90		100			
N. meningitidis	6	11			100	67	100		100	100	100
Klebsiella	6	11	X	50	X	50		X			
E. coli	4	7	X	100	100	100		50			
Enterobacter	4	7	X	X	100	50		X			
Citrobacter	2	4	X	X	100	100		50			
Others (*)	11	20									

Table 2. Frequency of 54 isolates and antibiogram belonging to 35 patients with pyogenic meningitis. Other organisms (*) include *Sal. typhimurium, non-haem streptococci, Strept. pyogenes, Prot. mirabilis* and *Ps. aeruginosa.* Three patients had mixed infections (see text). X indicates total antibiotic resistance).

3. *Throat and sputum :* (Table 3) *Strept. pyogenes* is the commonest isolate from throat (67%) and sputum (31%) and in both cases all the isolates were sensitive to penicillin. The resistance of *Klebsiella* in the sputum to ampicillin was very high (94%).

TABLE 3

Organisms	Isolates		Ampicillin	Carbenicillin	Cephaloridine	Chloramphenicol	Colistin	Co-trimoxazole	Erythromycin	Gentamicin	Neomycin	Penicillin	Tetracycline
	No.	%											
THROAT Strept. pyogenes	2607	67						53	97		4	100	67
H. influenzae :	124	3	89		84	90		82		87			
Strept. pneumoniae	108	3						79	96		3	100	89
Others (*)	1034	27											
SPUTUM Strept. pyogenes	267	31						62	98		7	100	71
Klebsiella	174	20	6		87	92		77		94			
H. influenzae	89	11	92		76	94		86		84			
Ps. aeruginosa	87	10		47		20	95			95			
Strept. pneumoniae	73	9						87	100		4	100	86
Others (**)	160	19											

Table 3. Frequency of organisms and antibiogram of isolates from throat and sputum. Other organisms from throat (*) include *B-haem Strept.* (other than group A), *Staph aureus, E.coli, Klebsiella, Proteus, Citrobacter, Ps. aeruginosa* and *Candida albicans* while other organisms from sputum (* *) include *Staph aureus, E.coli, B-haem strept.* (other than group A) *Proteus, Citrobacter* and *Candida albicans.*

4. *Ear :* (Table 4) *Ps. aeruginosa* was the commonest isolate from the ear (39%) and the sensitivity of this organism to the 2 commonly used antipseudomonas agents; carbenicillin and gentamicin was 46% and 94%. It was also highly sensitive to colistin.

TABLE 4

Organisms	Isolates No.	%	Ampicillin	Carbenicillin	Cephaloridine	Chloramphenicol	Cloxacillin	Colistin	Co-trimoxazole	Erythromycin	Fusidic acid	Gentamicin	Neomycin	Penicillin	Tetracycline
EAR Ps. aeruginosa	1396	39		46		9		94				94			
Proteus	686	19	78		87	81			79			95			
Staph. aureus	607	17					96		85	89	97		83	X	68
Klebsiella	277	8	9		68	84			78			96			
B-haem. strept.	233	6							39	98	96		9	100	47
Strept. pneumoniae	224	6							72	97	90		3	100	78
Others (*)	197	5													
MISCELLANEOUS Staph. aureus	2165	48					97		76	81	98		75	X	68
E. coli	511	11	49		79	80			76			93			
Klebsiella	506	11	7		67	75			69			79			
Ps. aeruginosa	313	7		45		17		98				81			
Proteus	296	7	52		75	78			69			88			
Others (**)	695	16													

Table 4. Frequency of isolates and antibiogram of ear and miscellaneous sites. Other organisms from ear (*) include *H.Influenzae, Strept. faecalis, E.coli, Aspergillus, Citrobacter,* and *Candida albicans* while other organisms from miscellaneous sites (* *) include *Strept. pneumoniae, Strept faecalis, Strept. viridans, Strept. pyogenes, Sal. typhi, H. influenzae, Sal. enteritidis, N. catarrhalis,* Bacteriodes, *Clostridia, Citrobacter, Acinobacter, Alkaligenes,* Pseudomonas species, *Serratia, Aspergillus* and *Candida albicans.*

5. *Stools :* (Table 5) Shigella and Salmonella were the commonest pathogens isolated from the gastrointestinal tract. The most frequently isolated shigella species were *Sh. sonnei* (52%) and *Sh. flexneri* (33%).

TABLE 5

Organisms	Isolates No.	%	Ampicillin	Cephaloridine	Chloramphenicol	Co-trimoxazole	Erythromycin	Fusidic acid	Gentamicin	Nalidixic acid	Neomycin	Nitrofurantoin	Oxolonic acid	Penicillin	Tetracycline
STOOLS Shigella	366	36	83	94	90	81			98		97				
Salmonella other than enteric fever group	351	35	86	90	92	95			98		93				
Enteropathogenic E. coli	65	7	70	87	71	76			96		94				
Sal. typhi	52	5	94	99	100	100			100		100				
Others (*)	172	17													
URINE E. coli	3577	59	59	87		78			98	97		98	99		
Klebsiella	1861	31	6	74		69			95	95		94	99		
Others (**)	645	11													
URETHRA N. Gonorrhoeae	755	100				62	99	98			90			91	98

Table 5. Frequency of isolates and antibiogram of stools, urine and urethral discharge. Other organisms from stools (*) include *Arizona, Plesiomonas, shigelloidis* and *Aeromonas hydrophila.* The stools samples were not tested for *Campylobacter.* Other organisms from urine (* *) include *Strept. faecalis, Staph. aureus, Sal. typhi, Sal. typhimurium, acinobacter, Alkaligenes, Citrobacter* and *Candida albicans.*

6. *Urine :* (Table 5) *E. coli* and *Klebsiella* were responsible for 59% and 31% of all isolates from urine. More than half of the *E. coli* isolates were sensitive to ampicillin whereas the majority of the Klebsiella were resistant to this antibiotic.

7. *Urethral discharge :* (Table 5) The main sensitivity pattern to *N. Gonorrhoeae* is to erythromycin, fucidin, penicillin and tetracycline.

8. *Miscellaneous sites :* (Table 4) *Staph. aureus* was the commonest isolate (48%) from miscellaneous sites other than the above mentioned areas and only 3% were resistant to cloxacillin.

DISCUSSION

In recent years, there has been an increase all over the world of the incidence of infections caused by gram-negative bacilli. The infection is sometimes hospital acquired and caused by antibiotic resistant organisms. The uncontrolled and indiscriminate use of antibiotics has also led to the evolution of such resistant strains. The selection of antimicrobial agent must therefore depend on the isolation of the causative organism and its in vitro sensitivity tests. The appropriate dosage and period of therapy are also important in the treatment of infections. Other factors to be considered include the age of patient, site of infection, presence of renal impairment, pregnancy and pharmacological and toxicological properties of the drug. The aspects of chemotherapy of the most common infections in Bahrain and their causative organism and sensitivity patterns are discussed below.

Bacteraemia

Sal. typhi, the commonest organism responsible for bacteraemia in this study was found to be sensitive to ampicillin, cephaloridine, chloramphenicol and gentamicin. Outbreaks in other countries due to strains resistant to chloramphenicol, streptomycin, sulphonamides, and tetracycline [1 2 14] were not encountered in Bahrain and chloramphenicol continues to be the drug of choice for typhoid fever. Alternative drugs include amoxicillin and co-trimoxazole.However, several other organisms were also isolated from blood culture and since the microbial causes of bacteraemia were variable and drug sensitivity was also variable, the selection of the appropriate antibiotic is often difficult without bacteriological results. Nonetheless, it is possible in some cases to predict the most likely causative organisms when bacteraemia is secondary to another infective focus. In such cases a combination of chemotherapy can be started in a critically ill patient (Table 6 and 7)

TABLE 6

Primary focus	Presumptive organism	Initial choice of antibiotic
Respiratory tract	Strept. pneumoniae	Benzyl penicillin
Urinary tract	Coliforms, Strept. faecalis	Gentamicin + Ampicillin
Gastrointestinal tract.	Coliforms, anaerobes	Gentamicin + Ampicillin Metranidazole
	Coliforms, Strept. faecalis Salmonella	Gentamicin + Ampicillin Chloramphenicol or Co-trimoxazole
Skeletal system	Staph. aureus	Flucloxacillin
Soft tissue	Staph. aureus Ps. aeruginosa Strept. pyogenes	Flucloxacillin Gentamicin Benzyl penicillin

Table 6. Recommended antimicrobial therapy in secondary bacteraemia.

TABLE 7

Organism	Treatment of choice	Alternative to Penicillin
Strept. viridans	Benzyl Penicillin + Gentamycin for 2 weeks with Benzyl Penicillin therapy extended for another 2 weeks.	Cephalosporin
Strept. faecalis	Benzyl penicillin + Gentamycin	Vancomycin
Staphylococci	Flucloxacillin + Gentamicin for 2 weeks with flucloxacillin therapy extended for another 2 weeks	Vancomycin
Strept. pneumoniae	Benzyl penicillin for 4 weeks.	Cephalosporin

Table 7. Recommended antimicrobial therapy in infective endocarditis.

and then the regimen can be changed, if necessary, depending on the bacteriological results. In the neonates, the initial blind choice is a combination of benzyl penicillin and an aminoglycoside which covers the two most common organisms found in this age group, *E. coli* and *B haem streptococci* as well as other organisms. This combination therapy is especially applicable when bacterial endocarditis is suspected to reduce the duration of treatment [17].

Pyogenic meningitis

Although it can occur in all age groups, pyogenic meningitis is most common during childhood and in this study 91% of the patients were children below the age of 9 years. Penicillin remained the drug of choice for meningitis due to *Strept. pneumoniae* in Bahrain but the emergence of penicillin resistant pneumococci in other countries may necessitate a change of regimen in the future [7 8]. Most isolates of *H. influenzae* were also sensitive to ampicillin and the incidence of resistance in this study was 10% while increasing rates of resistance were reported from other countries [12 15 18]. This new epidemiological pattern indicates that ampicillin alone should not be started before the sensitivity of the strain is known.

All *N. meningitidis* isolates were sensitive to penicillin but 33% were resistant to co-trimoxazole. Hence sulphonamides which were successfully used in the past can no longer be relied upon for treatment.

In this study 6 cases of meningitis were due to gram negative bacilli and since these have a wide variety of sensitivity patterns, it is essential to obtain bacteriological guidance. However, in the neonates, the treatment may be started with a combination of gentamicin and either chloramphenicol or ampicillin and the regimen can then be altered later (Table 8).

TABLE 8

Age of patient	Presumptive organism	Initial choice of antibiotic
Less than 2 months	Coliforms	Gentamicin + Chloramphenicol or Gentamicin + Ampicillin
	Group B Streptococci	Benzyl Penicillin
2 months to 6 years	Strept. Pneumoniae	Benzyl Penicillin
	H. influenzae	Chloramphenicol
	N. meningitidis	Benzyl Penicillin.

Table 8. Recommended antimicrobial therapy in pyogenic meningitis.

Respiratory tract infections

The majority of acute upper respiratory tract infections are viral and antibiotics are not required especially when the sputum remains mucoid. Bacterial infections however, are caused by a variety of organisms and *Strept. pyogenes,* the commonest isolate from the throat in this study, is sensitive to penicillin. Penicillin allergic individuals can be treated with erythromycin.

Bacterial pneumonia is also caused by a variety of organisms. *Strept. pneumoniae* is the commonest agent responsible for lobar pneumonia in previously healthy individuals although sputum culture may not reveal significant growth. In hospitalised patients undergoing treatment for other serious underlying disease, pneumonia can develop due to variety of gram-negative bacilli including *Klebsiella* and *Ps. aeruginosa* and in these cases the treatment can be started with aminoglycoside (like gentamicin or tobramycin while the search for the main pathogen is made from samples of sputum, blood, pleural fluid, lung puncture and trans-tracheal aspiration.

Ear

Ps. aeruginosa is the commonest isolate from ears in Bahrain. This organism is widely spread in hospitals [8 10] and it can cause septicaemia as well as infections of the skin, subcutaneous tissue, urinary tract and lungs. Resistance to antimicrobial agents is a well known characteristic of this organism and recommended drugs for the treatment of infections are either gentamicin or tobramycin.

Urinary tract infections

The majority of urinary tract infections in Bahrain were caused by *E. coli* and *Klebsiella.* Since *E. Coli* accounted for nearly 60% of all urinary infections, the initial antibiotic of choice should be effective against this organism. Ampicillin has long been considered as an effective bactericidal antibiotic in the treatment of urinary infections but other drugs namely nalidixic acid and its analogue oxolinic acid as well as aminoglycosides, co-trimoxazole and nitrofurantoin were found more effective. It should be noted however, that the sulphonamides must be avoided during the last few weeks of pregnancy because of the danger of kernicterus. Sulphonamides and nitrofurantoin are also contraindicated in patients with G6PD deficiency and nalidixic acid is also known to cause haemolytic anaemia with or without G6 PD deficiency.

Gonorrhoea

The incidence of penicillin-resistant *N. gonorrhoeae* in Bahrain was 9% and several regimens are available for treatment in such cases. The antibiotics recommended by the Centre for Disease Control, USA are ampicillin, spectinomycin and tetracycline [5]. In this study, most strains of this organism were sensitive to erythromycin, fucidin and tetracycline. It should be noted here that it is essential to test the urethral swab (discharge) for confirmatory cure culture within 2 weeks of completion of treatment.

Gastrointestinal tract infection

Most bacterial gastrointestinal infections in Bahrain were caused by salmonella and shigella. The most frequently isolated shigella species was *Sh. sonnei* which produces mild attacks that require no specific treatment unless the clinical features are serious or when the infection is due to other shigella species and in these cases ampicillin and co-trimoxazole are recommended. However, the use of antibiotics is contraindicated in salmonellal gastroenteritis unless there is secondary blood invasion. This is because the use of antibiotics will prolong the period post-convalescent excretion of salmonellae in the stools (i.e. the carrier state of the patient) thus prolonging the period of illness[3]. Likewise, infantile gastroenteritis due to entropathogenic *E. coli* also does not require antibiotic therapy because most infants will recover uneventfully if the water and electrolyte deficits are corrected promptly [11].

Miscellaneous sites

Staph. aureus the commonest isolate from sites other than the above mentioned areas is known to cause infections of the skin and soft tissue, bacteraemia, pneumonia, osteomyelitis and food poisoning. As in other countries, the incidence of resistance to penicillinase resistant penicillin (i.e. cloxacillin) in Bahrain is very low and cloxacillin is therefore the drug of choice [13 19]. Serious infection can however be treated with intravenous injection of methicillin (another penicillinase-resistant penicillin).

The low rate of anaerobic organism isolated in this study is due to the fact that strict anaerobic precautions for collection, transport and inoculation of most specimens were not followed. Recommended collection procedures like trans-tracheal needle aspiration and direct lung puncture must always be followed.

CONCLUSION

The study of bacterial and antimicrobial patterns within a defined geographical region is essential to suggest rational approach to the choice of antibiotics. In this study the patterns were analysed from samples obtained from the whole body except for the eye and the female genital tract. These areas need special consideration. The isolation of anaerobic organisms also needs to be studied further.

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