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Mussel RL, De Sa Silva E, Costa AM, Mandarim-De-Lacerda CA (2003). Mast cells in tissue response to dentistry materials: an adhesive resin, a calcium hydroxide and a glass ionomer cement. *J. Cell. Mol. Med.* 7:171-178.

Booth M, Bundy DA, Albonico P, Chwaya M, Alawi K (1998). Associations among multiple geohelminth infections in school children from Pemba Island. *Parasitol.* 116: 85-93.0.

Fransiscus RG, Long JC (1991). Variation in human nasal height and breath, *Am. J. Phys. Anthropol.* 85(4):419-427.

Stanislawski L, Lefeuvre M, Bourd K, Soheili-Majd E, Goldberg M, Perianin A (2003). TEGDMA-induced toxicity in human fibroblasts is associated with early and drastic glutathione depletion with subsequent production of oxygen reactive species. *J. Biomed. Res.* 66:476-82.

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Full Length Research Paper

Idiopathic oligospermia treatment: An alternate approach

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One of the factors of male infertility is idiopathic oligospermia in which the causative factor is not known. A direct case control, two-centers, prospective, randomized controlled two-arm parallel group trial was carried out to investigate the safety and efficacy of trialed medicine in Shifa-ul-Mulk Memorial Hospital for Eastern Medicine at Madinat-ul-Hikmah, Hamdard University Karach-74600, Pakistan. An assessment was conducted on the coded herbal formula Spermox (Test drug) to treat idiopathic condition of oligospermia; the test drug spermox was compared with FertiloX (Control drug). The idiopathic pathogenic states of spontaneous origin were detected on 62 clinically diagnosed patients. The conclusive findings were significant as improvements were seen in clinical assessment and semen analyses parameters. The value of sperm count per milliliter in spermox was found more than 29 million in 26 patients (p 0-032). It revealed that Spermox is more effective in upgrading the semen quality and quantity when compared with FertiloX for the treatment of idiopathic oligospermia. This is clearly evident that Spermox (Test drug) possesses a more viable value for the treatment of idiopathic oligospermia in comparison to FertiloX (Control drug).

Key words: Oligospermia, herbal medicine, male infertility, prospective, multicentre, randomized, clinical trial.

INTRODUCTION

Oligospermia is the deficiency of spermatozoa in the semen and is the basic cause of male infertility. The quality and quantity of semen having reduced sperm concentration display a marked abnormality in sperm morphology and motility and vitality (Dorland's Medical Dictionary, 2007; Grimes and Lopez, 2007). The associated risk may be involved in producing condition, including age, infection of *Chlamydia trachomatis*, Y chromosome deletions due to aberration mitochondrial changes, chemical effects of environmental hazards and

hormonal changes (Cavallini, 2006).

Although it is understood that in most cases of oligospermia and idiopathic form there is no direct medical or surgical involvement found to be curative. Despite the fact that it is comprehended that by and large of idiopathic oligospermia, there is no immediate therapeutic or surgical contribution discovered to be remedial at yet. However, the diverse therapeutic methodologies have been attempted. The treatment of idiopathic oligospermia and male infertility by using

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herbs and unani medicine have largely been undertaken and there are evidence where in natural medicine have proved useful in oligospermia. However, in the traditional medication, the following plants *Asparagus racemosus*, *Mucuna pruriens*, *Asparagus adscendens*, *Withania somnifera*, and *Tribulus terrestris*, etc., were used for stress treatment, anxiety, treat bacteria, retardation of the aging process and recovering men's sexual disorders, and in some cases to address infertility and case of oligospermia (Chittendon, 1956; Hedrick, 1919). These plants were used in spermox for the determination of the spermogenic effect. Spermox is not a commercial product; it is formulated first time for this clinical trial, however, the ingredients of this product is already reported in literature for the said activity.

It has been previously reported that *T. terrestris* and *W. somnifera* have good results in oligospermia and male infertility for the improvement of sperm quantity and quality. So by taking advantage, the coded herbal formulation spermox contains a total of five ingredients in which *A. adscendens*, *W. somnifera*, *A. racemosus*, *T. terrestris* and *M. pruriens* for the treatment of semen abnormalities causing infertility in man.

A. racemosus were used in this study and it was observed that streptozotocin as well as alloxan induced hyperglycemic rats showed an overall reduced sexual performance. The deleterious effect was significantly ameliorated in animals treated with polysaccharide-rich fraction of *A. racemosus*. This study validates the traditional claim of using *A. racemosus* as an aphrodisiac herb for treating sexual dysfunction in males (Mayank et al., 2009).

The rhizomes of white musli (*A. adscendens*) is an aphrodisiac; its effect is to increase sperm count hence are commonly used for the rejuvenative function (Chopra et al., 1996). Study on *W. somnifera* concluded that it is a tonic and prescribed in spermatorrhoea. It provides energy and vigour to the body to fight against chronic diseases (Panda and Kar, 1998). *T. terrestris* was proven to be a spermogenic herb (Mutee et al., 2012). The therapeutic applications of *M. pruriens* were reported to regulate steroidogenesis and improve semen quality in infertile men (Shukla et al., 2009).

MATERIALS AND METHODS

This is a two-centers, prospective, randomized, open-label, active-controlled study. The trial was completed in July, 2009 to June, 2011. These studies were completed in Shifa UI Mulk Memorial Hospital for Eastern Medicine, Hamdard University, Karachi and Alshifa Clinic Nazimabad. Only those participants selected who fulfilled inclusion criteria were used. A clinical trial protocol was filled by investigator at the start of treatment. After excluding withdrawal, the total patients who had finished test study were 62.

Semen samples were gathered in sterile tubes by masturbation after a sexual forbearance time of 3 to 5 days. Semen samples were instantly transformed for investigation. The tests were performed by World Health Organization rules standard semen quality parameters (WHO, 2010). The Data Monitoring Committee

audited the unblinded information for patient from both centers. The patients received treatment consisted of 96 patients screened; 85 met eligibility criteria and 78 patients agree to participate: coded herbal formulation Spermox prescribed to 32 patients, and 30 were treated with FertiloX. Eight patients in test group and 8 in the control group were excluded from the study because of incomplete follow-up. In order to find out the restorative evaluations of trialed medicines, 62 patients were examined clinically and laboratory investigations were taken during the course of treatment.

Control drug (FertiloX) is a very costly medicine, not so potent and exert some side effects. In order to overcome this problem, there is a great need to find new medicinal agents that have good efficacy and less adverse effects. Herbal medicine could be choice to treat idiopathic oligospermia and considering this option, a formulation has been designed based on literature citation. Therefore, one of the good candidates could be a coded herbal formulation Spermox (Farone and Koenigsberg, 1995).

Patients were categorized in two groups. Group A on test drug (Spermox) and group B on control drug (FertiloX). The duration of study was six-month. Sample was taken randomly to avoid bias in clinical trial. For the correct diagnosis of Idiopathic oligospermia, we had strictly followed WHO criteria based on complete history and semen analysis findings. After treatment, the test was repeated to find out the difference in treatment. Ethical committee clearance for this study was obtained prior the start of clinical trial. All patients gave written, informed consent and the protocol approval was already taken from Ethics Committee of the Faculty of Eastern Medicine, Hamdard University, Karachi, Pakistan according to principles based on the Declaration of Helsinki.

Inclusion criteria

Cases suffering from idiopathic oligospermia were selected and registered. Patients aged 24 to 50 years were included. Cases that have no other disease on routine checkup interfering with the current matter were selected. Infertile patient having sperm count less than 20 Million/ml were the choice of management. Patients were residing in Karachi, Pakistan. All socio-economical classes were included. Fertility test of female were seen to exclude the female, so that ultimate diagnosis is referred.

Exclusion criteria

Patients suffering from uncontrolled hypertension and diabetes mellitus and other chronic diseases were not allowed to participate. Patient having any sexual transmitted diseases were detected besides idiopathic oligospermia. Idiopathic oligospermia coexisted with any partner problem, that is, female factor was also not administered in the study.

Clinical assessment

The patients included in the trial were those reporting to outpatient unit. They were thoroughly examined for clinical signs and symptoms. Their laboratory reports were recorded. Consent of the patients was taken at the first examination, semen analysis was drawn for the estimation of sperm count and motility, and the standard clinical trial proforma was filled for registration. Different parameters, that is, age, duration, and other clinical sign and symptoms base line were studied and compared between two groups at base line and end of therapeutic applications.

Treatment assignment and follow-up

Sixty two patients consented to participate in the study. Pretreat-

Table 1. Distribution of treatment groups.

Age group	Treatment group		Total
	Test	Control	
24 – 27 Years	5	6	11
28 – 31 Years	6	3	09
32 – 35 Years	10	8	18
36 – 39 Years	5	4	09
40 – 43 Years	3	4	07
44 – 32 Years	2	4	6
48 – 51 Years	1	1	2
Total	32	30	62

ment clinical and laboratory parameters for the treatment groups were noted. The two treatment groups were comparable in efficacy results and side effects of the medicine administered. The clinical analyses were performed in all cases and treatment duration was completed between July, 2009 and June, 2011.

Efficacy measurements

The efficacy measurements involving the two treatments, the herbal medicine and the conventional medicine, were compared. The efficacy was determined using the results of semen analysis.

Statistical analysis

Statistical analysis was performed with SPSS, using excel software and Chi square test. The Chi square was used for paired data. All differences were considered statistically significant by generating a 'p-value' from Chi square test statistics. The result with 'p-value' less than 0.05 was defined as statistically significant. In order to validate the results, the statistical analysis was performed by Chi square; Fisher's exact test was used to find out the level of significance and to confirm the efficacy of the treatment drugs both in test and control group as Spermox and FertiloX, respectively.

RESULTS

The present investigations were carried out for the verification and comparative analysis of efficacy of these medicines for low sperm count and motility. The therapeutic evaluations of these medicines were conducted on 62 patients at Shifa-ul-Mulk Memorial Hospital, for Eastern Medicine, Hamdard University, Karachi and Alshifa Clinic, Nazimabad. The patients that received treatment consisted of 96 patients screened; 85 met eligibility criteria and 78 patients agree to participate: coded herbal formulation Spermox prescribed to 32 patients, and 30 were treated with FertiloX. Eight patients in the test group and 10 in the control group were excluded from the study, because of incomplete follow-up. In order to find out the restorative evaluations of trialed medicines, 62 patients were examined clinically and laboratory investigations were taken during the course of treatment after excluding the failure cases.

Control drug (FertiloX) is a very costly medicine, not so potent and exert some side effects. In order to overcome this problem, there is a great need to find new medicinal agents that have good efficacy and less adverse effects. Herbal medicine could be the choice to treat idiopathic oligospermia and considering this option, a formulation has been designed based on literature citation. Therefore, one of the good candidates could be a coded herbal formulation Spermox.

It has been previously reported that *T. terrestris*, *W. somnifera* have good results in oligospermia and male infertility for the improvement of sperm quantity and quality. So by taking the advantage, the coded herbal formulation Spermox contains a total of 5 ingredients in which *A. adscendens*, *W. somnifera*, *A. racemosus*, *T. terrestris* and *M. pruriens* for the treatment of semen abnormalities causing infertility in man.

In order to validate the results, the statistical analysis was performed by Chi square and Fisher's exact test to find out the level of significance and to confirm the efficacy of the treatment drugs both in test and control group as Spermox and FertiloX, respectively.

Patient characteristics

Total numbers of 32 patients were prescribed Spermox and FertiloX was prescribed to 30 patients as shown in Table 1. The age allocation of class interval was categorized as 24 to 50 years. The age distribution of 62 patients were recorded having 5 class intervals accordingly, 24 to 27, 28 to 31, 32 to 35, 36 to 39, 40 to 43, 44 to 32, and 48 to 51. It was observed from the data in Table 2 that infertility has a strong correlation with socioeconomic factors and this problem tends to worsened in illiterate population and the families were leading their life in stressful condition either due to joint family problems or other social factors.

Semen analysis

The normal range of semen quantity is 2 to 4 ml per ejaculation. The result depicted in Table 3 signifies no difference of treatment between two given medications as p value was calculated as 0.599 as shown in Table 3. The normal color of semen is grayish white to pale yellow and all patients of both groups were observed having normal color at base line and after treatment as well. Therefore, there was no change in semen color between test and control group. The range of sperm count is >20 millions/ml. It is a most common factor in oligospermic patients. After having the complete follow-up in test group out of 32 patients, 26 patients were recorded to be >20 millions/ml and only 6 patients were recorded to be <20 millions/ml. Whereas in the control group, out of 30 patients, 17 were recorded to be > 20 millions/ml and 13

Table 2. Demographic characteristics in treatment groups.

Socio demographic variable	Treatment group		Total (n)	
	Test	Control		
Age (years)	24 – 27	5	6	11
	28 – 31	6	3	09
	32 – 35	10	8	18
	36 – 39	5	4	09
	40 – 43	3	4	07
	44 – 32	2	4	6
	48 – 51	1	1	2
Education	Literate	13	12	25
	Illiterate	19	18	37
Family	Separate	10	09	19
	Joint	22	21	43
Prior family planning	Yes	15	4	19
	No	17	26	43

patients were recorded to be <20 millions/ml. The Chi square test p value were calculated to be less than 0.05; it showed that there was a significant difference between these two drugs as shown in Table 3.

Similar results were seen in morphology and rapid linear progression of semen analysis where p values were 0.001 and 0.046. The range of normal morphology is >30%/ml. It is also a most common factor in oligospermic patients.

This study was under taken as clinical evaluation of effect of herbal medicine on quantity and quality and motility of sperm in oligospermia. An attempt has been made to explore the performance of herbal (test drug) and authentic allopathic (control) medicine so as to asses their efficacy.

Adverse effects profile

All the patients enrolled in the study were valuable for safety. Side effects were defined as sign and symptoms that first occurred or became more severe during the course of treatment. Majority of adverse events were assessed as mild in severity and self-limiting in nature. Therefore, none of the patients withdrew from the study due to these adverse events. Side effects classified by the clinical exports were found to be drug related in patients administered FertiloX, such as nausea (5 patients), malaise (3 patients), headache (2 patients), and loss of appetite (4 patients), were the most observed drug related events among control recipients and no side effects were recorded in test treated recipients. No critical side effects recorded in any group, that is, hot flushes,

psychological upset, hypertension, etc. It is because of the fact that plant drug selected for the treatment of male infertility does not contain any chemical agent that may trigger the adverse drug reaction response. This can be explained further that chemical components of the plant drugs altogether are low in the frequency of occurrence and even administered together in synergistic fashion exhibit pronounced type of effective response for curative action.

DISCUSSION

Generally, there are different causes of infertility such as lacks in discharge per ejaculate, sperm count (e.g., oligospermia, low sperm count, azoospermia, no sperm in the discharge), sperm motility, or sperm morphology. Therefore, with the diagnosis, one can always pinpoint the causes of infertility and on this basis treatment modalities can be planned. The beginning assessment of the male partner ought to be quick, noninvasive, and less expansive. A comparative approach will suffice to pick the treatment choices for the couple for the wanted result.

Medicinal plants were selected to form dosage designed to manufacture Spermox. The literature citation have been thoroughly searched that all these plants are utilized to combat infertility in male. Basically, *Asparagus recemosu*, *M. pruriens*, *A. adscendens*, *W. somnifera*, and *T. terrestris*, the first three plants directly act on sperm motility and increment of sperm counts and related factors, whereas *Withnia sominifera* is an immunity enhancer and *Tribulus terresteris* is spermogenic.

The semen investigation is the beginning stage in the

Table 3. Results of semen analysis.

Semen analysis			Treatment group		Total (n)	p value	
			Test (Spermox)	Control (Fertilox)			
Quantity	Before treatment	<2 ml	08	06	14	0.325	
		2 - 4 ml	20	18	38		
		>4 ml	04	06	10		
		Total	32	30	62		
	After treatment	< 2 ml	4	6	10	0.547	
		2 - 4ml	24	18	42		
		>4 ml	04	06	10		
		Total	32	30	62		
Color	Before treatment	Grayish white	29	29	58	0.319	
		Pale yellow	03	01	04		
		Total	32	30	62		
	After treatment	Grayish white	32	30	62	0.00	
		Pale yellow	00	00	00		
		Total	32	30	62		
	Concentration	Before treatment	< 20 millions/ml	19	20	39	0.554
			≥20 millions/ml	13	10	30	
Total			32	30	62		
After treatment		< 20 millions/ml	06	13	19	0.035	
		≥20 millions/ml	26	17	43		
		Total	32	30	62		
Morphology		Before treatment	< 30%	28	25	53	0.728
			≥30%	04	05	09	
	Total		32	30	62		
	After treatment	< 30%	6	18	24	0.001	
		≥30%	26	12	38		
		Total	32	30	62		
	Linear progression	Before treatment	< 25%	22	18	40	0.597
			≥25%	10	12	22	
Total			32	30	62		
After treatment		< 25%	05	12	17	0.0463	
		≥25%	27	18	45		
		Total	32	30	62		

assessment of male infertility and when discovered to be normal, endocrine anomalies are amazingly uncommon,

and further hormonal assessment more often than not is superfluous. As a general manual for the conclusion of

male subfertility, the WHO has given typical qualities for semen examination such as volume > 2 ml, density > 20 million/ml, motility > 50% forward progression, morphology > 30% normal forms, round cells > 5 million/ml, and white cells > 1 million/ml (WHO, 1992; Damani and Shaban, 2008).

On the treatment with Spemox, the normal range of semen quantity is 2 to 4 ml per ejaculation. The range of sperm count was found to be >20 millions/ml. In case of Spemox and test drugs of 32 patients, 26 patients were recorded >20 millions/ml, whereas in FertiloX control group, out of 30 patients, 17 were recorded >20 millions/ml affording p value less than 0.05. Similarly, of test and control drugs, results for morphology and rapid linear progression of semen analysis afforded p values of 0.001 and 0.046, and the range of normal morphology was determined as >30% per ml. All these parameters corroborate with the aforementioned semen results and clearly displayed that Spemox is comparatively superior than FertiloX in the management of idiopathic oligospermia. In addition, no side or untoward effects have been observed in case of Spemox and use of medicinal plants product have shown that oligospermia is possible with considerable success. A lot of studies have provided evidence that medicinal plants products may improve semen parameters, but again is not consistent and variation in the treatment may occur, therefore, better designed clinical trials is a need for the management of male infertility (Arcaniolo et al., 2014).

Conclusion

The finding from this study demonstrated the following salient clinical assessment; there was statistically significant difference when comparing the effectiveness of herbal treatment Spemox to FertiloX for the treatment of idiopathic oligospermia as described in the thesis. This is clearly evident that Spemox possesses a therapeutic value for the treatment of idiopathic oligospermia.

There was no untoward manifestation associated with the use of Spemox and this has found good acceptability by all treated patients. The principal objective on herbal medicine Spemox as compared to FertiloX is to determine whether these may represent a platform for the development of novel therapeutic. This is an exercise of applying modern techniques and clinical design to product that have been in use for centuries. The efficacy of herbal formulation is a characteristic of a complex mixture of chemical compounds present in different herbs used as multiple dosage form design.

The results from this research study have clearly revealed the evidence of efficacy of test drug Spemox as compared to FertiloX. This study outlines an approach to

the scientific and clinical validation of traditional and conventional medicines, so in its ultimate dictate; this is a worthwhile exercise, since it leads to new class of therapeutics.

Conflict of interest

Authors have none to declare

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Full Length Research Paper

Multicenter bacteraemia among Sudanese children: Causative agents and antimicrobial susceptibility patterns

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Bacteraemia is a common cause of morbidity and mortality in children worldwide. Therefore, bacteraemia continues to be increasingly a serious health problem that needs an immediate attention and treatment. A retrospective hospital-based study was conducted on positive blood cultures collected from 804 children (aged less than 10 years) including both genders in a period between 2012 and 2013 in three different medical services center in Khartoum state, Sudan, out of 804 tested blood samples, among whom 226 isolates were recovered from blood cultures. The majority of the children with bacteraemia (77.4%) were found to be less than one year old (49.1% male and 50.9% female). The most frequent pathogen was found to be *Staphylococcus aureus* (33.6%), followed by *Klebsiella pneumoniae*. (30.5%), *Pseudomonas aeruginosa* (11.5%), *Burkholderia cepacia* (10.6%), *Streptococcus* spp., (7%), *Escherichia coli* (3.5%), *Acinetobacter* spp. (1.7%) and coagulase negative staphylococci (1.3%). This study shows the highest susceptibility rate of *S. aureus* to vancomycin (97.3%), and the lowest susceptibility rate (34.7%) was recorded for erythromycin. *Staphylococcus aureus* was the main etiological agent of bacteraemia in children, while the most isolates demonstrating susceptibility to vancomycin. Overall, erythromycin resistance was 65.3%. This information should be considered when empirical therapy is recommended for the treatment of children with bacteraemia. Most laboratories in Sudan use a single aerobic blood culture bottle for routine blood culture. So our recommendation is using aerobic in conjugation with anaerobic bottles in order to recover significantly more organisms.

Key words: Bacteraemia, children, antimicrobials, drug resistance, Sudan.

INTRODUCTION

Bacteraemia is a common cause of morbidity and mortality in children (Reimer et al., 1997) worldwide (Dawodu et al., 1997; Stoll et al., 1998; Bhutta and Yusuf,

1997; Orrett and Shurland, 2001). Therefore, bacteraemia continues to be a serious problem that needs immediate attention and treatment. For an accurate diagnosis and an

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appropriate choice of antimicrobials, blood culture, which usually takes a few days, is required. The empirical choice of antimicrobials for the treatment of bacteraemia is guided by an awareness of previous culture reports (Cisterna et al., 2001). The majority of the bacteraemia cases are caused by number of pathogens including *Staphylococcus* spp., *Streptococcus* spp., *Enterobacter* spp., *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas* spp. (Reimer et al., 1997). In a prospective five-year study on 344 clinically significant episodes of pediatric septicemia, the most common organisms were found to be *Salmonella* spp. (15.0%), ensuing by methicillin-resistant *S. aureus*. They have reported that *Haemophilus influenzae* accounted for 2.0% of all episodes (Cheng et al., 1991). Furthermore, another study has reported that among 408 bacterial strains, *Salmonella* spp. were the most commonly isolated (23%), followed by *S. aureus* and *Acinetobacter moraxella* (Gedebou et al., 1984). The most frequent etiologic agents of bacteraemia cases include *Staphylococcus* spp., *Streptococcus* spp., *Enterobacter* spp., *E. coli*, *K. pneumoniae* and *Pseudomonas* spp. (Reimer et al., 1997; Cisterna et al., 2001). We have conducted this study to facilitate the empiric treatment and management of children with bacteraemia. The purpose of this study is to determine the causative agents that accounts for bacteraemia among Sudanese children ≤ 10 years old and to assess their susceptibility to various groups of antimicrobial agents.

MATERIALS AND METHODS

A descriptive retrospective hospital based study was conducted on positive blood cultures taken from 804 children (aged less than 10 years) regardless of their genders, in a period between December, 2012 and December, 2013 in three different urban medical services center in Khartoum state including Soba University Hospital, Saed Abo Ella hospital and Ibrahim Malik hospital. Eligible patients had an axillary temperature of less than 39°C and a white blood cell (WBC) count of less than 5000/mm³ or less than 15,000/mm³. Exclusion criteria were a clearly identifiable infection apparent on physical examination (for example pneumonia, urinary tract infection, meningitis, osteomyelitis, septic arthritis), immunisation within the preceding 48 h and treatment with antibiotics within the preceding 7 days).

The selection include in-patients and out-patients. Patients with the clinical suspicion to suffer from bacteraemia were included if blood culture analysis was requested by the responsible physician. Patients older than 10 years and patients with unavailable laboratory parameter results were excluded. Patients with a potential blood culture contaminant and those with missing or inaccurate identification to the species level were excluded from further analysis. Sampling process, culturing, bacterial identification and susceptibility testing for antimicrobials were as follows: the blood specimens had been taken for culture after sterilizing the skin with 70% alcohol and then with 10% povidone iodine solution. One to three milliliters venous blood was taken from the patient and inoculated into an aerobic blood culture bottle that contained 50 ml of Tryptose phosphate broth and 0.02% polyanethol sulfonate (liquid). All cultures were checked daily for cloudiness, haemolysis, and gas production. Sepsis was defined according to the recommendations of Bone et al. (1992).

Organisms were identified via standard microbiological techniques; culture was incubated at 37°C for 24 h prior to the isolation and identification of the bacteria. Based on the Gram-staining, characteristics of the bacterial growth in the blood culture bottle was sub-cultured onto MacConkey agar, chocolate blood agar, and blood agar plates. Bacteria which have been isolated from colonies were further characterized by special biochemical methods; analytical profile index (API 20E) was used for gram negative bacilli, and susceptibility testing was evaluated using the disc diffusion methods according to the guidelines of the National Committee for Clinical Laboratory Standards (NCCLS) (Standards NCCLS (2007). The following antibiotics and concentrations (in brackets) were used: amikacin (30 µg), ampicillin (10 µg), amoxicillin-clavulanic acid (AMC) (20/10 µg), cefotaxime (30 µg), tetracycline (30 µg), erythromycin (15 µg), cefuroxime (30 µg), meropenem (10 µg), ceftriaxone (30 µg), ceftazidime (30 µg), vancomycin (30 µg), gentamicin (10 µg), ciprofloxacin (5 µg), cotrimoxazole (trimethoprim-sulfamethoxazole) (1.25/23.75 µg), cephalixin (30 µg), ceftazolin (30 µg), clindamycin (2 µg) and oxacillin (1 µg).

The data were collected from the clinical microbiology laboratory records which was filled in a prepared data sheet and included micro-organisms isolated from blood culture and antibacterial susceptibility data. The hospitals were informed for the purpose of the study and its objectives, before taking their permission, with protections of their records. Permission to carry out the study was taken from the Scientific Research Committee, Khartoum University. Minimum inhibitory concentrations (MICs) were done according to NCCLS guidance and interpretative criteria (2001). Statistical analysis was done using the Chi-squared test. *Staphylococcus aureus* (ATCC 25923), *Pseudomonas aeruginosa* (ATCC 49189) and one of *Escherichia coli* (ATCC 25922), were included to establish the validity of the experiment.

RESULTS

During the study period (2012 to 2013), a total of 226 out of 804 blood samples of selected children less than 10 years of age (49.1% male and 50.9% female) which gave a positive blood culture was analyzed. No significant difference showed between male and female inflicted with bacteraemia. Results have shown that most of bacteraemia cases (77.4%) were observed among children less than 12 months old, among whom (65.9%) were less than one month old. Only (17.3%) were observed in children aged between 3 to 10 years. There is a significant increase of bacteraemia in children aged one year or less ($P = 0.001$). The majority of the isolated pathogens were *S. aureus* (33.6%), followed by *Klebsiella* spp. (30.5%), *Pseudomonas* spp. (11.5%), *Burkholderia cepacia* (10.6%), *Streptococcus* spp. (7%), *E. coli* (3.5%), *Acinetobacter* spp. (1.7%) and coagulase negative staphylococci (1.3%) (Table 1). The antimicrobial susceptibility of bacteraemia isolates for 18 selected antimicrobial agents used in this study are summarized in Table 2. The highest susceptibility rate of *S. aureus* was to vancomycin (97.3%), whereas the lowest susceptibility rate was to erythromycin (34.7%). The highest susceptibility rates of other isolates to meropenem were *Klebsiella* spp. (100%), *Acinetobacter* spp. (100%), *Burkholderia cepacia* (100%), *E. coli* (87.5%) and *Pseudomonas* spp. (88.5%). However, vancomycin was

Table 1. Bacterial species isolated from 226 blood culture.

Species isolated	No. of isolates (%)
<i>Klebsiella</i>	69 (30.5)
<i>S.aureus</i>	76 (33.6)
<i>Streptococcus spp.</i>	16 (7)
<i>Burkholderia cepacia</i>	24 (10.6)

Table 2. Susceptibility rates of blood bacterial isolates to antimicrobial agents.

Drug	<i>S.aureus</i>		<i>Klebsiella pneumoniae</i>		<i>E coli</i>		CNS		<i>Streptococcus spp</i>		<i>Acinetobacter spp</i>		<i>B.cepacia</i>		<i>Pseudomonas aeruginosa</i>	
	n=76		n=69		n=8		n=3		n=16		n=4		n=24		n=26	
	No	S%	No	S%	No	S%	No	S%	No	S%	No	S%	No	S%	No	S%
CIP	0	0	46	82.6	7	42.9	0	0	10	50	3	100	14	92.9	24	83.3
MEM	0	0	67	100	8	87.5	0	0	0	0	4	100	24	100	26	88.5
AK	0	0	62	98.4	7	85.7	0	0	0	0	4	100	22	72.7	21	61.9
CXM	0	0	58	3.4	5	20	0	0	3	100	4	75	23	34.8	3	33.3
AMC	0	0	52	0	7	0	0	0	11	45.5	3	33.3	18	5.6	5	0
CTR	0	0	91	2.2	11	0	0	0	3	100	3	33.3	33	42.4	6	33.3
CAZ	0	0	58	5.2	7	14.3	0	0	0	0	4	50	23	73.9	18	61.1
COT	43	58.1	39	7.7	5	20	2	50	7	14.3	2	100	18	100	6	83.3
CN	5	60	30	3.3	4	25	0	0	0	0	1	100	8	0	9	11.1
CF	0	0	18	22.2	4	25	0	0	1	0	1	0	5	80	3	0
CTX	0	0	15	6.7	2	50	0	0	3	100	2	50	6	100	2	50
GEN	43	86	27	22.2	1	0	0	0	3	100	2	100	5	40	6	50
VA	74	97.3	0	0	0	0	3	100	13	92.3	1	100	0	0	0	0
OX	75	40	0	0	0	0	3	33.3	0	0	0	0	0	0	0	0
E	75	34.7	0	0	0	0	3	66.7	1	0	0	0	0	0	0	0
CD	74	62.2	0	0	0	0	3	66.7	0	0	0	0	0	0	0	0
TE	70	71.4	0	0	0	0	3	100	3	0	0	0	0	0	0	0
AMP	0	0	10	0	0	0	0	0	15	73.3	0	0	3	0	2	0

n = Number of total isolates, n= Number of tested isolates, S% = Percentage of Sensitive isolates, CIP: Ciprofloxacin, AK: Amikacin, MEM: Meropenem., VA: Vancomycin., E: Erythromycin, CTX: Cefotaxime, CAZ Ceftazidime, COT: Co-trimoxazole., GEN: Gentamicin, AMP: Ampicillin, AMC: Amoxicillin-Clavulanic acid , CXM: Cefurixime, CTR: Ceftriaxone., CD: Clidamycin, TE: Tetracyclin, CN: Cephalexine, OX: Oxacillin, CF: Cefazolin, CNS:Coagulase Negative Staphylococci.

detected to give the highest susceptibility rate of 96.7% to a variety of bacteraemia isolates; amoxicillin plus clavulanic acid have exhibited the lowest susceptibility rate of 7.3% (Table 3).

DISCUSSION

Blood for culturing is a routine procedure for investigating the cause of suspected infection in the majority of patients attending an emergency department(unit). Isolation of a true pathogen from blood culture ultimately warrants and augur well treatment with an appropriate antibiotic. This study provides information regarding the main etiological agents that cause bacteraemia in children of both inpatients and outpatient and its antimicrobial susceptibility patterns. *S. aureus* was reported to have emerged as a major cause (33.6%). These results are in accordance with other studies that have pointed out *S.*

aureus as the most common bacteria isolated from blood of children (Nimri and Batchoun, 2004; Mohammad, 2010). The second most common organism causing bacteraemia in this study was *Klebsiella* spp. (30.5%). Similar results were reported in Jordan (Standards NCfCL, 2001). In another studies conducted elsewhere, *E. coli* was the most common organism (70%) (Berkley et al., 2005). In this study, the occurrence of *Pseudomonas* spp. *Streptococcus* spp. *E. coli* and *Acinetobacter* spp. were 11.5, 7, 3.5 and 1.7%, respectively. Different occurrence of these blood isolates were reported in different exhaustive literature (Mohammad, 2010; Joshi et al., 2000). Nonetheless, *Pseudomonas* spp. was the most common cause of neonatal sepsis in Karachi, Pakistan (Bhutta and Yusuf, 1997).

Burkholderia cepacia has the potential to cause fatal infections in hospital, and multidrug resistance makes them a serious threat in hospital settings. *B. cepacia* has been reported from blood stream infections (Aaron et al.,

Table 3. Susceptibility rate (%) of different blood bacterial isolates to antimicrobial agents.

Drugs	Bacteria	
	No. of isolate	Sensitive (%)
CIP	104	82 (78.8)
MEM	130	125 (96.1)
AK	116	100 (86.2)
CXM	96	18 (18.8)
Aug	95	7 (7.3)
CTR	150	23 (15.3)
CAZ	110	34 (30.9)
COT	122	56 (45.9)
CN	57	7 (12.3)
CF	31	9 (29)
CTX	30	13 (43.3)
Gen	87	53 (60.9)
VA	91	88 (96.7)
OX	78	31 (39.7)
E	79	28 (35.4)
CD	78	48 (61.5)
TE	76	53 (69.7)
AMP	30	11 (36.7)

2000). In this study, *B. cepacia* reported for 10.6%. Coagulase negative Staphylococci encountered for 1.3%. Other studies reported coagulase negative staphylococci as the most common bacteria isolated from infant with bacteraemia (Sabui et al., 1999). The most effective antimicrobial agent against *S. aureus* which has been demonstrated in this study was vancomycin (97.3%), followed by gentamicin (86%). Similar results for vancomycin were reported in Jordan (Mohammad, 2010; El-Nasser, 2009). However, another author reported high susceptibility rates of *S. aureus*, reaching 59.5% to gentamicin (Blomberg et al., 2007). From our study we observed resistance rate of *S. aureus* to erythromycin (65.3%) which was higher than documented resistance rate of 33.1% conducted elsewhere (Delialioğlu et al., 2005). However, the highest susceptibility rate (100%) to meropenem observed in this study was for *Klebsiella*. Similar results have been reported in the literature (Endtz et al., 1997). Whereas the highest resistance rate (100%) to ampicillin observed in this study was for *Klebsiella*, similarly low susceptibility rate (0%) of *Klebsiella* to ampicillin has been reported in Jordan (Mohammad, 2010).

CONCLUSION AND RECOMMENDATION

Our study shows that *S. aureus* is the main causative agent of bacteraemia in children. Treatment of bacteraemia is compromised by antimicrobial resistance. Accordingly, this study is important in order to facilitate the empirical treatment of children with bacteraemia. Most laboratories in Sudan use a single aerobic blood culture

bottle for routine blood culture. So our recommendation is using aerobic in conjugation with anaerobic bottles in order to recover significantly more organisms. Further studies are needed to help authorities to formulate antimicrobial prescription policies.

Conflicts of interest

Authors have none to declare.

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