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Physicians' Knowledge and Perception of Antimicrobial Resistance: A Survey in Khartoum State Hospital Settings

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Authors' contributions

The only author performed the whole research work. Author SIK wrote the first draft of the paper. Author SIK read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: To assess physicians' knowledge and perception regarding antimicrobial resistance and current antibiotic practices at the three main hospitals at Khartoum State-Sudan.
Study Design: A cross- sectional survey.
Place and Duration of Study: Physicians from the three main Khartoum state teaching hospitals (Khartoum, Omdurman and Khartoum North) had been surveyed between October 2011 and March 2012.
Methodology: A total of 350 Physicians identified from different departmental specialties were interviewed using a 40 item, self-administered questionnaire.
Results: Of physicians surveyed 38.0% considered antibiotic resistance were very important in their hospitals, 41.7% nationally and 44.3% globally. The majority of respondents (47.5%) perceived the problem of antibiotic resistance as sever problem in their hospitals. Factors identified as important in producing resistance include, widespread antibiotic use (54.3%), poor access to local antibiograms (47.4%), inappropriate course duration (46.3%), and inappropriate empiric choice (44.9%).The respondents were less likely to perceive patient's demand and role of pharmaceutical companies' promotion of antibiotics as very important factors (19.1% and 18.3% respectively).The intervention considered very useful by the largest percentage of physicians was "educational programs" (45.7%) followed by "updating about local antibiotic resistance pattern" (37.4%) and "access to current antibiogram" (35.2%). Antibiotic restriction programs were

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regarded as less helpful. Knowledge of resistance organisms and resistance-prone antibiotics was poor.
Conclusion: Although physicians were aware of the antibiotic resistance, their perceptions about its importance, its causes and potential solutions are often contradictory and variable. These contradictory perspectives present challenges that must be overcome if we are to successfully address the mounting problem of antibiotic resistance.

Keywords: Antibiotic resistance – knowledge; awareness survey.

1. INTRODUCTION

Antimicrobial resistance has increasingly become threat to patient safety in health care settings. Inappropriate use of antimicrobials and noncompliance with infection control precautions as the main risk factors for antimicrobial resistance. The recognition that antibiotic resistance caused in part by excessive antibiotic use has prompted calls for reform [1]. Since antibiotics are medications that mainly prescribed by physicians, any action aimed at improving use of antimicrobials must necessarily target physicians. Yet the optimal methods for addressing this problem remain obscure. Because such reform requires fundamental changes in Physicians' behavior and the process of bringing about these changes is affected by their knowledge and awareness [2].

Knowledge is the first step in modifying behavior in relation to physicians' adherence to clinical practice guidelines and behavior change based on influencing knowledge and attitude is probably most sustainable than indirect manipulation of behavior alone [3]. Pathman et al. [4] described four steps in the process, stating that when physicians comply with practice guidelines they must first become *aware* of guidelines, then intellectually *agree* with them; decide to *adopt* them in the care they provide and then regularly *adhere* to them at appropriate time. If awareness of guidelines and procedures is deficient, it is unlikely that good practice will follow. The emergence of antibiotic resistance as a global problem underscores the need for physicians to be aware of its existence and factors that drives its development and it is important to better understand what physicians know about antimicrobial resistance and how they acquire and maintain that knowledge [5,6].

Previous studies have identified Sudanese physicians' attitudes and preference concerning antimicrobial prescribing and use in primary care and hospital settings [7,8]. However little is known about their knowledge and attitudes about antimicrobial resistance. We surveyed physicians from different clinical specialties in the three main hospitals at Khartoum State (Capital of Sudan) to assess their knowledge, attitudes regarding antimicrobial resistance and prescribing. Our goal was to gain some understanding of this public health problem and to learn more about their perception about this problem. The information obtained from this study can be useful in designing more effective antibiotic stewardship interventions and control programs in these main leading hospitals in Sudan.

2. METHODOLOGIES

2.1 Study Design, Period, Setting and Participants

A cross- sectional survey of physicians at the three main Khartoum state teaching hospitals (Khartoum, Omdurman and Khartoum North) was conducted between October 2011 and

March 2012. The three hospitals were selected because they were geographically representative of the area and shared the same professional affiliations as tertiary-level teaching hospitals. A total of 350 physicians were targeted. Eligible physicians included in the survey were house staff officers and registrars and who were prescribe antibiotics in their clinical practice from internal medicine, surgery, pediatric, obstetrics and gynecology (Obs & Gyn). Medical doctors from psychiatry, radiology, ophthalmology and anesthesiology were not included as they prescribe antimicrobial agents less often than do other physicians.

2.2 Survey Instrument

A self-administered questionnaire was distributed in the three hospitals among attending house-officers and registrars. Questionnaires were distributed on site during working hours and participants were asked to respond immediately. The survey questionnaires were distributed and collected back by final year pharmacy student of National college of Medical and Technical Sciences (Batch 3) as a graduation research project. Each participant was asked to complete all sections of questionnaire. There was no incentive for subjects to participate and no reminders were supplied. The questionnaire content was based on a previous survey described in Indian study [9], but adopted to Sudanese system and modified for the purposes of our study. No pilot study conducted to validate our modified questionnaire.

The questionnaire composed of 4 sections and 40-Items. These sections addressing participants' awareness, knowledge and attitudes, regarding antibiotic resistance. Section (A) of questionnaire recorded demographic characteristics of the participants, including their sex, age, occupancy, specialty and year of experience, in addition to the hospital name, department and date of interview (8 questions). Section (B) consists also of 8 questions about the participant knowledge and assessment to the magnitude of the problem. Section (C) is about the causes of the problem and the participant given 13 factors and he/she had to elicit the importance of each factor in the problem. Section (D) concerned the possible measures that can be applied to decrease the risk of bacterial resistance; seven different solutions were suggested and participants were asked to rate the usefulness of each one to solve the problem. In addition to the above closed questions another four open questions about the opinion of participant about complication of antibiotic resistance and intervention to combat the problem, also the most resistant organisms in his/her setting and most prescribed antibiotic/s as general and for resistant organisms.

2.3 Data Analysis

Questions of opinions used 5-point Likert-style graded response option, ranging from "not great" to" extremely great" and "less than" to "more than" to describe the magnitude and importance of the problem, "unimportant" to "very important" for factors contributing to the problem and "very useful" to "not useful at all" for interventions to prevent resistance. Interviewers obtained written consent before administering the questionnaire. The interviewee informed why the information was being collected, and how it would be used, and read them a statement informing them that their participation was voluntary before the start of the interview and confirmed that their answers are anonymous and confidential. Approval for the study obtained from National College for Medical and Technical Sciences Ethical Committee.

Data collected were analyzed using (SPSS version 16) for statistical analysis and Excel 2007. Participants were not sampled randomly. Frequency analysis for different demographic data was presented for each hospital. Proportions rate analysis for different response items were calculated for closed questions and their significance assessed by Chi square test. For assessing the relationship between various Likert scale items, we used a Person correlation coefficient and the *(P* = .05) was considered statically significance. The answers to opened questions were combined and categorized according to its frequency.

3. RESULTS

Of the 350 medical staff members completed the survey, 182 (52.0%) from Khartoum teaching hospital, 98 (28%) from Omdurman teaching hospital and 70 (20%) from Khartoum north teaching hospital. The proportion of male to female respondents was 57.7% vs. 42.3% respectively. 175 (50%) of respondents their age between 20-25 years; and the majority 323 (92.3%) had experience between 1-4 years. 199 (56.9%) of physicians were from medical specialty and 87 (24.9%) were from surgical specialty. About 75% of participants were house officers while only 25% were registrars. Details of demographic characteristic of each hospital were shown in Table 1.

3.1 Magnitude of the Problem

Physicians were asked to make an assessment to the severity of the problem of antibiotic resistance in their own hospital. 16.9 % thought that antibiotic resistance was not a great problem, 26% minimally great, 24% moderately great, 12.9% as a great, 10.6% extremely great problem, and (9.7%) they do not know. The severity of the problem was not influenced by the occupation between house officers and registrars ($P \leq .26$).

As measured by questionnaire, physician perception of the problem of antibiotic resistance in their hospital, nationally and globally varied (Table 2); 38.0% of physicians thought that antibiotic resistance were very important in their hospitals (34.9% house officers vs. 47.2% registrars, $P \leq .01$), 41.7% nationally (39.1% house officers vs. 49.4% registrars, $P \leq .28$), and 44.3% worldwide (39.8% house officers vs. 57.3% registrars, $P \leq .03$).

Table 1. Demographic data of the study population

Hospital name	Khartoum n(%)	Omdurman n(%)	Khartoum north n(%)	Total n(%)
Respondents				
No. (%)	182 (52.0%)	98 (28.0%)	70 (20.0%)	350 (100%)
Sex				
Male	100 (49.5%)	49 (24.3%)	53 (26.2%)	202 (57.7%)
Age (Years)				
20 - 25	98 (28%)	45 (12.9%)	32 (9.1%)	175 (50.0%)
26- 30	71 (20.3%)	40 (11.3%)	30 (8.6%)	141 (40.2 %)
≥31	14 (4.1%)	13 (3.9%)	7 (2.1%)	34 (10.1%)
Specialty				
Medicine	103 (29.4%)	66 (18.9%)	30 (8.6%)	199 (56.9%)
Surgery	49 (14%)	30 (8.6%)	8 (2.3%)	87 (24.9 %)
Pediatric	5 (1.4%)	1 (0.3%)	18 (5.1%)	24 (6.9%)
Obs & Gyn	7 (2%)	1 (0.3%)	1 (0.3%)	9 (2.6%)
Other	19 (5.4%)	0 (0.0%)	12 (3.4%)	31 (8.9%)
Occupation				
House officers	130 (37.2%)	77 (22.0%)	54 (15. 4%)	261 (74.6%)
Registrars	52 (14.8%)	21 (6.0%)	16 (4.6%)	89 (25.4%)
Experience (Years)				
1 - 4	173 (49.4%)	85 (24.3%)	65 (18.6%)	323 (92.3%)
5 - 9	8 (2.3%)	9 (26%)	4 (1.1%)	21 (6.0%)
≥10	2 (0.6%)	4 (1.1%)	0 (0.0%)	6 (1.7%)

Table 2. Physicians rating of the importance of antibiotic resistance (AR) problem

Importance of the AR problem	Unimportant N (%)	Minimally important N (%)	Moderately important N (%)	Very important N (%)	Don't know N (%)
How do you assess the importance of the problem of AR in your hospital?	8 (2.3%)	69 (19.7%)	123 (35.1%)	133 (38.0%)	17 (4.9%)
How do you assess the importance of the problem of AR nationally?	4 (1.1%)	46 (13.1%)	140 (40.0%)	146 (41.7%)	14 (4.0%)
How do you assess the importance of the problem of AR worldwide?	2 (0.6%)	23 (6.6%)	143 (40.9%)	155 (44.3%)	27 (7.7%)

The proportion of physicians who rated that problem of antibiotic resistance as very important in their hospitals ranged from 30.6% at Khartoum North hospital to 39.0% at Khartoum hospital to 45.7% at Omdurman hospital, with no significant difference between the three hospitals. About half of the respondents (49.7%) assess the rate of the problem of antibiotic resistance in their hospital was similar to other hospitals in Khartoum or nationally and about quarter of them (24%) considered it similar to global or worldwide, 20.3% of them answered they do not know (Fig. 1). There were significant differences in their perceptions

about antimicrobial resistance being a problem worldwide, nationally, and in their institution ($P \leq .0001$).

More than half of the respondents (51.7%) considered antibiotic resistance was a major problem when prescribing antibiotics. Registrars were significantly more likely to perceive it as a major problem than house officers (57.3% registrars vs. 49.8% house officers, $P \leq .02$). However, there were no different between specialties with respect to frequency of perception antibiotic resistance as a major problem on prescribing (medicine 51.3%, surgery 61.6%, pediatric 46.2 %, Obs/Gyn 50 %, $P \leq .16$)

Of total respondents, 39.1% agreed that antimicrobials were overused in their institutions; this proportion among the three hospitals was varied with significant difference (48.4% in Khartoum hospital, 32.9% in Khartoum North hospital and 26.5% in Omdurman hospital), 52.3% agreed it was acceptable and 4.6% underused.

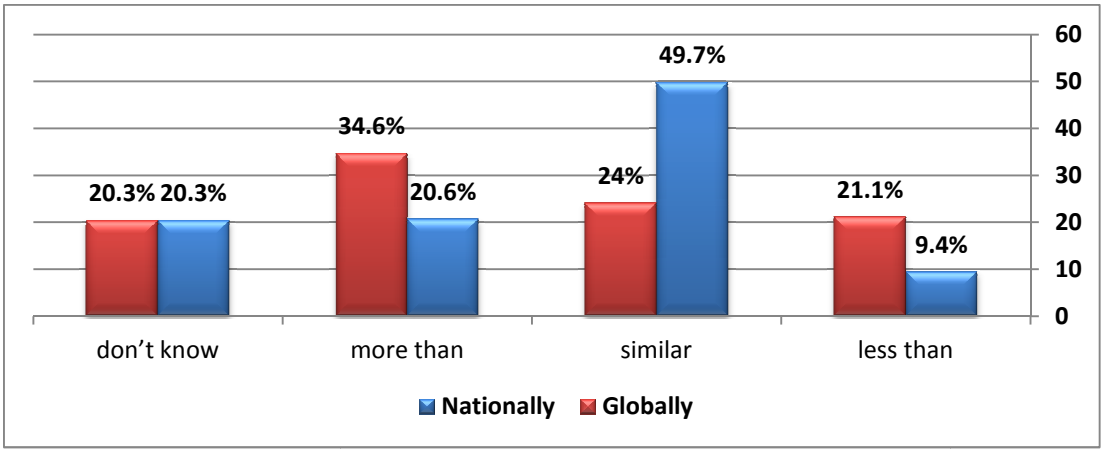

Fig. 1. Physicians rating to the extent of the problem of antibiotic resistance in their hospitals compared to national and global problem (n=350)

3.2 Causes of the Problem

The factors were perceived as being very important contributors to resistance: widespread antibiotic use (54.3%), poor access to local antibiograms (47.4%), inappropriate course duration (46.3%), inappropriate empiric choice (44.9%), and use of broad-spectrum antibiotics (40.6%). The respondents were less likely to perceive patient's demand and role of pharmaceutical companies' promotion of antibiotics as very important factors (19.1% and 18.3% respectively). There was no significant difference in rating most of the factors contributing to antibiotic resistance problem between house officers and registrars (Table 3).

3.3 Solutions and Interventions Needed

Given a list of 7 interventions as possible solutions for preventing antimicrobial resistance, participants were asked to indicate what they believed to be useful strategy. The intervention considered very useful by the largest percentage of physicians were "educational programs" (45.7%) followed by "updating about local antibiotic resistance pattern" (37.4%) and "access to current antibiogram" (35.2%). Only 21.7% of respondent thought that antibiotic cycling would be very useful in preventing antibiotic resistance. Although most physicians cited widespread use of antibiotics as a very important cause of antibiotic resistance, solution that restrict use of antibiotics was considered as very useful interventions by only 16%. Ranges of 0.3%-6.9% of respondents answered "I don't know". A two–way contingency table analysis revealed a significant association between specialty and most of the interventions proposed for controlling bacterial resistance (Table 4).

We record physicians' opinions about the opened questions and the most frequent times mentioned were considered. Of respondents (90%) were answered the open questions (315/350). Increased mortality, morbidity, and failure of the treatment were the most consequences addressed (22.9%), followed by failure of treatment of common infections which may lead to impact on public health (13.0%).

With regards to identification the resistance organism/s in their hospitals, the three most microorganisms pointed out by physicians as the most frequently encountered antibiotic-resistance bacteria in the three hospitals were *S. aureus* (22.6%), *E. coli* (14.6%) and *pseudomonas sp* (7.9%), Table 5. This is selection sequence was more or less similar per each individual specialty with a significant difference between them ($P \leq 0.01$). About one third of physicians in each specialty do not know the most resistant organism in their departments ($P \leq .0001$).

In general practice ceftrixone was the most frequent choice (29.2%) prescribed for common infections as empiric antibiotic declared by physicians, followed by amoxiclave (24.4%). While vancomycin was the most frequent (18.2%) antibiotic in case of resistant organisms, followed by Merpenem (6.1%). These selections did not different widely among different hospitals and different specialties. 36.7% and 16.5% of the respondents did not give an answer to the most frequent choice in general practice and resistant cases respectively as shown in Fig. 2.

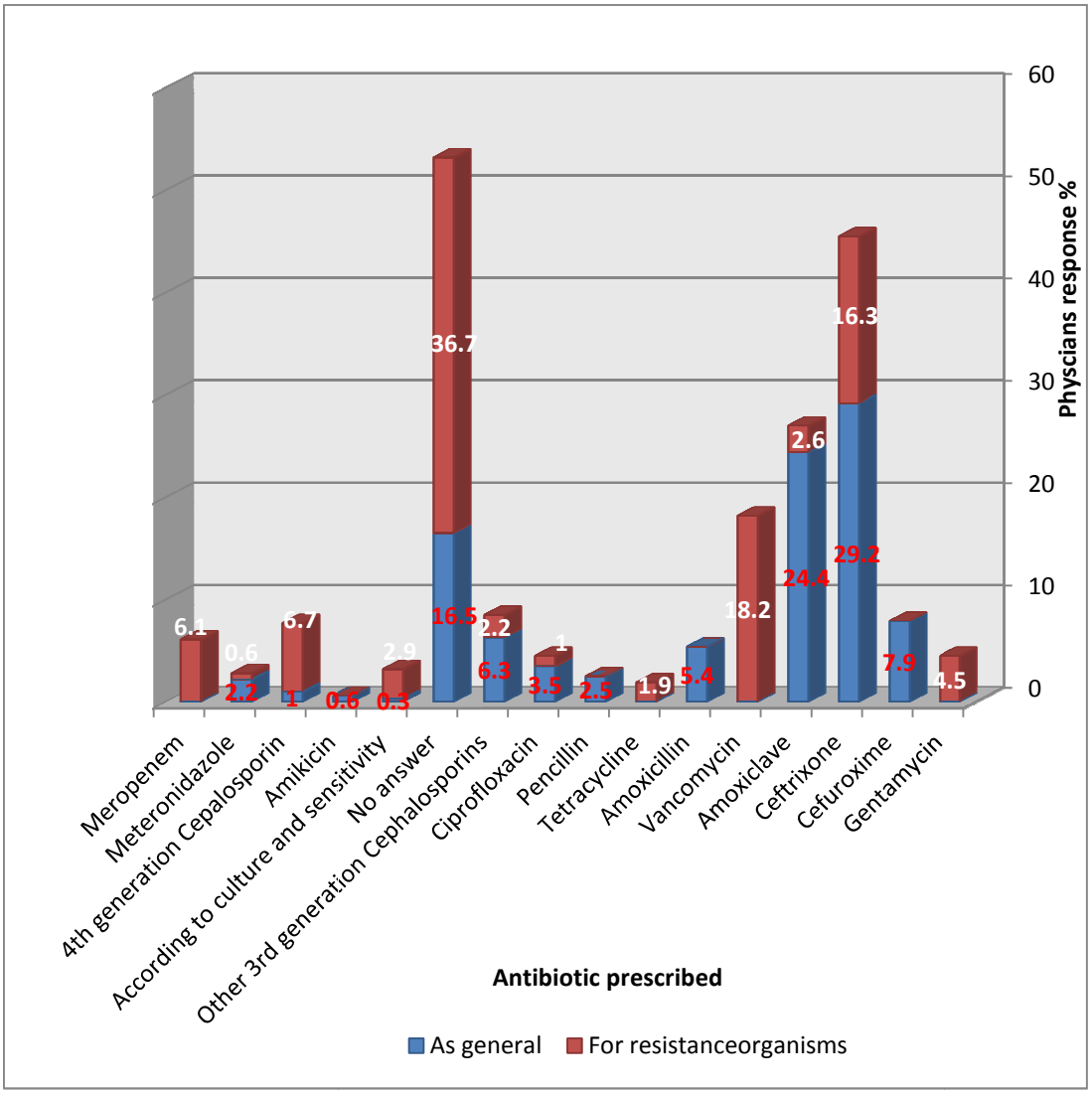

Fig. 2. Shows the most prescribed antibiotics as general and for resistance organisms

Table 3. Physicians rating of the factors contributing to antibiotic resistance problem

Factor	Unimportant N (%)	Minimally important N (%)	Moderately important N (%)	Very important N (%)	Don't know N (%)	*P*-value
Widespread use of antibiotics						
House officers	8 (3.1%)	36 (13.8%)	77 (29.5%)	133 (51.0%)	7 (2.7%)	.43
Registrars	5 (5.6%)	11(12.4%)	20 (22.5%)	52 (58.4%)	1(1.0%)	
Inappropriate empiric choices						
House officers	8 (3.1%)	35 (13.4%)	90 (34.5%)	109 (41.8%)	19 (7.3%)	.18
Registrars	6 (6.7%)	7 (7.9%)	30 (33.7%)	43 (48.3%)	3 (3.4%)	
Inappropriate duration of course						
House officers	8 (3.1%)	42 (16.1%)	85 (32.6%)	119 (45.6%	7 (2.7%)	.23
Registrars	7 (7.9%)	15 (16.9%)	21 (23.6%)	44 (49.4%)	2 (2.2%)	
Use of broad spectrum antibiotics						
House officers	12 (4.6%)	39 (14.9%)	100 (38.3%)	105 (40.2%)	5 (1.9%)	.66
Registrars	4 (4.5%)	18 (20.2%)	27 (30.3%)	38 (42.7%)	2 (2.2%)	
Poor access to local antibiograms and obtain culture and sensitivity tests						
House officers	9 (3.4%)	40 (15.3%)	86 (33.0%)	111 (42.5%)	15(5.7%)	.02
Registrars	2 (2.2%)	10 (11.2%)	17 (19.1%)	57 (64.0%)	3 (3.4%)	
Lack of antibiotics prescribing guidelines						
House officers	14 (5.4%)	41 (15.7%)	97 (37.2%)	103 (39.5%)	6 (2.3%)	.31
Registrars	5 (5.6%)	11 (12.4%)	25(28.1%)	44 (49.5%)	4 (4.5%)	
Microbe mutations						
House officers	13 (5.0%	56 (21.5%)	79 (30.3%)	97 (37.2%)	16 (6.1%)	.02
Registrars	8 (9.0%)	13 (14.6%)	20 (22.5%)	47 (52.8%)	1 (1.1%)	
Lack of antibiotic restriction policies						
House officers	8 (3.1%)	57 (21.8%)	98 (37.5%)	81(31.1%)	17 (6.5%)	
Registrars	5 (5.6%)	9 (10.1%)	29 (32.6%)	41 (46.1%)	5 (5.6%)	.049
Promotion by pharmaceutical medical representatives to antibiotics						

House officers	41 (15.7%)	59 (22.6%)	85 (32.6%)	50 (19.2%)	26 (10.0%	.34
Registrars	13 (14.6%)	25 (28.1%)	29 (32.6%)	19 (21.3%)	3 (3.4%)	
Patient demands and expectations						
House officers	40 (15.3%)	69 (26.4%)	92 (35.2%)	50 (19.2%)	10 (3.8%)	.18
Registrars	14 (15.7%)	18 (20.2%)	26 (29.2%)	28 (31.5%)	3 (3.4%)	
Inadequate hand-washing as infection control program						
House officers	16 (6.1%)	70 (26.8%)	89 (34.1%)	78 (28.9%)	8 (3.1%)	.18
Registrars	8 (9.0%)	21 (23.6%)	21 (23.6%)	37 (41.6%)	2 (2.2%)	
Non-availability of antibiotic surveillance programs as infection control tool						
House officers	10 (3.8%)	63 (24.1%)	98 (37.5%)	70 (26.8%)	20 (7.7%)	.05
Registrars	4 (4.5%)	15 (16.9%)	29 (32.6%)	38 (42.7%)	3 (3.4%)	
Poor updating about the situation of antibiotics resistance in my institution						
House officers	16 (16.1%)	59 (22.6%)	81 (31.0%)	92 (35.2%)	13 (5.0%)	.18
Registrars	6 (6.7%)	19 (21.3%)	21 (23.6%)	42 (47.2%)	1 (1.1%)	

Table 4 .Physicians rating to interventions to reduce antibiotic resistance

Intervention		Specialty (department)					Chi	*P*
		Medicine N (%)	Surgery N (%)	Pediatric N (%)	Obs /Gyn N (%)	Others N (%)		
	Not useful	2 (1.0%)	0 (0.0%)	2 (7.7%)	0 (0.0%)	0 (0.0%)	29.4	.02
	Minimally useful	35 (17.9%)	17 19.8%)	6 (23.1%)	1 (10.0%)	10 (30.3%)		
Institutional- specific	Moderately useful	89 (45.6%)	46 53.5%)	14 (53.8%)	4 (40.0%)	7 (21.2%)		
antibiotic guidelines	Very useful	60 (30.8%)	22(25.6%)	3 (11.5%)	5 (50.0%)	14 (42.4%)		
	Not useful	6 (3.1%)	3 (3.5%)	2 (7.7%)	1 (10.0%)	0 (0.0%)	22.4	.13
	Minimally useful	21 (10.8%)	10 (11.6%)	3 (11.5%)	1 (10.0%)	4 (12.1%)		
Educational	Moderately useful	68 (34.9%)	28 (32.6%)	18 (69.2%)	4 (40.0%)	16 (48.5%)		
programs	Very useful	97 (49.7%)	44 (51.2%)	3 (11.5%)	4 (40.0%)	12 (36.4%)		
	Not useful	2 (1.0%)	4 (4.7%)	2 (7.7%)	2 (20.0%)	1 (3.0%)	36.8	.002
	Minimally useful	34 (17.4%)	16 (18.6%)	3 (11.5%)	3 (30.0%)	3 (9.1%)		
Access to current antibiogra	Moderately useful	74 (37.9%)	32 (37.2%)	19 (73.1%)	2 (20.0%)	17 (51.5%)		
	Very useful	79 (40.5%)	29 (33.7%)	2 (7.7%)	3 (30.0%)	10 (30.3%)		
Regular microbiology	Not useful	6 (3.1%)	2 (2.3%)	0 (0.0%)	2 (20.0%)	0 (0.0%)	40.9	.001
surveillance and consultatio	Minimally useful	33 (16.9%)	15 (17.4%)	14 (53.8%)	1 (10%)	8 (24.2%)		
	Moderately useful	86 (44.1%)	40 (46.5%)	9 (34.6%)	4 (40.0%)	11 (33.3%)		
	Very useful	67 (34.4%)	24 (27.9%)	2 (7.7%)	3 (30.0%)	12 (36.4%)		
	Not useful	4 (2.1%)	2 (2.3%)	0 (0.0%)	1 (10.0%)	0 (0.0%)	21.1	.18
Updating about local	Minimally useful	32 (16.4%)	19 (22.1%)	3 (11.5%)	2 (20.0%)	11 (33.3%)		
antibiotic resistance	Moderately useful	77 (39.5%)	33 (38.4%)	17 (65.4%)	5 (50.0%)	9 (27.3%)		
pattern	Very useful	79 (40.5%)	32 (37.2%)	6 (23.1%)	2 (20.0%)	12 (36.4%)		
	Not useful	6 (3.1%)	1 (1.2%)	0 (0.0%)	1 (10.0%)	1 (3.0%)	17.1	.38
	Minimally useful	43 (22.1%)	26 (30.2%)	7 (26.9%)	1 (10.0%)	8 (24.2%)		
Antibiotic cycling	Moderately useful	85 (43.6%)	32 (37.2%)	12 (46.2%)	5 (50.0%)	10 (30.3%		
intervention	Very useful	42 (21.5%)	19 (22.1%)	6 (23.1%)	3 (30.0%)	6 (18.2%)		
Antibiotic restriction	Not useful	2 (1.0%)	2 (2.3%)	0 (0.0%)	2 (20.0%)	2 (6.1%)	31.8	.01
interventions	Minimally useful	50 (25.6%)	36 (41.9%)	5 (19.2%)	3 (30.0%)	11(33.3%)		
	Moderately useful	93 (47.7%)	32 (37.2%)	15 (57. 7%)	3 (30.0%)	13 (39.4%)		
	Very useful	37 (19.0%)	10 (11.6%)	3 (11.5%)	2 (20.0%)	4 (12.1%)		

Table 5. Most frequent antibiotic-resistance organisms in the three hospitals

Most resistant organism	Hospital			Total N (%)	P
	Khartoum n (%)	Omdurman n(%)	Khartoum North n (%)		
S. aureus	38 (12.1%)	20 (6.3%)	10 (3.2%)	68 (21.6%)	.084
E. coli	26 (8.3%)	9 (2.9%)	11 (3.5%)	46 (14.6%)	.01
Pseudomonas	16 (5.1%)	5 (1.6%)	4 (1.3%)	25 (7.9%)	.17
MRSA	12 (3.8%)	2 (0.6%)	7 (2.2%)	21 (6.7%)	.35
Salmonella	3 (1.0%)	4 (1.3%)	12 (3.8%)	19 (6.0%)	.049
Streptococcus	7 (2.2%)	6 (1.9%)	1 (0.3%)	14 (4.4%)	.31
M. Tuberculosis	4 (1.3%)	0 (0.0%)	0 (0.0%)	4 (1.3%)	-
Kellebsalla pneumonia	2 (0.6%)	0 (0.0%)	0 (0.0%)	2 (0.6%)	-
P. falciprium	0 (0.0%)	1(0.3%)	0 (0.0%)	1 (0.3%)	-
Don't Know	70 (22.2%)	34 (10.7%)	11 (3.5%)	115 (36.5%)	.0001
Total	178 (56.5%)	81 (25.7%)	56 (17.8%)	315 (100.0%)	

4. DISCUSSION

Antibiotic resistance is an emerging public health problem, and resistance pathogens currently exist for which no first-line treatment is effective and is aggravated by the lack of development of new antimicrobial agents [10]. The rapid and sharp increase in antibiotic resistance has been attributed to inappropriate antimicrobial use and non-compliance with infection control precautions. It has been demonstrated that physicians will not alter their management practices unless they are both aware of and in agreement with the changes that are being proposed. Thus, a better understanding the knowledge, beliefs and awareness of resident house staffs is crucial to efforts to reduce inpatient antibiotic resistance, as they prescribe a substantial portion of these agents in teaching hospitals where problems of antibiotic resistance are most sever. Furthermore, since the problems of antimicrobial resistance are not limited by specialty, a better understanding of all specialties is also essential [11].

This study is focus extensively in house officers and to lesser extent to registrars, and includes physicians in medicine, surgery, pediatric and Obs/Gyn in the three main Khartoum state teaching hospitals. When combined results of "moderately great", "great" and "extremely great" and considered as sever against combined results of "not great" and "minimally great" as not sever, the majority of respondents perceived the problem of antibiotic resistance as sever problem in their hospitals (47.5% vs. 42.9%). The survey has shown that physicians in these hospitals were aware of the problem of antibiotic resistance as general. 38.0%, 41.7 and 44.3% of physicians assessed the problem locally, nationally and globally respectively as very important problem. About 50% thought the problem in their institution is similar as countrywide, while about 35% of them considered it more than that seen worldwide. 51.7% declared that antibiotic resistance was a major problem when though to prescribe antibiotics. Many publications have documented the high rate of antibiotic resistance in different settings in Khartoum state. A study performed in Khartoum teaching hospital investigated the level of antibiotic resistance of aerobic nosocomial isolates to commonly used antimicrobial agents demonstrated that overall resistance of different urinary pathogens was 46% to gentamicin ,68% to ciprofloxacin and 67% to cotrimoxazole [12]. Another work was conducted for determination of the prevalence of antimicrobial resistance among pathogenic bacteria isolated from three major hospitals in Khartoum State against commonly used antimicrobial agents. Results showed that the highest resistance was seen against penicillin, tetracycline and amoxicillin also there is a marked resistance against third generation cephalosporins. Also Staphylococci (coagulase negative S.aureus) showed a marked resistance against methicillin and vancomycin. The lowest resistance was seen against amikacin and meropenem [13]. These results differ from those of Wester *et al*.[14], who surveyed 490 internal medicine physicians in Chicago-area hospitals to assess their perception and knowledge about importance of antibiotic resistance and found that 87% of respondents perceived antibiotic resistance as a very important national problem but only 55% perceived it to be a very important problem in their institution. Other more studies have found a higher level of awareness of the antibiotic resistance [15,16].

Physicians also had a reasonable idea of the major factors contributing to the problem. Wide spread use and inappropriate use were believed to be important general causes of resistance by about 80% of the respondents. Arjun et al [6], found that 97% of house staff at the Johns Hopkins hospital – USA- believed that better antimicrobial use would help addressed the issue of resistance. In fact the use of antimicrobial agents, by itself, is considered to exert a selective pressure on resistance [17], in addition, the use of antibiotics for the treatment of non-bacterial, mostly viral infections and the overuse of broad-spectrum

antibiotics in the management of bacterial infections promotes antibacterial resistance. [18] The prevalence of self-medication with antibiotics in the community in Khartoum State, capital of Sudan is alarmingly high and documented in several occasions. [19,20]. A major reason for the large scale prescription of antibiotics is inadequate knowledge about the consequences of bacterial resistance. Contradictory reducing antibiotic use was believed effective in ameliorating resistance by only 60%. This discrepancy may be due to a lack of awareness of the effectiveness of antibiotic restriction or to skepticism about its feasibility in actual practice. [15].

Interestingly, neither patient's demands and expectations nor marketing promotion strategies by pharmaceutical companies were thought to play a major role antibiotic resistance problem (22.3% and 19.7% respectively). Many studies confirmed that the rate of irrational prescribing practices increases due to the growing demand for antibiotics on the part of the patients and this result in softening the physicians' attitude and responding to the patient expectations. [21]. Influence of pharmaceutical companies on doctors is very well recognized and many local and international studies confirm that drug companies representative's visits markedly influence doctors' drug preference towards the marketed drugs and have effect in attitude and behavior of prescribing pattern of general practitioner [7,22,23].

Inadequate hand-washing as infection control program was identified as a very important cause by only (30.9%). This may reflect a similar lack of awareness of the effectiveness of this simple, yet underused practice and the laxity of hand hygiene washing and disinfection by Sudanese health care workers, and this was previously confirmed by other studies. [24,25].The spread of resistance organisms throughout a ward or even a hospital has repeatedly been identified as being related to the breakdown of infection control measures, especially hand hygiene.[26]. Hand-washing has been shown to be the single most important factor in the prevention of transmission of infection in the hospital setting. [27].

The three most favored interventions believed that they to be very useful in preventing development of antibiotic resistance were educational program, updating about local antibiotic resistance pattern and accessing to current antibiogram (45.7%, 37.4 and 34.6% respectively). Carla *et al*. [28] found a similar results in Brazilian teaching hospital; in that study "physicians education about antimicrobial therapy" and "knowing pathogens and antimicrobial susceptibility" were ranked as the 2 most important strategies (44.2% and 30.3%). Current antibiograms for the most hospitals in our country are not readily available and there is need of improving access to results of local antimicrobial susceptibility tests because there is currently no feedback to the staff about the local resistance trends at the surveyed hospitals. There was much less support in interventions that restrict physicians' behavior and practice such as antibiotic restriction and antibiotic cycling interventions, perhaps because they restrict physicians autonomy and complicate antibiotic prescribing practice. This is consistent with findings from other surveys, which showed that physicians preferred voluntary changes in prescribing practices, rather than interventions, which imposed limitations. [29,30]. When the risk factors for bacterial resistance are identified, effective measures should be undertaken to reduce the risk of future resistant infections. The strategies for limiting bacterial resistance are consistently discussed in the literature. The adoption of certain guidelines, protocols or polices is associated with more appropriate antibiotic use, improved patient outcomes and minimized resistance emergence.

There was awareness of the consequences of resistance including increase mortality and morbidity and less frequently treatment failure and death. *S. aureus* (21.6%) was the most resistance organism addressed by physicians followed by *E. coli* (14.6%) and pseudomonas

sp (7.9%) and these findings did not widely different between different occupations and specialties at the three hospitals and consistent with a previous local work conducted to determine the levels of aerobic bacterial contamination and antibiotic resistance in the operating theatres and surgical wards of five major hospitals in Khartoum state and showed the majority of bacterial strains tested (*staphylococci, Escherichia, pseudomonas* and *proteus*) have exhibited marked multiple-drug resistance to commonly used antimicrobial agents ([12]. Also many physicians are unaware of resistance-inducing antibiotics such as third generation cephalosporins, which should be avoided in resistant organisms as empiric therapy.

This study has some limitations. First, preceptor-ship is a volunteer contribution at surveyed institutions, and there is no official registry of preceptors; therefore, questionnaire were distributed only to those whom the data collector encountered during their routine service hours at the hospitals; as majority interviewed were house officers, with low experience. Secondly, as with most surveys, it is possible that respondents might give socially desirable answers, rather than their true opinions or practices.

Finally, one may question whether the attitude of doctors in other parts of Sudan to antimicrobial resistance is reflected by the results of this survey. As this survey was conducted in the three large public, tertiary teaching hospitals and involved large number of prescribing doctors, we are confident that the results may be applied to other public general hospitals in Sudan. However, the generalizability of the results to other health care settings remains to be demonstrated.

5. CONCLUSION

Although physicians were aware of the antibiotic resistance, their perceptions about its importance, its causes and potential solutions are often contradictory and variable. These contradictory perspectives present challenges that must be overcome if we are to successfully address the mounting problem of antibiotic resistance.

This study suggests that, to prevent the development of antibiotic resistance, we should further promote education activities about antimicrobial therapy, create innovative strategies to attract physicians' attention to campaigns about antimicrobial resistance prevention.

CONSENT

Author declares that ‘Interviewers obtained written consent before administering the questionnaire. The interviewee informed why the information was being collected, and how it would be used, and read them a statement informing them that their participation was voluntary before the start of the interview and confirmed that their answers are anonymous and confidential.

ETHICAL APPROVAL

Approval for the study obtained from National College for Medical and Technical Sciences Ethical Committee.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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