Здоровье и общество

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THE EFFECT OF APPLICATION OF MONITORING AND TRAINING PROGRAMS ON QUALITY OF ANTIMICROBIAL DRUGS USE IN HIGH-RISK DEPARTMENTS

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The antibiotic resistance as a problem acquired character of pandemic. The WHO included it in top ten global health threats. In low-income countries, the main goal of the WHO global action plan is to control increase of antimicrobial resistance with purpose to improve quality of antibiotics application.
This purpose of study was to evaluate effectiveness of integrated program of rational application of antimicrobial drugs to improve quality of medical care in multidisciplinary surgical hospital in the Kyrgyz Republic.
The research comprised several stages including establishment of prevalence of infection associated with provision of medical care and implementation of training programs of rational use of antimicrobial drugs to improve quality of medical care.
The implementation of comprehensive training and monitoring programs at hospital level made it possible to reduce total consumption of antimicrobial drugs in Defined Daily Doses per 100 Bed-Days (DDD/100BD) by 2.4 times, mainly due to third-generation cephalosporins, and aminoglycosides, macrolides. As a result, financial expenditures for drugs purchase decreased up to 2.7 times. The practical implementation of recommendations of perioperative antibiotic prevention permitted to increase consumption of cephalosporins of first generation. To develop and to implement training and monitoring programs an integrated approach is needed that, taking into account the specifics of particular medical organization and conditions of multidisciplinary interaction. Further research is needed to study application of rational practices of using antimicrobial drugs, preventing occurrence of HAI, controlling increase of antibiotic resistance.

K e y w o r d s : *antibiotics; antimicrobials; antimicrobial resistance; drug resistance; drug consumption, quality; high-risk department.*

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Abbreviations:

AMD — Anti-microbial Drug.
HAI — Healthcare-associated infection.
SSI — Surgical Site Infection.

Introduction

Antimicrobial resistance is growing at an alarming rate worldwide. The problem of antibiotic resistance has now acquired the character of a pandemic and is included by the World Organization in the list of the top ten threats to global health [1, 2].

CDDEP researchers have published the report "The State of Antibiotics in the World in 2021", which presents extensive data on the global use of AMDs and resistance to them, as well as factors of resistance to them, based on extensive CDDEP research and data collection through Resistance Map (www.resistancemap.org), which is widely used by researchers, politicians and the media. The report notes that since the publication of the first report "The State of Antibiotics in the world in 2015", resistance to AMDs has stabilized in some high-income countries, but continues to grow in many low- and middle-income countries [3, 4].

According to the results of many researchers, it has been proven that reducing AMDs consumption can affect the level of resistance pathogenesis [4–7]. The study of drug consumption helps to identify their irrational use, and carry out targeted measures to optimize drug treatment, and can also become a tool for monitoring the effectiveness of training programs for healthcare professionals and other measures aimed at improving pharmacotherapy [6–8]. Improving the quality of antibiotic use in hospitals is one of the main goals of the global action plan of the World Health Organization (WHO) to combat resistance to AMP [4, 5, 7, 9].

To study the peculiarities of the development of the drug supply system in the country, its problems, and prospects for development, it is necessary and appropriate to assess the consumption of medicines in real clinical practice for subsequent optimization of the appointment and use of medicines. At the same time, it should be noted that the study of the dynamics of the consump-

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tion of systemic antimicrobial drugs (AMDs) in healthcare organizations is very relevant and limp because today's range of AMP is a serious threat to humanity. Thus, according to expert estimates, in stationary conditions, up to 20–30% of AMDs prescriptions may be unreasonable [1, 5, 10]. According to the World Health Organization (WHO), national health budgets' share of medical expenses varies from 40 to 70% [8].

The leading factors leading to the formation and spread of antibiotic resistance are low adherence to infection control measures. To determine the level of prevalence with the determination of the qualitative and quantitative characteristics of HAI in healthcare institutions and the practical implementation of epidemiological surveillance of HAI, it is recommended to use the prevalence method [8–10].

The study of point prevalence is relatively simple and does not require additional financial costs and additional equipment, while observation can cover a significant number of patients [10, 11].

The aim of the study

Evaluating the effectiveness of the implemented comprehensive program for the rational use of antimicrobials and improving the quality of medical care in a multi-disciplinary hospital in the Kyrgyz Republic

The goal is to develop a program for monitoring consumption and training in rational use using consumption data in a multidisciplinary hospital in the Kyrgyz Republic.

Materials and methods

The present study consisted of several stages, including:

1. Determination of the basic level of the prevalence of healthcare-associated infections (HAI) by the method of cross-sectional prevalence, qualitative and quantitative characteristics of HAI and risk factors, and, analysis of the level and structure of AMD consumption.

2. Implementation of training programs on epidemiological surveillance of HAI, identification of risk factors for their occurrence, monitoring of microbiological results, and, principles of rational use of AMD.

3. Monitoring the prevalence of HAI and the use of AMD.

Researchers from the Quality Committee, including a clinical pharmacologist, an expeditor, and an infection control specialist, carried out comprehensive clinical and analytical work from 2016 to 2019 based in a multidisciplinary hospital (Bishkek). In the first stage, a basic assessment of the initial level of AMD consumption was carried out. Information on the structure and volume of consumers and motion, the number of bed days spent by patients in the hospital for 2016–2019 was obtained from the database of medicines of the pharmacy, the procurement department, and reports of the structural units of the hospital.

ABC/VEN analysis and the ATC/DDD methodology recommended by the World Health Organization (Anatomic Therapeutic Chemical classification/Defined Daily Dose) were used to assess the consumption of AMD. The level of AMD consumption in the hospital in DDD units (DDD), the total amount of medication used for the year in milligrams/grams was divided by the established daily dose of this medication adopted by WHO for this year. To study the consumption of medicines in the hospital, we used the indicator DDD/100 bed days (DDD/100BD). The number of bed days when calculating DDD/100BD was determined by the bed occupancy indicator, which all four rows compared the consumption of medicines in healthcare organizations of different capacities and in different time intervals.

Since 2016, the method of studying the prevalence and HAI by the microcross- sectional prevalence, determining the qualitative and quantitative characteristics and risk factors of their introduced. To conduct the study, the "Instruction on epidemiological surveillance of HAI in high-risk departments (surgery, intensive care, anesthesiology, and intensive care)" approved by the Order of the Ministry of Health of the Kyrgyz Republic dated 15.08.2016 No. 716 was used. Data for qualitative assessment were collected by analyzing medical histories, interviewing doctors on the issues of medical procedures and the validity of antimicrobial drug use, and visual characteristics of the epidemiologically dangerous procedures used. The results were recorded in the form of collecting data on the prevalence of infection and risk factors. Quantitative assessment was used to calculate the prevalence of infections and risk factors by forming and then analyzing a database in Epi Info software applications.

Based on the data obtained, we have developed a modular training program for doctors, including the organization of an infection control system in a hospital, standard definitions of the "case" of HAI and preventive measures, the rational use of antimicrobials in surgical departments, perioperative antibiotic prophylaxis, monitoring of the microbial landscape and antibiotic resistance to improve the quality of training, a practical block has been introduced, including analysis of the "Treated case" database, determination of the structure and frequency of development and prediction of cases of HAI with the calculation of risk factors for their occurrence. On a Regular of the safety of medicine al procedures and hospitals, hygiene has been introduced into the practical training. At the final stage, a training module was conducted on the methodology for calculating the needs and forming local applications of AMD, taking into account the studied structure of morbidity, the level of ISMP, the local microbial landscape and the level of antibiotic resistance.

The presented publication reflects the impact of comprehensive measures for continuous training and monitoring of to prevalence of HAI and the level of consumption of antimicrobial drugs of systemic use.

Excel 2013, Excel Query, Excel PIVOT, Epi, and Info were used for data collection and processing.

Results

In our study, the base level of AMD consumption in 2016 was 89.44 DDD/100BD. The structure of con-

sumption was dominated by cephalosporins — 36.73 DDD/100BD, aminoglycosides — 32.56 DDD/100BD, macrolides — 9.68 DDD/100BD (Fig. 1). At the same time, a high proportion of AMD purchase costs was noted — 62.6% of total drug costs, which amounted to 11.394557 som.

A study of point prevalence in 2016 determined the baseline level of which was 18.2%. The highest rate of HAI was recorded in the following departments: intensive care — 35.7%, urology — 31.3%, purulent surgery — 26.1%, the loans west — in the department of eye microsurgery — 5.6% (Table 1).

The UTIs occupy a leading position in the structure of cases of HAI — 49%, ISIA — 22%, upper respiratory tract infections — 9%. At the same time, out of 77 cases of HAI, only 27 patients underwent a microbiological study to determine antibiotic sensitivity.

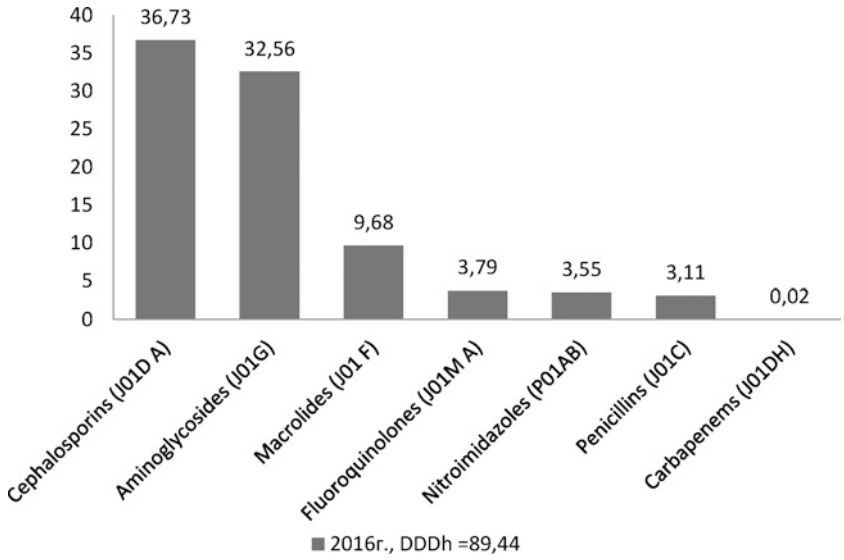

Fig. 1. AMD consumption level (DDD/100BD) for 2016 in surgical departments.

Of the 423 patients, 300 (70.9%) patients received AMD, 180 (60%) of them for therapy, and 120 (40%) patients for prevention. Thus, the study of point prevalence and the use of ATX/DDD methodology revealed a high incidence of HAI (18.2%) the level of AMD consumption (89.44 DDD/100BD) in high-risk departments.

A comprehensive training and monitoring program implemented siin017 has made it possible to achieve significant success in the practice of using AMD in a hospital, both from the quantitative and qualitative side: to reduce the level of AMD consumption and the share of financial costs for their purchase, to improve the practice of using AMD.

The total level of AMD consumption in 2017 decreased by 33.9%, in 2018 it decreased by 1.8 times compared to 2016 and amounted to 32.3 DDD/100BD. In 2019, the level of AMD consumption amounted to 37.2 DDD/100BD, which is 4.9 DDD/100BD more compared to the previous year, while this indicator is 2.4 times lower compared to 2016 (Table 2).

Table 1

Results of the basic study of point prevalence, 2016

Departments	Number of patients	HAI		Acquired infections outside the hospital	
		Absolute number	%	Absolute number	%
Surgery of the face and otolaryngology	50	10	20,0	15	30,0
Urologic	112	35	31,3	25	22,3
Neurosurgical	88	12	13,6	1	1,1
Vascular surgery and microsurgery	47	3	6,4	3	6,4
Purulent surgery	23	6	26,1	13	56,5
General surgery	35	3	8,6	2	5,7
Ophthalmology	54	3	5,6	2	3,7
Intensive Care unit	14	5	35,7	5	35,7
Total…	423	77	18,2	66	15,6

Cephalosporins are the leaders in consumption among all groups of antimicrobials (Fig. 2).

The dynamics of the consumption of cephalosporins, as the leading group of AMD, indicate a tendency to decrease the use of cephalosporins of the third generation — ceftriaxone by 2.9 times, ceftazidime by 1.5 times (Fig. 3). A 12.6-fold increase in the level of cefazolin consumption indicates an active process of implementing protocols of perioperative antibiotic prophylaxis. A slight increase in the consumption of fourth-generation cephalosporin with antisynegin activity — cefepime indicates the introduction of etiisotropictimicrobial therapy into practice.

Table 2

Antimicrobial drug consumption for 2016–2019, DDD/100BD

Name of the group (ATX-group)	2016	2017	2018	2019
Penicillins (J01C)	3.11	12.94	1.07	1.0
Cephalosporins (J01D A)	36.73	21.96	22.77	21.17
Macrolides (J01 F)	9.68	11.88	1.59	0.98
Fluoroquinolones (J01M A)	3.79	7.74	4.4	9.99
Nitroimidazoles (P01AB)	3.55	2.18	0.94	2.74
Aminoglycosides (J01G)	32.56	2.18	1.25	1.03
Carbapenems (J01DH)	0.02	0.14	0.1	0.22
Glycopeptides (J01XA)	0	0.094	0.074	0.093
Lincosamides (J01FF)	0	0.042	0	0
Linezolid (J01XX08)	0	0	0.001	0
Nitrofurantoin (J01XE)	0	0	1.4	0
Tetracyclines (J01A)	0	0	0.12	0
Consumption, DDD/100BD	89.44	59.15	33.59	37.22
Expenditure per AMD, som	29,665,493.14	10,897,648.89	7,351,133.22	11,050,041.91

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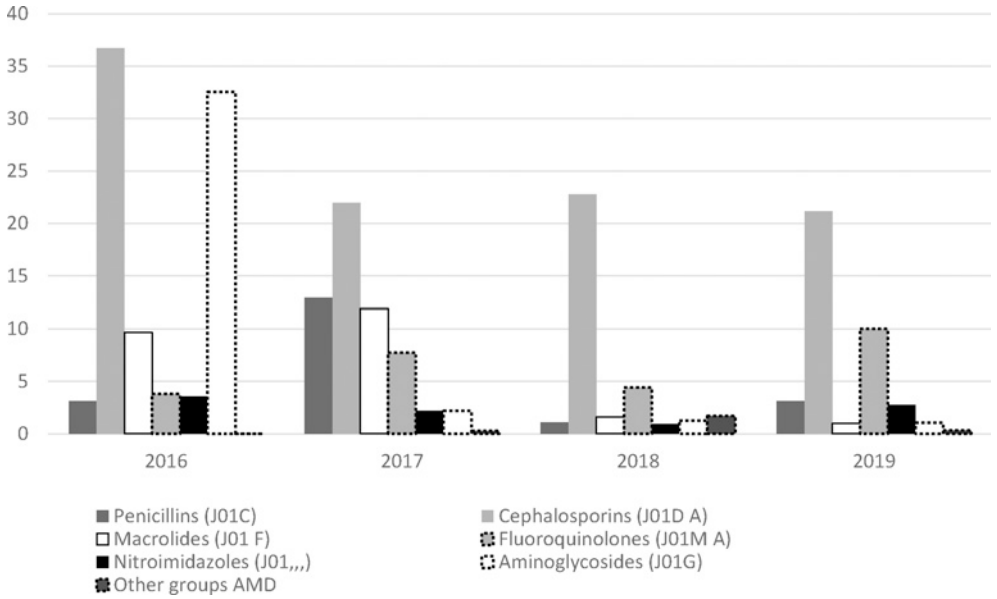
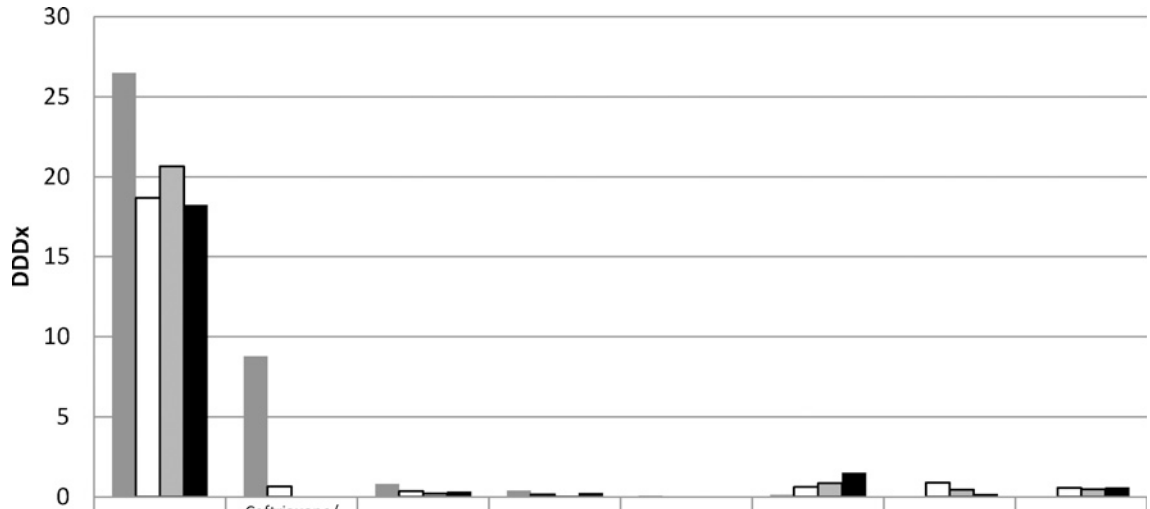


Fig. 2. DDD/100BD dynamics for a group of major AMD groups for the period 2016–2019.



	Cephtriaxones	Ceftriaxone/ sulbactam	Cefuroxime	Ceftazidime	Cefoperazone	Cefazolin	Cefotaxime	Cefepime
2016	26,47	8,79	0,82	0,39	0,078	0,12	0	0
2017	18,68	0,66	0,37	0,16	0	0,62	0,9	0,56
2018	20,65	0	0,22	0,008	0	0,86	0,46	0,48
2019	18,22	0	0,35	0,26	0	1,51	0,2	0,61

Fig. 3. Dynamics of consumption of DDD/100BD of the cephalosporin group for the period 2016–2019.

Reduction of consumption of AMD group of macrolides by 9.9 times: The DDD/100BD of azithromycin in 2019 decreased by 12.6 times compared to the baseline, and clarithromycin by 6.8 class is presented in Table 3.

Table 3

Consumption of macrolide group antibacterial agents (J01F), DDD/100BD, 2016–2019

Name of the medicinal product (international nonproprietary name)	2016	2017	2018	2019
Roxithromycin	1.3	1.7	0.09	0.00
Azithromycin	3.68	5.9	0.65	0.29
Clarithromycin	4.7	4.28	0.85	0.69
Total...	9.68	11.88	1.59	0.98

As can be seen from Table 4, in the penicillin group in 2017 there was a sharp rise in DDD/100BD from 3.11 to 12.94, in subsequent years there was a decrease in the level of consumption, in general, DDD/100BD decreased by 3.1 times by 2019.

During the 4 years of implementation of training and monitoring programs in high-risk departments, AMD (DDD/100BD) consumption was reduced by 2.4 times, while AMD costs decreased by 2.7 times (Table 4).

The statistical performance of the hospital is shown in Table 5, which shows a decrease in the incidence of healthcare-associated infection from 18.2% to 12.1%;

Table 4

Consumption of antibacterial agents of the penicillin group (J01C), DDD/100BD, 2016–2019

Name of the medicinal product (international nonproprietary name)	2016	2017	2018	2019
Ampicillin/sulbactam	0.047	0.850	0.166	0.2
Amoxicillin/Clavulanic acid	0.008	0.670	0.12	0.1
Ampicillin	0.442	1.350	0.12	0.1
Amoxicillin	0.447	2.340	0.114	0.06
Benzylpenicillin	2.166	7.730	0.52	0.54
Total...	3.11	12.94	1.04	1.0

Table 5

The frequency of development of healthcare-associated infections in the hospital, 2016–2019

Name	2016	2017	2018	2019
Number of discharged patients	17,226	18,001	18,220	19,021
Healthcare-associated infections, %	18.2	17.8	14.4	12.1
Urinary tract infections,%	9.0	7.8	6.8	6.0
Surgical site infections,%	4.5	4.0	4.2	4.1
Other healthcare-associated infections, %	4.7	6.0	3.4	2.0
Number of microbiological studies	452	675	757	986

the incidence of urinary tract infection from 9% to 6% over 4 years.

Discussion

The leaders of AMD consumption in our study, as in many healthcare organizations in Belarus and Russia, were cephalosporins, mainly ceftriaxone, and its basic consumption level was 29.6% of all AMD. Reducing consumption from 26.47 to 18.22 DDD/100BD will reduce the risk of selection of polyresistant microorganisms, primarily vancomycin-resistant enterococci.

A high baseline level of macrolide consumption was noted at -9.68 at DDD/100BD, which is more than 5 times higher than the identical indicator for Russia in 2010 (1.9 Bp). At the same time, over 4 years, the measures implemented by us allowed us to reduce the above indicator to 0.98 DDD/100BD mainly due to azithromycin, roxithromycin, and claroxithromycin, which is comparable with rational practices of using AMD.

A 32-fold decrease in the consumption of aminoglycosides due to gentamicin was noted as a rational indicator. A slight increase in amikacin consumption by 0.54 DDD/100BD is associated with the introduction into the practice of methods of epidemiological surveillance of HAI and active bacteriological support for nosocomial infections.

Consumption rates of AMD groups of carbapenems (0.22 DDD/100BD) and glycopeptides (0.093 DDD/100BD) are comparatively lower than identical indicators of other countries.

The level of consumption of fluoroquinolones of 9.99 DDD/100BD in 2019 is comparable with identical indicators of healthcare institutions in other countries, however, the increase in consumption from 3.39 to 9.99 DDD/100BD due to ciprofloxacin, levofloxacin, and moxifloxacin, and is also associated with the introduction of methods for detecting nosocomial infections and bacteriological support.

Conclusions

From 2016 to 2019, a group of specialists of the Quality Committee developed and implemented in the practice of high-risk departments (surgical and intensive care units) a training and monitoring program for the rational use of AMD and the level of prevalence of HAI by the method of point prevalence.

The implementation of comprehensive training and monitoring programs at the hospital level allowed to reduce the total consumption of DDD/100BD AMP by 2.4 times, mainly due to third-generation cephalosporins, aminoglycosides, macrolides, which reduced the number financial costs for their purchase by 2.7 times.

The introduction of the point prevalence method allowed reducing in the prevalence of HAI in high-risk departments by 6.1%, UTI by 3%, and ISIA by 0.4%.

An increase in the consumption of cephalosporins of the first generation is associated with the widespread introduction into the practice of protocols for perioperative antibiotic prophylaxis. The active introduction of isotropic antibiotic therapy is associated with an increase in the number of microbiological studies, and, as a result, a moderate increase in the consumption of AMD in the Watch group.

When developing and implementing training and monitoring programs, an integrated approach is needed, taking into account the specifics of a particular healthcare organization and the conditions of multidisciplinary interaction. In this connection, further research is needed to study the use and implementation of rational practices for the use of antimicrobial drugs, the prevention of the occurrence of HAI, and the containment of the growth of antibiotic resistance.

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