MEDICAL SCIENCE MONITOR

PUBLIC HEALTH

e-ISSN 1643-3750
© Med Sci Monit, 2017; 23: 725-731
DOI: 10.12659/MSM.899848

Received: 2016.06.01
Accepted: 2016.07.14
Published: 2017.02.09

Effectiveness of Antibiotic Use Management in Tianjin (2011–2013): A Quasi-Experimental Study

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABE 1 Hai-Hong Zhang*
BC 1 Yue Du*
A 2 Wei Liu
D 3 Shi-Duo Song
C 3 Wen Zhao
F 1 Guo-Wei Huang
AG 1 He-Sheng Wang

1 School of Public Health, Tianjin Medical University, Tianjin, P.R. China
2 Department of Public Health, Tianjin Municipal Commission of Health and Family Planning, Tianjin, P.R. China
3 Department of Infectious Diseases, The Second Hospital of Tianjin Medical University,Tianjin, P.R. China

* Authors contributed equally

Corresponding Author: He-Sheng Wang, e-mail: heshengguang2014@163.com
Source of support: This work was supported by Tianjin Municipal Commission of Health and Family Planning

Background: In this study we investigated changes in the status of antibiotic use in Tianjin since the implementation of the Antibiotic Stewardship Program (ASP) (2011–2013), as well as existing problems, strategies, and outcomes to promote rational clinical antibiotic use.

Material/Methods: A quasi-experimental study was performed to investigate situations of antibiotic use in secondary and tertiary general hospitals in Tianjin from April 2011 to 2013. Five major indicators were analyzed: percentage of antibiotic use in inpatient cases (%), antibacterial use density (AUD), proportion of prophylactic antibiotic application for type I surgical incision, compliance rate of medication administration 0.5–2.0 h before such procedures, and antibiotic prophylaxis for ≤24 h in patients receiving these surgeries.

Results: There was a decrease in the percentage of antibiotic use across general hospitals (60.38% to 46.88%), in AUD (51.60% to 35.37%), and in the proportion of prophylactic antibiotic applications for type I incisions (86.67% to 25.08%). For patients undergoing these procedures, there was an increased compliance rate of medication administration of 0.5–2.0 h prior to surgery (86.38% to 100%), and of antibiotic prophylactic use for ≤24 h (40.30% to 96.37%).

Conclusions: Implementation of the ASP campaign has reduced irrational antibiotic use, promoted rational antibiotic use, and delayed antibiotic resistance.

MeSH Keywords: Antibiotics • Hospitals, General • Investigational • Management Audit

Full-text PDF: http://www.medscimonit.com/abstract/index/idArt/899848

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Background

Antibiotics are one of the major agents widely used in clinical practice for the prevention and treatment of infections. However, irrational antibiotic using has also become a common issue worldwide [1–3], which has resulted in a rise and exacerbation of antibiotic resistance, and leading to a decline in clinical efficacy and an increase in adverse reactions. Irrational antibiotic use has presented an enormous challenge to infection control in hospitals. The World Health Organization (WHO) considers "bacterial resistance" to be one of the healthcare issues that is severely threatening to human life. Similarly, China is also facing a large threat from antibiotic use [4–6]. To enhance the management of antimicrobial agents, the Ministry of Health (MOH) of the People's Republic of China released the "Nationwide Special Campaign for Antibiotic Stewardship Program (ASP) 2011" and conducted a specific rectification of irrational antibiotic use in China [6–10]. In this study, we investigated and analyzed the changes in relevant indicators in antibiotic use in 41 medical organizations (19 tertiary hospitals and 22 secondary hospitals) between 2011 and 2013 in an attempt to evaluate the effectiveness of specific activities in the control of antibiotic use in secondary and tertiary hospitals in Tianjin, China.

Material and methods

Study design

The special antibiotic use rectification program was initiated in November 2011 in China. In the present study, antibiotic use data were collected through inpatient medical records (1 year defined as 1 cycle) in April of each year, starting from 2011, for 3 consecutive years (i.e., April of 2011, April of 2012, and April of 2013). Based on a quasi-experimental study, the Quality Management System (QMS) and Plan-Do-Check-Act (PDCA) management concept [11–13], antibiotic use indicators were assessed and analyzed to compare any changes among the 3 cycles.

Data collection

This clinical investigation was conducted in 2011 at 41 public hospitals, including 19 tertiary general hospitals and 22 secondary general hospitals in Tianjin, which is one of 4 directly controlled municipalities of China. The use of antibiotics in the 41 hospitals was summarized for analysis. The valid hospital records with hospitalization duration between 3 and 30 days were collected from each hospital. The data on antibiotic consumption were normalized to defined daily doses (DDD)/100 days for inpatients, and a total of 14 760 cases were included in this study.

Evaluation criteria

According to the requirements of the "Nationwide Special Campaign for Antibiotic Stewardship Program (ASP) in 2011", the percentage of antibiotic use in inpatient cases at general hospitals should not exceed 60%, and antimicrobial use density (AUD) in general hospitals must be controlled at 40 defined daily doses (DDDs) per 100 patient days. Moreover, the percentage of antibiotic prescriptions given to emergency patients cannot exceed 40.00%, and the proportion of prophylactic antibiotic use in patients undergoing type I incision surgeries cannot exceed 30.00%. Finally, preoperative inpatient prophylactic antibiotic use should be performed 0.5–2 h before surgery (except for Cesarean sections), antibiotic selection and treatment course must be rational, and the duration of prophylactic antibiotic use for those undergoing type I incision operations must be controlled within ≤24 h.

Ethics

The study protocol was approved by the Ethics Committee of Tianjin Medical University and informed consent was obtained from each participant.

Calculated indicators

1. Percentage of antibiotic use in inpatients = number of patients using antibiotics at discharge/total number of patients discharged over same period ×100%.
2. AUD was defined as DDDs per 100 patient days, and was calculated using the equation, AUD = total antibiotics consumption (cumulative DDD amount) × average length of hospital stay/total number of patients (person-time) discharged from hospital over same period ×100.
3. Proportion of prophylactic antibiotic use for type I incision = number of cases of prophylactic use during type I incision surgery/total number of type I incision surgeries ×100%.
4. Compliance rate of rational antibiotic use 0.5–2.0 h before type I incision surgery = number of cases using antibiotic prophylaxis 0.5–2.0 h before type I incision surgery/total number of cases using antibiotic prophylaxis before type I incision surgery over same period ×100%.
5. Compliance rate of antibiotic prophylactic use for ≤24 h in patients receiving type I incision surgery = number of cases with ≤24 h of antibiotic prophylaxis after type I incision surgery/total number of cases receiving antibiotic prophylaxis for type I incision surgery over same period ×100%.

Strategies

The Antibiotic Stewardship Program (ASP) in 2011–2013 was led by a working group of the Infection Quality Control Center in Tianjin Health Bureau. The working group was composed

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

of experts in epidemiology, clinical experts, data verification personnel, and local residents. The working group examined the clinical use of antibacterial drug in April 2011, April 2012, and April 2013 in the 41 hospitals. Notification was made in cases of unreasonable antibiotic use. Training was also performed by 2 infection specialists for the doctors and pharmacists who carry out the ASP. A total of 295 doctors and pharmacists was trained during these periods.

Academic communications

A multidisciplinary team of clinical professionals specializing in infectious disease, critical care medicine, microbiology, disinfection and isolation, and pharmacology participated in professional conferences, seminars and training courses in a variety of areas. Through discussion and in-depth study, professionals could effectively master the cutting-edge information of industry change and workplace experience, thus being able to play a vital role in correctly diagnosing infectious patients in hospitals, properly treating infectious patients, and enhancing the prevention and control of infection hazards in a hospital setting.

Clinical training

Clinical training was provided by a multidisciplinary team of experts in the areas of infection control, refractory disease strategies, perioperative antibiotic prophylaxis, laboratory-to-clinic microbiology communication, conditions for initial hospital visiting of acquired immune deficiency syndrome (AIDS) patients and protection of medical staff, basic principles of antibiotic use, and guidelines for clinical antibiotic use against infectious diseases. In addition, to improve diagnosis and treatment of infections, training courses were provided in the following areas: acquisition of common infectious diseases during long-term hospitalization, monitoring of the accumulation of infectious diseases with known or unknown sources, and construction of infection prevention software and hardware. Moreover, clinical training also included courses on the advantages of hand washing and the efficacy of using alcohol hand rub. Other courses of interest covered the establishment of temporary quarantine zones for newly admitted patients, recent advances in environmental disinfection, infections resulting from unsanitary hospital environments, prevalence and trends of novel Middle East coronavirus infections, and a general increase of nosocomial infections related to surgery-induced patient hypothermia.

Assessment of prescriptions

Antibiotic prescriptions were analyzed and assessed by infection experts and hospital quality control centers. On-site feedback was provided to each hospital regarding several issues of antibiotic use, including overuse, the presence of name redundancies for generic formulas, drug selection and distribution challenges, specific drug biases, lack of first-generation cephalosporin for surgical prophylaxis in hierarchical catalogues, and whether surgical prophylactic antibiotics (e.g., aztreonam, cefoxitin, and ceftriaxone) should be included in catalogues.

Information management

A number of measures were introduced in Tianjin since the initiation of the ASP campaign in 2011 to implement hierarchy management of clinical antibiotic use, promote scientific and rational antibiotic use, reduce antibiotic resistance, and ensure safety of medical service. This was done to accomplish antibiotic prophylaxis and rational diagnosis and treatment of infectious diseases. In addition, nosocomial infections and infectious outbreaks in general hospitals were monitored via antibiotic use and resistance surveillance networks. Prescriptions and medical orders were identified by computer-assisted electronic prescription systems through integration of clinical patient data, basic medication information, and the pathogen spectrum of infection. Electronic prescription systems can increase the rate of standardized prescriptions; as such, use of information technology is a developing trend in standardized management, and a long-term strategy for achieving rational antibiotic use in a clinical setting.

Data analysis

Antibiotic consumption data was provided by hospitals of Tianjin, Tianjin Center for Nosocomial Infection Control review, and checked with the relevant hospital infection data. Statistical analysis was performed using SPSS software version 17.0. The ratios of antibiotic use in hospitalized patients are mainly presented as percentages. Repeated measure analysis of variance was conducted for comparison among groups; a p-value <0.05 was considered statistically significant.

Results

A total of 14 760 cases were included in this study and the sex distributions were 2023/2877, 1984/2936, and 2631/2289 of male/female in 2011, 2012, and 2013, respectively. The average ages of studied case in 2011, 2012, and 2013 were 48±13.5, 46±14.1, and 47±16.3, respectively. There was no significant difference in the number, sex distribution, or age between the 3 years.

Antibiotic use in all hospitals

The percentage of antibiotic use in inpatient cases from all hospitals was controlled within 60.00%, as required, and was

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Table 1. Antibiotic use in all general hospitals from 2011–2013.

	April 2011	April 2012	April 2013	*F* value	*p*
Percentage of antibiotic use by inpatients (%)	60.38	52.25*	46.88*	50.226#	0.000#
AUD of inpatients (DDD/100 patient days)	51.60	37.75*	35.37*	27.838#	0.000#
Proportion of prophylactic antibiotic application for type I incision operation (%)	86.67	32.1*	25.08*	51.148#	0.000#
Compliance rate of antibiotic prophylactic use 0.5–2.0 h before type I incision operation	86.38	100.00*	100.00*	63.345#	0.003#
Compliance rate with antibiotic prophylactic use for ≤24 h in patients receiving type I incision operations (%)	40.30	87.50*	96.37*	15.527#	0.000#

# Indicates statistical analysis results from 2011–2013; * indicates a statistically significant difference compared with the results of 2011 ($p<0.05$).

Table 2. Antibiotic use in tertiary hospitals during 2011–2013.

	April 2011	April 2012	April 2013	*F* value	*p*
Percentage of antibiotic use by inpatients (%)	60.25	51.83	48.44*	28.041#	0.000#
AUD of inpatients (DDD/100 patient days)	56.07	36.45*	34.50*	19.027#	0.000#
Proportion of prophylactic antibiotic application for type I incision operation (%)	69.40	28.90*	24.45*	50.489#	0.000#
Compliance rate of antibiotic prophylactic use 0.5–2.0 h before type I incision operation	85.70	100.00*	100.00*	11.001#	0.000#
Compliance rate of antibiotic prophylactic use for ≤24 h in patients receiving type I incision operations (%)	50.00	93.21*	97.00*	16.981#	0.000#

# Indicates statistical analysis results from 2011–2013; * indicates a statistically significant difference compared with the results of 2011 ($p<0.05$).

reduced gradually from 60.38% to 46.88% from April 2011 to April 2013. AUD was improved annually and decreased from 51.60 to 35.37 DDDs, meeting the requirement of AUD <40 DDDs. The proportion of prophylactic antibiotic applications for type I incision procedures was reduced from 86.67% to 25.08%, not exceeding 30.00%, as specified by governmental guidelines on antibiotic use. The percentage of antibiotic prophylaxis 0.5–2 h before surgery (except for Cesarean section) was increased from 86.38% to 100%. The compliance rate of antibiotic prophylaxis for ≤24 h in patients undergoing type I surgical incision operations significantly increased from 40.30% to 96.37% ($p<0.05$) (Table 1).

Antibiotic use in tertiary hospitals

The percentage of antibiotic use by inpatients and AUD in tertiary hospitals was reduced from 60.25% to 48.44% and from 56.07 DDDs to 34.50 DDDs, respectively. The proportion of prophylactic antibiotic applications for type I incision operations decreased from 86.67% to 25.08%. The percentage of antibiotic prophylaxis 0.5–2 h before surgery (except for Cesarean section) increased from 85.70% to 100%. The compliance rate of antibiotic prophylactic use for ≤24 h in patients with type I incision surgeries in all general hospitals significantly increased from 50.00% to 97% ($p<0.05$) (Table 2).

Antibiotic use in secondary hospitals

The percentages of antibiotic use by inpatients and AUD were reduced from 61.27% to 44.84% and from 49.18 DDDs to 35.90 DDDs, respectively. The proportion of prophylactic antibiotic application for type I incision operations decreased from 100% to 28.86%. The percentage of antibiotic prophylaxis 0.5–2 h before surgery (except for Cesarean section) increased from 98.84% to 100%. The compliance rate of antibiotic prophylactic use for ≤24 h in patients with type I incision surgeries improved from 50.00% to 97%. All these changes were statistically significant ($p<0.05$), except for the change in the timing

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

Table 3. Antibiotic use in secondary hospitals from 2011–2013.

	April 2011	April 2012	April 2013	*F* value	*p*
Percentage of antibiotic use by inpatients (%)	61.27	53.15*	44.84*	27.268#	0.000#
AUD of inpatients (DDD/100 patient days)	49.18	40.65	35.90*	10.235#	0.000#
Proportion of prophylactic antibiotic application for type I incision operation (%)	100.00	67.90*	28.86*	20.303#	0.000#
Compliance rate of antibiotic prophylactic use 0.5–2.0 h before type I incision operation	98.84	100.00	100.00	1.483#	0.246#
Compliance rate of antibiotic prophylactic use for ≤24 h in patients receiving type I incision operations (%)	36.00	74.14	95.00*	4.332#	0.024#

# Indicates statistical analysis results from 2011–2013; * indicates a statistically significant difference compared with the results of 2011 ($p < 0.05$).

of antibiotic prophylaxis in patients receiving type I incision operations (Table 3).

Discussion

Antibiotic resistance is not a newly emerging issue, yet it has become increasingly threatening. Although antibiotic resistance is a phenomenon that occurs during the natural developmental process, irrational antibiotic use can accelerate the emergence of antibiotic resistance. Education and clinical management in antibiotics use have become strong measures to control bacterial resistance globally through controlling and monitoring the prescription and pre-authorization of antibiotics use [14–16]. Causal analysis of irrational antibiotic use was performed by the Chinese government, and significant improvement has been made through specific rectification of antibiotic use. As a result, all indicators for antibiotic use showed a decreasing trend, with the compliance rate of rational antibiotic use increasing annually.

Inappropriate antibiotic selection by doctors and misunderstanding of drug indications has influenced the misuse of antibiotics to treat viral infections rather than bacterial infections. A national prevalence survey about hospital infection and antibiotics using in Britain pointed out the general antibiotic use rate was 34.7%; the intensive care unit has the highest antibiotic use rate of 60.8%, and the use of antibiotics in surgery was about 36% [17]. Studies have shown that more than 50% of the antibiotic was used unreasonably [18]; the unseasonable using results in the rise of antibiotic resistance, prolonged hospitalization, and increased medical expenses. Mexico and Brazil use promulgation of policy to restrict antibiotic sales; the restriction on antibiotics use has an influence on the use of nonsteroidal anti-inflammatory drugs and analgesics drugs [19]. In addition, an intervention study [20] showed the education and training of pharmacists can promote the rational use of vancomycin in intensive care units (ICUs). Unreasonable antibiotic use can be controlled through education and training of clinicians, clinical pharmacists, and nurses.

Medical staff knowledge of antibiotics needs to be further improved [21–23]. Moreover, antibiotics were prescribed based on experiences rather than pathogenic laboratory examination, indicated by the low rate of such analyses [24]. Some antibiotics were prescribed as desired by patients and their families to avoid doctor-patient disputes [25,26]. Furthermore, misunderstandings occurred with respect to public knowledge of antibiotic use, including the misinterpretation of antibiotics as the equivalent of anti-inflammatory agents. Some misunderstood the concept of antibiotics, exaggerating their efficacy and abusing them via direct purchase over-the-counter at drug stores. The "2010 Survey on Household Medications in China" showed that 79.4% of residents had a habit of stocking antibiotics, and 75.4% of residents medicated themselves or family members for the treatment of inflammation, cold, or fever [27].

Antibiotic use in each department was improved through a specialized comprehensive management program. Training on rational antibiotic use was enhanced to strictly control drug indication and administration, and to determine the frequency of antibiotic use based on pharmacokinetic features, following the principle of "minimum effective dose and shortest treatment course". Antibiotic use was guided by the results of bacterial culture and drug susceptibility testing. Scientific, efficient, pragmatic, and advanced management of antibiotic use was accomplished through implementation of a long-term scientific and comprehensive management system. Based on information technology, this system monitored nosocomial infections and outbreaks in general hospitals via clinical antibiotic use and resistance surveillance networks. Combined with a computer-assisted electronic prescription system, this

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

strategy achieved highly efficient, scientific, and pragmatic management of antibiotic use, reducing the length of hospital stays, decreasing the misuse of healthcare resources, and delaying antibiotic resistance [28–31].

The results of antibiotic resistance monitoring before and after ASP revealed that the resistance of *Pseudomonas aeruginosa* to carbapenem and to meropenem continuously declined in both tertiary and secondary hospitals from 2010–2012, the latter decreasing from 23.01% to 15.75%. Drug resistance of *Acinetobacter baumannii* decreased, as evidenced by the reduction of meropenem resistance from 26.16% to 14.04%. Since the implementation of the ASP campaign, antibiotic resistance of *Acinetobacter baumannii* has declined, as represented by a significant 25–30% reduction in β-lactam resistance, and resistance reductions for fluoroquinolone and aminoglycoside of 50% to 20–30%, consistent with the results reported by another domestic study [32]. The overall resistance of *Pseudomonas aeruginosa* decreased for meropenem (38.9% to 11.2%), ciprofloxacin (26.5% to 12.4%), and imipenem (41.5% to 22%) over the period of study [33].

Since the initiation of the ASP campaign in April 2011 in Tianjin, rational antibiotic use has been improved by establishing prescription assessment systems. Antibiotic costs were reduced by 122 million RMB in 2013, and cumulatively by 786 million RMB over the course of the 3-year study. The current goal of rational antibiotic use was largely achieved in urban areas. Significant improvements were made in all regions through collaborative efforts and controls from health administrative departments, professional societies, disease control centers, medical institutions, and insurance sectors [34–36].

There are some limitations in this study. It was targeted at overall antibiotic use in general hospitals without detailed exploration of antibiotic use in specialized fields, such as internal medicine, surgery, obstetrics and gynecology, pediatrics, and intensive care [37,38]. However, based on the developing trend of the ASP campaign, relatively satisfactory outcomes have been accomplished in the management of antibiotic use in China.

Conclusions

Antibiotic use management is a complicated issue and a long-term challenge. Significant improvements have been achieved in antibiotic use in Tianjin through the ASP campaign, although continuous efforts are required to consolidate and enhance these improvements for normalizing rational antibiotic use in our future work.

Acknowledgements

The authors thank Professor Shi-duo Song and Dr. Wei Liu for their excellent work.

Conflict of interests

The authors declare that they have no competing interests.

References:

1. Cars O, Molstad S, Melander A: Variation in antibiotic use in the European Union. Lancet, 2001; 357: 1851–53
2. Laxminarayan R, Duse A, Wattal C et al: Antibiotic resistance-the need for global solutions. Lancet Infect Dis, 2013; 13: 1057–98
3. Maciulaitis R, Janusonis T, Petrikaite V, Aukstakalniene A: [Assessment of antibiotic use and comparison with recommendations for their rational use]. Medicina (Kaunas), 2006; 42: 999–1005
4. Yin X, Song F, Gong Y et al: A systematic review of antibiotic utilization in China. J Antimicrob Chemother, 2013; 68: 2445–52
5. Hvistendahl M: Public health. China takes aim at rampant antibiotic resistance. Science, 2012; 336: 795
6. Guang-ren L: Exploration of the management of antibiotics use in the clinic. China Pharmacy, 2011; 26: 2406–8
7. Ministry of Health PsRoC. Administrative regulations for clinical use of antibacterial agents
8. Ministry of Health PsRoC. The guiding principles for Clinical use of antibacterial drugs
9. Ministry of Health PsRoC. Notification for the special campaign of antibiotics rational use in hospitals
10. China NHaFPCotPsRo. Further to carry out the national special clinical application of antibacterial drugs
11. Catherine Offutt CC. The PDCA model: A basic evaluation tool. Proceedings of Society for Information Technology & Teacher Education International Conference, 2002; 78–79
12. Wu Y LS: [The application of PDCA management model in electronic medical records system.] Chinese Journal of Health Informatics and Management, 2012; 9: 75–79 [in Chinese]
13. Harris AD, Bradham DD, Baumgarten M et al: The use and interpretation of quasi-experimental studies in infectious diseases. Clin Infect Dis, 2004; 38: 1586–91
14. Akpan MR, Ahmad R, Shebl NA, Ashiru-Oredope D: A review of quality measures for assessing the impact of Antimicrobial Stewardship Programs in Hospitals. Antibiotics (Basel), 2016; 5(1): pii: E5
15. Yoon YK, Park GC, An H et al: Trends of antibiotic consumption in Korea according to national reimbursement data (2008–2012): A population-based epidemiologic study. Medicine (Baltimore), 2015; 94: e2100
16. Liu X, Liang J, Zao J et al: Vacuum sealing drainage treatment combined with antibiotic-impregnated bone cement for treatment of soft tissue defects and infection. Med Sci Monit, 2016; 22: 1959–65
17. Report EPHaA. English National Point Prevalence Survey on Healthcare-associated Infections and Antimicrobial Use, 2011 *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/331871/English_National_Point_Prevalence_Survey_on_Healthcare_associated_Infections_and_Antimicrobial_Use_2011.pdf* 2011
18. Davey P, Brown E, Charani E et al: Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev, 2013; 2013: CD003543
19. Santa-Ana-Tellez Y, Mantel-Teeuwisse AK, Leufkens HG, Wirtz VJ: Effects of over-the-counter sales restriction of antibiotics on substitution with medicines for symptoms relief of cold in Mexico and Brazil: Time series analysis. Health Policy Plan, 2016 [Epub ahead of print]

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]

20. Tavakoli-Ardakani M, Ghassemi S, Alizadeh AM et al: Effects of pharmacist intervention on the utilization of vancomycin in a teaching hospital. Iran J Pharm Res, 2015; 14: 1281–88
21. Xiao-ping L: Analysis and suggestion to antibiotics abuse. Medicine and Philosophy, 2005; 12: 20–24
22. Hu Yan BJ, Hu Xianming: [Exploring on the status, reasons and countermeasures of antibiotics abuse.] Chinese Journal of Social Medicine, 2013; 30: 128–30 [in Chinese]
23. Reynolds L, McKee M: Factors influencing antibiotic prescribing in China: An exploratory analysis. Health Policy, 2009; 90: 32–36
24. Sujuan Y: [Current situation analysis and countermeasures of irrational use of antibiotics.] Chinese Journal of Modern Applied Pharmacy, 2000; 17: 498–500
25. Li Wei-qing YQ-r, Chen Yi-wei: Antimicrobial drugs application in Type I and Type II operations during perioperative period: Survey and analysis. Chin J Nosocomiol, 2008; 18: 407–9
26. Jin-ai Q, Juan H, Chun-fang H, Yun Z: [Intervention and effect of prophylactic use of antibiotics during perioperative period of cleaning incision surgery.] Chin J Nosocomiol, 2011; 21: 2562–64 [in Chinese]
27. Bi P, Tong S, Parton KA: Family self-medication and antibiotics abuse for children and juveniles in a Chinese city. Soc Sci Med, 2000; 50: 1445–50
28. Li-hui M, Jia Z: [Antibiotics usage management model by information system.] Chin J Nosocomiol, 2009; 19: 1422–24 [in Chinese]
29. Su HC LY, Zhang H, Lin JH, Lin Q: [Information management of clinical rational use of antimicrobial agents.] Chinese Journal of Hospital Pharmacy, 2013; 407–8 [in Chinese]
30. Ling L, Bo Y, Fang H: [Application practice of information management system about rational use of antibacterial drugs in the management of antibacterial drugs.] China Pharmacy, 2013; 24: 1545–47 [in Chinese]
31. Li JS, Zhang XG, Wang HQ et al: The meaningful use of EMR in Chinese hospitals: A case study on curbing antibiotic abuse. J Med Syst, 2013; 37: 9937
32. Xu NZ , Wang ZJ: [Study on drug resistance of *Acinetobacter baumannii* before and after special antibacterial drugs remediation.] Journal of Pharmaceutical Practice, 2014; 32: 203–5 [in Chinese]
33. Li SY, Duan JJ: [Comparison of resistance rate of *Pseudomonas aeruginosa* in a hospital after specific rectification of antibiotics during 2010–2012.] China Pharmacy, 2013; 24: 3978–80 [in Chinese]
34. Yao L, Li-ping Y: [Analysis of the practice of antimicrobial agents in our hospital before and after the special rectification of antimicrobial drug use.] Drug Evaluation 2013; 10 [in Chinese]
35. Yao BH: [Special rectification activities on antibiotic use in 2011 and 2012 in a Hospital: A comparative analysis.] Evaluation and Analysis of Drug-Use in Hospitals of China, 2014; 14: 36–39 [in Chinese]
36. Luo EJ HL, Hong YL: [Effect of special rectification activities on clinical application of antibiotics.] Chin J Nosocomomiol, 2012; 22: 3130–31 [in Chinese]
37. Zou XX, Fang Z, Min R et al: Is nationwide special campaign on antibiotic stewardship program effective on ameliorating irrational antibiotic use in China? Study on the antibiotic use of specialized hospitals in China in 2011–2012. J Huazhong Univ Sci Technolog Med Sci, 2014; 34: 456–63
38. Hou D, Wang Q, Jiang C et al: Evaluation of the short-term effects of antimicrobial stewardship in the intensive care unit at a tertiary hospital in China. PLoS One, 2014; 9: e101447

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS] [Index Copernicus]