

Utilization of clinical practice guideline on antimicrobial and its determinants in China: A multilevel analysis

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Research article

Keywords: Clinical practice guideline, Antimicrobial, Multilevel analysis, China

Posted Date: February 26th, 2020

DOI: <https://doi.org/10.21203/rs.2.24574/v1>

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Version of Record: A version of this preprint was published at BMC Health Services Research on April 6th, 2020. See the published version at <https://doi.org/10.1186/s12913-020-05171-z>.

Abstract

Background: Nowadays, irrational use of antimicrobials has threatened public health. It's necessary to expanding the use of clinical practice guideline (CPG) on antimicrobial for facilitating the proper use of antimicrobial. However, the utilization status of CPG on antimicrobial and the influencing factors are largely unknown.

Methods: A cross-sectional survey was conducted, using a structured questionnaire, on a sample among physicians from 16 public hospitals in eastern, central and western part of China. A multilevel regression model was employed to examine factors associated with physicians' utilization of CPG on antimicrobial.

Results: A total of 815 physicians included in this study. About eighty percent of the surveyed physicians reported their strict adherence to the CPG on antimicrobial. Dimensions of "subjective norm", "perceived risk" and "behavioral intention" from the domain of physician belief, dimension of "ease of use" from the domain of CPG traits, and dimensions of "top management support" and "organization & implementation" from the domain of hospital practice were significantly associated with physicians' utilization of CPG on antimicrobial. And most demographics of physician were not found to be significantly related to the CPG use. In addition, results showed region is a significant factor affecting physicians' CPG use.

Conclusions: This study depicted the current status of CPG on antimicrobial and comprehensively identified its potential determinants not only from the three domains, such as physician belief, at the individual level, but also from the location region at the organizational level. The results will provide direct reference on implementation of CPG on antimicrobial and will be generalizable to the setting of health care system.

Background

Antimicrobial have left its own marks on the history of medical treatment, owing to effectively lowering the morbidity and mortality from infectious diseases [1]. Nowadays, however, the rise in the prevalence of irrational use of antimicrobial has weakened its original effectiveness and contributed to growing resistance that will undermine our ability to fight infections with varying degrees [2], or even worse.

As one of the world's largest consumers of antimicrobial for human health [3], China has witnessed some of the most severe crisis brought on by the antimicrobial resistance (AMR). To address AMR, various measures have been taken by China's health authorities, with varying degrees of success [4]. Clinical practice guideline (CPG) is recommendation for physicians based on best evidence, which do play a significant role in standardizing clinical treatment and improving the outcomes of medical services [5]. Although the CPG have been shown to be effective and Guiding Principles for Clinical Application of Antimicrobial have launched in 2015, it still remains largely unknown whether regulation implementation, nature of guidance with mandatory or other reasons make any difference to adherence to CPG on antimicrobial, which has made a barrier to expanding the CPG implementation.

Calling for effective interventions for promoting utilization of guidelines depends on a clear understanding of the determinants of guideline use. However, current researches usually focus on the factors within the domain of medical staff or the general public, especially their knowledge, attitude, and practice (KAP) on antimicrobial and its prescribing behavior [6-10], few studies have involved the potential factors within other domains, such as the organizational impact, CPG traits and so on. To bridge this knowledge gap caused by focusing on single domain, this study will comprehensively include sets of potential influencing factors from the domains of physician, hospital and CPG itself, and seek to investigate determinants associated with utilization of CPG on antimicrobial at different domains. These results are intended to play an important role when it comes to tailor interventions about advancing utilization of CPG on antimicrobial.

Methods

Study design

As China is a vast country with huge regional diversity at socioeconomic development, we conducted a cross-sectional questionnaire study using a multistage sampling method. In the first stage, provinces of Fujian, Hubei, Yunnan & Sichuan were selected on behalf of eastern, central and western regions of China, respectively. Secondly, 5~6 general hospitals (including tertiary and secondary hospitals) were selected from each of the selected region. Lastly, in each selected hospital, 16~20 physicians of tertiary hospitals and 10~15 physicians of secondary hospitals were randomly sampled from major departments of internal medicine and surgery, respectively. And 3~5 physicians of tertiary hospitals were randomly sampled from the other four sorts of departments as gynecology and obstetrics, ophthalmology and otorhinolaryngology, orthopedics, and others, respectively. While in each sampled secondary hospital, about 10 physicians were randomly selected from these four departments in total. Thus, 50~60 physicians from each tertiary hospital and 30~40 physicians from each secondary hospital were invited to participate in the survey.

Questionnaire

The questionnaire was developed on the basis of the literature review [11-24] and revised by experts in the fields of clinical medicine, health management, and epidemiology and health statistics. The structured questionnaire consisted of three parts 33 items. Part 1 covered 24 items 8 dimensions from 3 domains: physician belief (including dimensions of "attitude", "subjective norm", "perceived risk", "behavioral intention"), CPG traits (including dimensions of "relative advantage", "ease of use"), and hospital practice (including dimensions of "top management support", "organization & implementation"). Part 2 covered 3 items to measure physicians' utilization of CPG on antimicrobial. Part 3 was a personal information card consisted of 6 items, including several basic characteristics of participants as gender, age, education,

professional title, department and years of practice. Questions in part 1 and part 2 were measured using a five-point Likert scale, where 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly agree. The questionnaire showed satisfactory reliability with Cronbach's α of each dimensions and the whole questionnaire above the recommended threshold of 0.7 [25].

Data Collection

Data collected from April 2018 and lasted nearly one year. With the support of sampled hospitals, each round for filling out the questionnaire was accompanied by trained facilitators to introduce the study purpose, ensuring participants' understanding of this study and what to do. All responses were anonymous, but participants were invited to submit their contact information voluntarily if they were interested in the study and wanted to keep informed of the results.

Analysis

Descriptive statistics were performed to depict characteristics of physicians and hospitals. Each dimension scores were calculated as the mean item scores per dimension. Spearman Rank correlation was used to assess the relationships between socio-demographic characteristics and utilization of CPG on antimicrobial, Pearson correlation was used to assess the relationships between each dimension and utilization of CPG on antimicrobial. In addition, given the hierarchical nature of the data [26], multilevel linear regression model (SAS University Edition) was performed to identify the association between demographic characteristics, organizational characteristics, and dimension scores from three domains (independent variables) and utilization of CPG on antimicrobial (dependent variable). The rationale for using the multilevel approach in relation to the clustering effect is that physicians (individual level) in the same hospital (organizational level) tend to be more alike in their personal belief or perceptions of CPG use, as well as their assessments on CPG traits or hospital practice in promoting CPG use and real CPG utilization. Thus, multilevel approach would be more robust in determining whether factors at the organizational level or at the individual level are statistically significant. Statistical significance was set at $P < 0.05$.

Results

Participants A total of 815 physicians from 16 general hospitals were included in this study. The characteristics of the participants and the hospitals are presented in Table 1. Over half of the respondents were males ($n=459$). Most of respondents were under 45 years old ($n=728$). About 90% reported having bachelor degree or above ($n=802$). Of respondents, 37.18% were from internal medicine and 34.97% were from surgery department. Regarding hospital characteristics, the samples consisted of 12 tertiary hospitals and 4 secondary hospitals. And 6 hospitals were in the eastern, 5 in the central and 5 in the western of China. **Current Status of Utilization of CPG on Antimicrobial** The utilization of CPG on antimicrobial was assessed by three items, which had average scores of 3.95 ± 0.62 , with 1 being the

minimum scores and 5 being the maximum scores. Of the statements “In the past year, I have strictly followed the CPG on antimicrobial in practice”, 81.23% (n=662) of physicians agreed about this statement, 16.69% (n=136) were in neutral, and 2.09% (n=17) against it. Eighty percent of physicians (n=652) reported their agreement on the item “In the past year, I have actively participated in the study or training of CPG on antimicrobial”, 18.04% (n=147) declared their neutrality, and 1.96% (n=16) have an objection to it. Regarding the statement of “In the past year, I have actively recommended the CPG on antimicrobial to colleagues”, 71.90% (n=586) of physicians reported they have recommended the CPG on antimicrobial to other medical staff, 25.89% (n=211) showed their neutrality, and 2.21% (n=18) were opposite to this statement.

Perceptions and Beliefs towards the Utilization of CPG on Antimicrobial Physicians’ perceptions and beliefs towards the utilization of CPG on antimicrobial consist of four dimensions, namely attitude, subjective norm, perceived risk and behavioral intention. The mean score for each dimension was 4.29 ± 0.56 , 4.15 ± 0.61 , 2.24 ± 0.85 , 4.13 ± 0.56 , respectively (see Table 2) (see page 21). Most physicians reported that following the CPG on antimicrobial in clinical practice is a right thing (91.66%, n=747), a wise choice (90.43%, n=737) and good for all (93.99%, n=766). Similarly, most physicians reported that people who were important to them are tended to follow CPG on antimicrobial (86.38%, n=704), had a positive evaluation of CPG on antimicrobial (88.10%, n=718), thought it’s a right thing to use CPG on antimicrobial (89.82%, n=732). The proportion of physicians who were afraid the grasp of CPG on antimicrobial would take their extra time, afraid prescribing via CPG on antimicrobial would reduce revenue and efficiency, was 19.75% (n=161), 9.20% (n=75), 12.15% (n=99), respectively. And regarding behavioral intention, majority of physicians said they are willing to use CPG on antimicrobial (92.39%, n=753), recommend it to other doctors (86.63%, n=706), follow CPG on antimicrobial in the future (87.24%, n=711), respectively.

Traits of the CPG on Antimicrobial The traits of the CPG on antimicrobial were measured by two dimensions as relative advantage and ease of use. The mean value for each dimension was 3.95 ± 0.68 and 3.86 ± 0.65 , respectively. With respect to the dimension of relative advantage, the items “reducing medical costs”, “improving prescribing efficiency” and “contributing to better clinical outcomes” was appreciated by 71.66% (n=584), 76.93% (n=627) and 78.65% (n=641) of physicians, respectively. And there are also about a fifth of physicians reported their neutral stance on these items. Concerning dimension of ease of use, 75.21% (n=613) deemed their incapability in mastering the knowledge of CPG on antimicrobial in a short time. After grasping the CPG on antimicrobial, 80.61% (n=657) of the physicians perceived that they can quickly put it into practice, while 69.33% (n=565) of them had a view that the CPG is simple and easy to use.

Hospital Practice in Promoting the Utilization of CPG on Antimicrobial The dimensions of “top management support” and “organization & implementation” were applied to depict the hospital practice in promoting the utilization of CPG on antimicrobial. The average score for each dimension was 3.99 ± 0.63 and 4.01 ± 0.64 , respectively (see Table 2). Concerning the dimension of “top management support”, 83.07% (n=677) and 84.05% (n=685) of the physicians agreed on the statements of “Administrators promote the widely use of CPG on antimicrobial in various departments” and “Administrators attach great importance to the promotion of CPG on antimicrobial”, respectively. And three quarters of physicians thought the administrators of the hospital had provided supports in training, funding and other aspects. Similar situation also exists in the dimension of “organization & implementation”. About four fifths of physicians

reported acknowledgements that the hospitals have provided information about CPG on antimicrobial (81.10%, n=661), held regular feedback on the CPG use (80.49%, n=656), and performed daily inspection, supervision and evaluation (85.03%, n=693), respectively. Correlations to utilisation of CPG on antimicrobial The result of correlation analysis (Table 3) show physicians' utilisations of CPG on antimicrobial was significant correlated ($P<0.001$) with eight dimensions of attitude, subjective norm, perceived risk, behavioural intention, relative advantage, ease of use, top management support and organisation & implementation, respectively. In addition, with regard to demographic characteristics, it also showed that age, professional title, years in practice and region have significant association with physicians' utilisations of CPG on antimicrobial. Multilevel Linear Regression Analysis Table 4 presents the two-level linear regression results of the utilization of CPG on antimicrobial. At the individual level, the utilization of CPG on antimicrobial was significantly associated with subjective norm ($P<0.001$), perceived risk ($P=0.016$), behavioral intention ($P<0.001$) at the domain of physician beliefs, ease of use ($P<0.001$) at the domain of CPG traits, and top management support ($P<0.001$), organization & implementation ($P<0.001$) at the domain of hospital practice. Additionally, with regard to the demographic characteristics, physicians who worked at department of ophthalmology and otorhinolaryngology versus other department was associated with 16% reduction in utilization behavior of CPG on antimicrobial; interestingly, no other significant differences were detected. As for the organizational level, the multilevel regression analysis showed the hospital in the region of eastern significantly decreased the utilization of CPG on antimicrobial ($P=0.001$).

Discussion

Since there was a dearth of literature on utilization of CPG on antimicrobial' utilization and its potential determinants, this study described the current status of regarding CPG utilization and comprehensively identified its potential influencing factors from the domains of physician belief, CPG traits and hospital practice. The results of this study will not only provide direct guidance on implementation of CPG on antimicrobial, but also add the research knowledge and evidence on CPG use, and further provide beneficial reference for expanding CPG impact.

As demonstrated in this study, about eighty percent of the surveyed physicians reported their strict adherence to the CPG on antimicrobial and active participant in regarding training, and more than seventy percent of the participants have recommended the CPG on antimicrobial to their colleagues. These result indicated fairly high utilization level of CPG on antimicrobial. Many physicians had implemented the CPG in their work and actively took their efforts to expand the CPG use.

With respect to the determinants identification, dimensions of "subjective norm", "perceived risk" and "behavioral intention" from the domain of physician belief, dimension of "ease of use" from the domain of CPG traits, and dimensions of "top management support" and "organization & implementation" from the domain of hospital practice showed significant association with physicians' CPG use. And physicians who worked in different department have significant effects on their utilization of CPG on antimicrobial, while other demographic characteristics of physician were not found to be significantly related to the CPG

use. Besides, for the potential influencing factors of the hospital characteristics, region is a significant factor affecting physicians' CPG use as physicians in the eastern region had a lower utilization of CPG on antimicrobial. However, association between hospital rank and the CPG use was not found.

In consistence with many previous studies, this result also highlights the importance of organizational implementation and management support [17,27,28]. With regard to promoting the use of CPG on antimicrobials, the "organization & implementation" activities (routine information collection, inspection, supervision, evaluation, feedback, etc.) will greatly benefit shaping expected behavior and norms of the medical staff. And the concrete support (information, education, funds, personnel, etc.) from hospital administrators also expects to play a positive role in leading a smooth process of CPG uptake. Besides, having been deemed as powerful predictors in former studies, many factors on physician belief also demonstrated their significant effect on the use of CPG on antimicrobial in this research. Such as subjective norm, a kind of perceived norm and pressure from influential persons, it is unsurprisingly for its significant association with CPG use detected in this study. Especially in the setting of public hospitals with a clear hierarchical system [29], it seems inevitable for the individual to subject to invisible pressure from all around like colleagues or superiors, and comply with perceived norms and orders [30], such as strictly adherence to the CPG or greatly emphasis on physician autonomy. This point is also mutually verified with the previous content that significant impact of organizational activities on CPG use. Additionally to the hospital practice and physician belief, the impact of CPG traits on CPG use also can't be ignored. This study also reveals that physicians tend to adopt the CPG easy to master and use. To avoid taking the first-line physicians too much time and effort to learn CPG and put it into practice, it will be wise to concise the CPG on antimicrobials as much as possible. And some brief explanations to the key points will be probably appreciated and further benefit the expanding use of CPG.

However, in contrary with previous researches [20,31], significant effects of attitude and relative advantage were not detected in this study. The plausible reason may be that many physicians are required to follow CPG on antimicrobial by their organization whatever their subjective attitude or assessment towards certain guideline [19]. Anyone who disobeys CPG will confront with great pressure from their organization [29]. This finding also further confirmed the impact of subjective norm and perceived risk. Additionally, there are also other contraries to former papers that younger physicians or with fewer years' experience tended to be more likely to use guidelines [32,33]. Such difference may be resorted to the situation that physicians in East Asia be easily "institutionalized" when they first enrolled in the working hospital. These results also imply the great importance of organizational impact, which also explained the phenomena reported in the current studies that physicians working in different departments demonstrated great differences in compliance with CPG [34].

Generally speaking, the results of this study will not only guide the real practice of promoting the use of CPG on antimicrobials, but also intend to provide clues or inspirations for future research. In additional to its significance, this study is also strengthened by some features. On the one hand, with representation from 16 hospitals in eastern, central and western parts of the nation, the important facilitators and barriers to utilization of CPG on antimicrobial determined in this study will be generalizable to the setting

of health care system in China. As the largest developing country with the largest population, China's experience in promoting the use of CPG on antimicrobials will provide helpful reference for other countries, especially the most developing countries in the world. On the other hand, considering cluster bias, multilevel analysis model is applied in the data analysis, which will be more robust in investigating the potential influencing factors from different levels. However, there are still some limitations of this study. First of all, owing to the social desirability bias [35], the participants of this study may be unwilling to voice negative assessment about themselves and the hospitals, which may directly lead to overestimation of the attitude, belief, intention and utilization of CPG on antimicrobial. Secondly, clustering effects were found at the organizational (hospital) level, while the number of selected tertiary and secondary hospitals was not balanced well. Although rankings of the hospitals did not show its significance, it still cannot eliminate the effects caused by the rankings. Thirdly, this study is also limited by collecting cross-sectional data at a single point-in-time to determine the influencing factors, it may be more prudent to investigate the causality by panel session data or so on in future research.

Conclusions

This study depicted the current status of CPG on antimicrobial and comprehensively identified its potential determinants not only from the three domains, such as physician belief, at the individual level, but also from the location region at the organizational level. The results will provide direct reference on implementation of CPG on antimicrobial and will be generalizable to the setting of health care system.

Abbreviations

CPG: Clinical practice guideline

AMR: antimicrobial resistance

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the medical ethics committee, Fujian Medical University, China. Written informed consent was obtained from all study participants.

Consent to publish

Not applicable.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research was supported by National Natural Science Foundation of China (Grant Number: 71704026) and the Soft Science Project of Fujian Provincial Department of Science and Technology (Grant number: 2017R0044). And the funders had no involvement in study design, data collection, statistical analysis and manuscript writing.

Authors' Contributions

LW designed and conducted the project, contributed to grasp the subject and revised the manuscript. DQ carried out the data analysis and drafted the manuscript. LW and DQ developed the questionnaire. All authors read and approved the manuscript before submission.

Acknowledgments

We acknowledge the support of each hospital for their involvement in this study, as well as all facilitators who contributed to coordination in the site. We also like to thank all physicians who agreed to the participation.

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Tables

Table 1 Characteristics of the sample physicians and hospitals

Characteristic	Frequency	Percentage (%)
Physician characteristics (n=815)		
Gender		
Male	459	56.32
Female	356	43.68
Age		
<35 years old	432	53.01
35~44 years old	296	36.32
≥45 years old	87	10.67
Education		
Junior college or below	13	1.60
Bachelor	345	42.33
Master	379	46.50
Doctor	78	9.57
Professional Title		
Junior	304	37.30
Intermediate	310	38.04
Senior	201	24.66
Department		
Internal medicine	303	37.18
Surgery	285	34.97
Gynecology and obstetrics	73	8.96
Ophthalmology and otorhinolaryngology	73	8.96
Other	81	9.94
Years in Practice		
<5 years	254	31.17
5~10 years	241	29.57
11~15 years	227	27.85
16~20 years	83	10.18
>20 years	10	1.23
Hospital characteristics (n=16)		
Ranking		
Tertiary	12	75.00
Secondary	4	25.00
Region		
Eastern	6	37.50
Central	5	31.25
Western	5	31.25

Table 2 Scores for each dimension

Domain	Dimension	Mean	S.D.
Physician belief	Attitude	4.29	0.56
	Subjective norm	4.15	0.61
	Perceived risk	2.24	0.85
	Behavioral intention	4.13	0.56
CPG traits	Relative advantage	3.95	0.68
	Ease of use	3.86	0.65
Hospital practice	Top management support	3.99	0.63
	Organization & Implementation	4.01	0.64

Table 3 Factors correlated to utilization of CPG on antimicrobial

Characteristic	Correlation coefficient	P value
Individual level		
<i>Domain: Physician belief</i>		
Attitude	0.472	<0.001
Subjective Norm	0.535	<0.001
Perceived Risk	-0.322	<0.001
Behavioral Intention	0.644	<0.001
<i>Domain: CPG traits</i>		
Relative Advantage	0.568	<0.001
Ease of use	0.543	<0.001
<i>Domain: Hospital practice</i>		
Top management support	0.601	<0.001
Organization & Implementation	0.568	<0.001
<i>Demographics characteristics</i>		
Gender	0.024	0.497
Age	0.084	0.016
Education	-0.034	0.332
Professional Title	0.051	0.143
Department	-0.013	0.709
Years in Practice	0.081	0.021
Organizational level		
Hospital Rank	-0.020	0.565
Region	0.174	<0.001

Table 4 Multilevel linear regression of the utilization of CPG on antimicrobial

Variables	Coefficient (95% CI)	P value
Individual level		
<i>Domain: Physician belief</i>		
Attitude	-0.019 (-0.090~0.052)	0.603
Subjective norm	0.160 (0.097~0.223)	<0.001
Perceived risk	-0.046 (-0.082~-0.009)	0.014
Behavioral intention	0.298 (0.222~0.373)	<0.001
<i>Domain: CPG traits</i>		
Relative advantage	0.038 (-0.025~0.101)	0.239
Ease of use	0.124 (0.066~0.182)	<0.001
<i>Domain: Hospital practice</i>		
Top management support	0.150 (0.082~0.217)	<0.001
Organization & Implementation	0.164 (0.102~0.227)	<0.001
<i>Demographic characteristics</i>		
Gender (Ref: Female)		
Male	0.031 (-0.033~0.096)	0.335
Age (Ref: ≥45 years old)		
<35 years old	0.018 (-0.177~0.212)	0.856
35~44 years old	0.094 (-0.078~0.266)	0.282
Education (Ref: Doctor)		
Junior college or below	0.074 (-0.193~0.332)	0.580
Bachelor	0.021 (-0.098~0.130)	0.725
Master	0.022 (-0.084~0.120)	0.672
Professional Title (Ref: Senior)		
Junior	-0.049 (-0.185~0.086)	0.474
Intermediate	-0.020 (-0.116~0.077)	0.686
Department (Ref: Other)		
Internal medicine	-0.005 (-0.108~0.097)	0.921
Surgery	-0.015 (-0.120~0.090)	0.772
Gynaecology and obstetrics	0.029 (-0.104~0.161)	0.672
Ophthalmology and otorhinolaryngology	-0.153 (-0.285~-0.022)	0.022
Years in Practice (Ref: >20 years)		
<5 years	-0.280 (-0.615~0.056)	0.102
5~10 years	-0.288 (-0.612~0.036)	0.081
11~15 years	-0.311 (-0.622~0.001)	0.050
16~20 years	-0.176 (-0.449~0.098)	0.207
Organizational level		
Ranking (Ref: Secondary)		

Variables	Coefficient (95% <i>CI</i>)	<i>P</i> value
Tertiary	0.005 (-0.083~-0.092)	0.917
Region (Ref: Western)		
Eastern	-0.143 (-0.224~-0.061)	0.001
Central	-0.071 (-0.152~-0.010)	0.085

Bold *P* values indicate significance ($P < 0.05$).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [supplementaryfile.doc](#)