The Effect of Patient Knowledge and Involvement on Antibiotic Abuse and Health Care Services-Evidence from an Audit Study in China

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Abstract

This study estimates the effects of a patient's knowledge of antibiotics on preventing antibiotic abuse. We carried out an audit study in which simulated patients were paired and sent to the same physician for a check-up with the same chief complaint. Of the pair, the simulated patient from the treated group is told to say, "I learned from the internet that simple flu/cold patients should not take antibiotics. Is that right?" We find that a patient's knowledge of antibiotics can reduce the probability of a prescription of antibiotics and drug costs. However, a patient's knowledge of antibiotics reduces the probability of a physician to respond with polite words after being thanked and causes the patients to be less willing to recommend the physician to their parents.

1. Introduction

China has a high usage of antibiotics around the world. While in many countries, antibiotics are used for about one third of hospitalized patients, they were used for two thirds of the inpatient population in China (Roumie et al., 2005). World Health Organization has recommended that Chinese hospitals decrease the rate of antibiotic use for inpatients to 30%, and the Ministry of Health of China also requested that the rate be lessened to 50% (Guo, 2004). The rate of antibiotic use for outpatients in China was high as well. A survey on studies of individual Chinese hospitals showed that the range of antibiotic use was 40% to 60% (Cao and Dai, 2008; Gao et al., 2006; Roumie et al., 2005; Zhao et al., 2007).

This high rate of antibiotic usage can lead to an elevated level of antibiotic resistance in patients. Among hospitalized patients, the mean prevalence of resistance between 1999 and 2001 was 41% in China, while the mean prevalence for Intensive Care Unit (ICU) inpatients and non-ICU inpatients in the U.S. was 20% and 17%, respectively (Zhang et al., 2006). Among outpatients, the average prevalence during the same year span was 26% in China and 13% in the U.S. (Zhang et al., 2006). Furthermore, China also has a rapid growth rate of resistance. The annual growth rate was on average of 22% between 1994 and 2000 in China, while the rate was only 6% between 1999 and 2002 in the U.S. (Zhang et al., 2006). Resistant bacteria strains, as noted by Phelps (1989), incur costs for more powerful drugs, increase days of hospitalization, and, on rare occasion, cause death. When translated into pecuniary terms, the cost is estimated to be $55 for an extra antibiotic, $300 for each additional hospital day and $1 billion for death. Given the estimated 150 million annual antibiotic prescriptions in the U.S., the total cost would be at least $.1 billion with it exceeding $30 billion in the worst case (Phelps, 1989).

Given these harmful effects, why is antibiotic abuse so prevalent in China? This question can be analyzed from two aspects. Due to a lack of professional knowledge on antibiotics on the provider side, many physicians rely on faulty assumptions that antibiotics are effective in curing all diseases, and do not use standard medical procedures as the basis for antibiotic prescription (Cao and Xie, 2004). Moreover, even when some physicians are aware that an antibiotic is not effective in the treatment, they tend to apply antibiotics to prevent potential infections and avoid future trouble dealing with complicated conditions (Zhang, 2004). This phenomenon is especially pronounced before and after a surgical operation (Zhang, 2004).

The situation is further worsened by a distorted economic incentive. It has been reported that drug sales account for about half of the total revenue in some big hospitals with doctors able to get as high as a 20% rebate for antibiotics from manufacturers (Chen, 2005; Chen and Hu, 2000). Given this economic incentive, physicians are likely to prescribe more antibiotics than what is optimal for the patients. Since patients often lack enough professional knowledge to assess a prescription, it results in a moral hazard problem when physicians abuse antibiotics to pursue their own interests, rather than the patients'.

On the consumer side, many have the mistaken perception that antibiotics are a panacea, and that the latest and most expensive antibiotics are the most effective ones (Cao and Xie, 2004). It is a common practice for patients to request antibiotics from physicians, take newer ones if their conditions do not improve within a few days, and then change the dosage at their own discretion (Li, 2005). Due to consumer misuse, bacteria has become much more resistant to older antibiotics in China than in Western countries (Hu, 2008). This further exacerbates antibiotic use and results in a vicious circle of continuous abuse.

This study is an attempt to understand the reasons for antibiotic abuse and find out possible ways to decrease it. To answer this, we conducted an audit study in which simulated patients went to physicians for a check-up with the same chief complaint. Our study has two purposes. First, we intend to assess the rate of antibiotic usage in China, as well as the variation of the rate across different urban and rural areas. To achieve this purpose, every simulated patient went to see a physician and gave the same chief complaint.

Our second purpose is to study whether patient knowledge could alleviate the moral hazard problem and decrease antibiotic abuse. To achieve this, we had pairs of well-matched simulated patients, A and B, go to see the same physician with a short time interval between their visits. They followed the same transcript, except that, after physicians finished collecting clinical history, A would say "I learned from the internet that simple flu/cold patients should not take antibiotics," while B would say nothing. Thus, A represented a well-informed patient and B a less-informed one. Prescriptions and evaluation forms were collected after the audits for further analysis.

The audit methodology has been used in numerous settings, especially where discrimination is suspected. For example, Ayres and Siegelman (1995) studied whether black and female buyers were discriminated against by car dealers. Bertrand (2004) examined whether there was racial discrimination in the labor market. With matched pairs of testers and random assignments, this approach can isolate the effects of a particular variable. Moreover, the in-person audit can provide quantitative and qualitative data on both the outcome and the process of the audit (Pager, 2007). Applied to our study, this method enabled us to gather information on whether the simulated patient received a prescription and how he/she was treated during the outpatient visit.

Our study presents several findings. First, a patient's knowledge on antibiotics can reduce the probability of getting a prescription. It decreases prescription rate from 97 percent for simulated patient group, B, to 83 percent for simulated patient group, A. As to the prescription rate for antibiotics (conditional on prescription), a patient's knowledge led to a 19 percentage-point decrease, from 66 percent for simulated patients, B, to 47 percent for simulated patients A. Secondly, a patient's knowledge can reduce the cost of drug expenditures. The total drug expenditures, conditional on prescription, was 150.51 RMB for simulated patient group, B, and 105.84 RMB for simulated patient group, A, reflecting a 39.97 RMB reduction. Finally, patients with more knowledge on antibiotics received worse services from the physicians. On a scale of 1 to 5 (low to high), simulated patient group, A, rated an average of 3.20 for their satisfaction with the visit, 0.28 point less than the 3.48 rated by simulated patient group, B.

Our paper has two contributions. First, we are able to examine a causal relationship between patient knowledge and antibiotic abuse using the audit method. Studying the causal effect of patient knowledge using observational data is a challenging task because of the problems inherent in unobserved patient heterogeneity. In the real world, well-informed patients not only possess more knowledge on the drug, but are different from less-informed patients in many other ways. For instance, well-informed patients may be more educated, have better attitudes, and are able to communicate more efficiently with the physician, all of which may affect a physician's prescription practice. The rate of antibiotic use, as well as the quality of service, can also differ systematically when well informed patients choose better doctors. Thus, it is impossible to study the pure effect of a patient's knowledge on clinical outcomes using observational data.

We overcame the abovementioned difficulty using an audit method, where simulated patients A and B visited the same physician and gave the same chief complaint. The only difference between A and B was that A demonstrated to have more knowledge on antibiotics. In this way, we can obtain outcomes free of the effects from numerous confounding factors. By comparing the results between the two groups of simulated patients, we are able to examine the effect of patient knowledge on two categories of relevant outcomes. The first is its effect on health care utilization. We can decide if and by how much patient knowledge affects clinical outcomes such as a physician's prescription for antibiotics and drug expenditures. The second is the effect on service quality. We can study how a patient's knowledge influences the quality of a physician's service such as the discussion of relevant information and the expression of care.

The second contribution of our paper is that we can assess to what extent is antibiotic abuse due to reasons on the provider's side. While empirical observations suggest that there is an overuse of antibiotics, they do not provide evidence on whether the prescription for antibiotics is a result of a patient's request or a physician's own medical analysis. In our study, simulated patients did not request the physician to prescribe antibiotics, so such prescriptions must have been decided by the physician himself. By isolating the decision on antibiotic use to the physician only, our study can provide clear evidence on the role of physicians in antibiotic abuse in China. Understanding the driving force of antibiotic abuse has important policy implications. If patients are mainly responsible for the abuse, the situation may be improved by educating the public on antibiotics; otherwise, education on antibiotics should be targeted towards physicians and authorities should enforce more stringent laws for antibiotic misuse.

2. Literature review

It has been argued that educating patients on medication options can increase a patient's power over a range of decisions such as treatment choice. The effect of empowerment can be studied from two perspectives: a physician's prescribing practice and a patient-physician relationship.

One line of research has shown that patients' use of information can affect a physician's prescription behavior. Some find beneficial effects. For example, Hollon et al. (2003) reported that women familiar with osteoporosis drugs due to Direct-to-Consumer Advertising (DTCA) had nine times the odds of having bone densitometry performed on them as compared with matched control groups. Weissman et al. (2003) also noted that, if patients had more knowledge on medical drugs, physicians were more likely to identify new conditions which were often underdiagnosed or undertreated in the general public.

However, other researchers pointed out effects that have not been proven beneficial or harmful to patients. Kravitz et al. (2005) found that physicians were significantly more likely to prescribe antidepressants for standardized patients with depression if they made a request for a specific drug. This practice has the potential to both avert underuse and promote overuse. In addition, Mintzes et al. (2003) cautioned that physicians prescribed the DTCA drug requested by patients in more than 70 percent of the cases even though they were not confident of its effect.

Our paper differs from other studies in the sense that while many papers focus on the fact that a patient's knowledge on certain drugs increases the use of those drugs, our paper tries to examine whether patient knowledge can decrease the likelihood of an antibiotic prescription.

Another line of research examined how a patient's improved drug literacy affects a patient-physician relationship. Researchers have shown that more knowledge on drugs motivates more effective discussions between patients and their physicians, while some take a skeptical view of this claim, fearing that such knowledge decreases patient trust in physicians and erodes physician authority (Kravitz, 2000; Maguire, 1999). Indeed, if the patient questions the prescription or if the physician refuses to prescribe the requested drugs, it may result in a disruption in productive discussion and trust between the patient and the physician (Jagsi, 2007). So far, no consensus has been reached on the effect of a patient's knowledge on the patient-physician relationship.

3. Methodology

Our study employed an audit technique in which simulated patients were trained and sent to hospitals for a physician visit. For our standard protocol, the chief complaint for simulated patients was, "For the last two days, I've been feeling fatigued. I have a light fever, slight dizziness, a sore throat and a poor appetite. This morning, the symptoms worsened so I took my body temperature. It was 99°F." We designed the symptoms in a way such that they were neither serious nor unique to viral infections.

A cold can be divided into two categories of infection: viral and bacterial. Antibiotics are only effective in treating the latter. According to the guidelines set by the Pharmacy Administration Commission of Chinese Hospital Association and the China Pharmaceutical Association, antibiotics should be applied only when bacterial infections are confirmed by patient symptoms and results of blood or urine tests. Therefore, the chief complaint alone cannot provide sufficient basis for an antibiotic prescription.

The first goal of this study is to access the rate and variation of antibiotic use for flu/cold patients in China. For this end, we conducted our first fieldwork in two urban areas, Beijing and Nanjing, between December 2008 and March 2009, and one rural area, Jiangsu, in January 2009. Our sample hospitals were all general hospitals, with specialized and Chinese medicine ones excluded. We chose 9 large general hospitals (more than 800 beds) in Beijing, 8 similar hospitals in Nanjing, and 52 local county and town level general hospitals in Jiangsu. Simulated patients were recruited from college students, with an age range of 18 to 22 years. We gave them three hours of group instruction and allowed six hours of individual practice. Simulated patients tested the protocol five times in Beijing before the actual implementation of our audit study.

During the four weeks of fieldwork, each of the simulated patients was assigned hospitals for their visits. They were instructed to request an attending or chief physician in the Department of Respiratory Diseases, or the Department of Internal Medicine in the absence of such a department. During the outpatient visits, simulated patients gave physicians their chief complaint as per instruction. In the follow-up inquires made by the physicians, simulated patients were instructed not to claim other clinical symptoms such as nausea and sputum, which were not included in the chief complaint, nor any previously related clinical history. If the physician proposed temperature taking, tonsil checks or auscultation, simulated patients cooperated. If the physician suggested a blood test or chest X-ray, simulated patients waited for one to two seconds for a voluntary explanation on the purpose of the tests. If the physician did not provide this, simulated patients asked why they needed the test. For safety reasons, we instructed simulated patients to avoid such medical tests by saying "I am in a hurry. Can I skip this test?"

When suggested a prescription, the simulated patient waited for three to four seconds for the physician to voluntarily inform them of any side effects. If the physician did not do so, simulated patients asked for this information. In addition, simulated patients also asked the physician for a prescription for his/her "absent sister" who had similar symptoms. Patients thanked the physician before leaving with their prescription if they were given one.

In some hospitals, the price of the drug was displayed on the prescription. If not, simulated patients went to the pricing window to obtain the amount for their prescription. We obtained total drug expenditures this way in most cases. In cases where we could not obtain the price from the hospital, we found them on the website of the local authority or through search engine results, which we then added to obtain the total drug expenditure amount. Appendix A provides a detailed explanation on the calculation of drug expenditures.

When simulated patients finished the outpatient visit, we asked them to complete a detailed summary form concerning their experience. Questions covered the whole process including greeting, physician inquiry, medical checks, diagnosis, prescription (if any) and drug expenditure (if any). We collected all the forms and had 36 observations from Beijing, 62 from Nanjing and 67 from Jiangsu.

The second goal of this study is to examine the effect of a patient's knowledge on the reduction of antibiotic use. To do so, we conducted a study in Beijing. 14 large and comprehensive hospitals were selected, and college students were recruited as simulated patients. Again, they received three hours of group training on the protocol and had six hours for individual practice. But, this time, we grouped them into pairs. For each pair, simulated patients A and B shared the same gender, a similar age and physical appearance.

Before the audit, the roles of A and B and the sequence of their visits to the hospital were randomly allocated within each pair. For each pair, the visits were conducted either in the morning or afternoon. 1.5-2 hours after the first simulated patient visited a physician, the other simulated patient would approach the registration window to register for the same physician. During the outpatient visit, simulated patients used the same chief complaint and procedures from the first fieldwork. However, after the physician finished inquiring about the symptoms and collected the patient's clinical history, A would ask "I learned from the internet that simple flu/cold patients should not take antibiotics. Is that right?" No matter what reply the physician gave, A would just listen and nod without further questions. In contrast, B would not say this but follow the instructions given by the physician. Thus, we had A and B play the role of the well-informed and less-informed patient, respectively.

Besides the on-site summary form, we also had these patients complete an additional evaluation form concerning the quality of the physician's service. After completing all the audits, simulated patients would evaluate the service they received from each physician. They would rate on a 1 to 5 scale (low to high) for the service they received from each physician and their degree of satisfaction. The last question on the evaluation form asked simulated patients how willing they were to recommend the physician to their parents if they had similar symptoms. 0 denoted that they were strongly against this recommendation and 10 denoted that they were strongly in favor of this recommendation. We collected all the forms and received a total of 128 observations for this study.

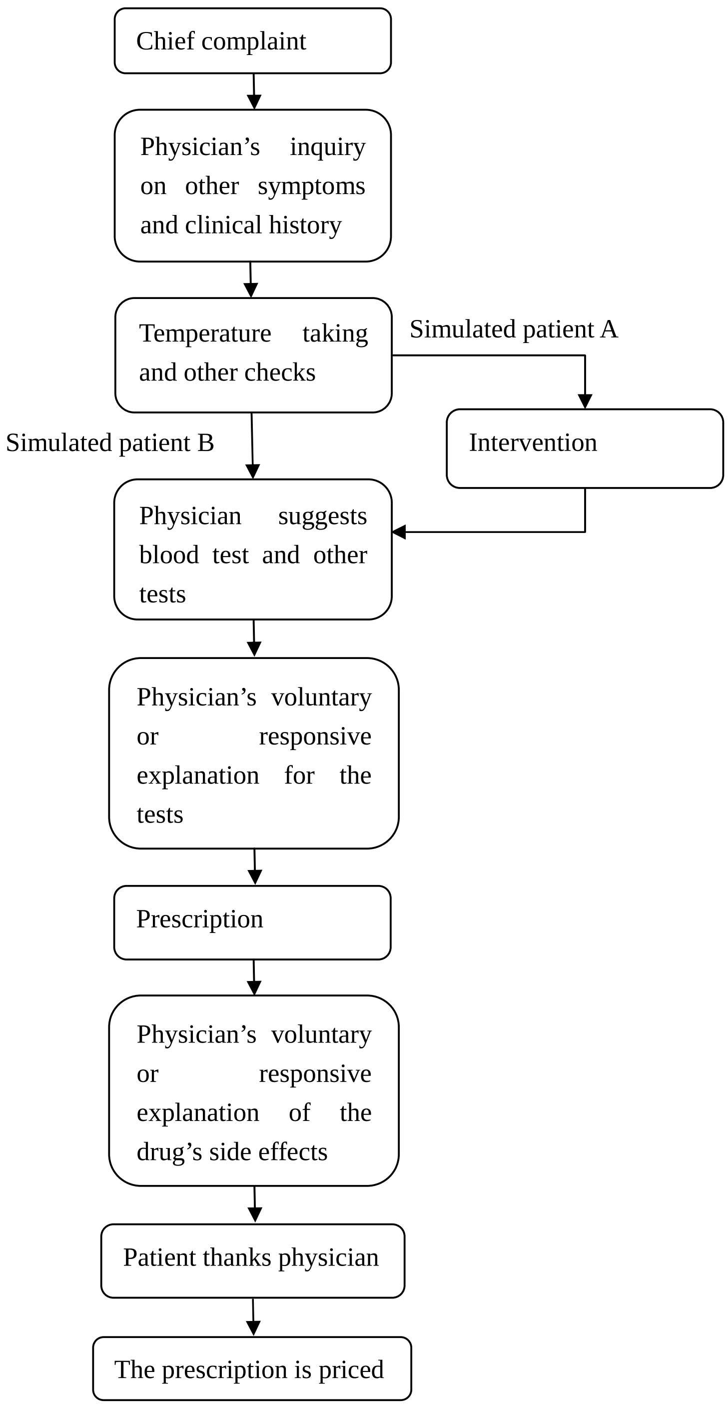

Fig. 1.
Outpatient visit process

4. Results

4.1. The antibiotic usage rate and its variations

Table 1 summarizes antibiotic usage across different areas. It is worth noting that the prescription rates for antibiotics in both urban and rural areas were high. Conditional on prescription, antibiotics were prescribed in 67% of the cases in Beijing, 82% of the cases in Nanjing and 71% of the cases in Jiangsu. In developed countries such as the U.S., the rate of antibiotic prescriptions for outpatients diagnosed with the common cold fell from 59.9% to 49.1% between 1995 and 2002 (Roumie et al., 2005).

Drug expenditures in urban areas were much higher than in rural areas. For example, the average total drug expenditure, unconditional on prescription, was 111.98 RMB in urban areas, more than twice the 45.74 RMB cost in the rural area of Jiangsu. The comparison of drug expenditures, conditional on prescription, also showed that the expenditure more than doubled in urban areas. Besides large differences in drug expenditures between urban and rural areas, there was also a sizable disparity between Beijing and Nanjing cities. Total drug expenditures, conditional on prescription, in Beijing was about 151.51 RMB, more than twice the 70.51 RMB cost in Nanjing. In both cities, the expenditures were high when compared to local living standards. They amounted to 4 percent of the average monthly wage in Beijing, and 2.7 percent of that in Nanjing.[1]

Another thing worth noticing from Table 1 is that though the symptoms patients were instructed to provide were not serious ones, simulated patients in rural Jiangsu received three or more types of drug for 32 percent of their visits. The rate was significantly larger in urban areas, with an average of 62 percent of their visits. In addition, the rate varied in cities. Simulated patients in Beijing were prescribed three or more types of drug in 67 percent of the cases, which was 14 percent more than those in Nanjing. The differences are striking considering that all simulated patients issued the same chief complaint.

In general, data from the first fieldwork showed that the rate of a prescription and the frequency of it being an antibiotic prescription were high in both urban and rural regions. Drug expenditures were high when compared to the surrounding standard of living in all areas, with large disparities between urban and rural areas, and between different urban cities.

Table 1
Comparison between areas

	Urban				Rural
	All	Beijing	Nanjing	Average	Jiangsu
Prescription rate	0.90	0.96	0.82	0.91	0.88
Prescription rate for antibiotics (unconditional on prescription)	0.62	0.64	0.68	0.65	0.55
Prescription rate for antibiotics (conditional on prescription)	0.72	0.67	0.82	0.72	0.71
Total drug expenditures in RMB (unconditional on prescription)	92.60	145.45	58.00	111.98***	45.74
Total drug expenditures in RMB (conditional on prescription)	103.44	151.51	70.51	123.41***	52.83
Types of drugs prescribed (conditional on prescription)	2.68	2.92	2.57	2.80***	2.38
One type of drugs prescribed (conditional on prescription)	0.06	0.06	0.04	0.05	0.08
Two types of drugs prescribed (conditional on prescription)	0.40	0.27	0.43	0.33***	0.60
Three or more types of drugs prescribed (conditional on prescription)	0.54	0.67	0.53	0.62***	0.32
Number of hospitals	83	23	8	31	52
Number of observations	229	100	62	162	67

Note: Asterisks (***, **, *) denote that the difference between the urban and rural area average is significant at 1%, 5% and 10%, respectively.

[1] The average annual wage in Beijing in 2008 was 44,715 RMB. Source: http://www.bjstats.gov.cn/tjnj/2009-tjnj/
The average annual wage in Nanjing in 2007 was 31,905 RMB. Source:
http://www.njtj.gov.cn/2004/2008/laodongli/3-5.htm

4.2. The effects of patient knowledge on health care utilization

Table 2 presents the effects of patient knowledge on health care utilization. There was significant difference between simulated patients A and B. The prescription rate for simulated patients A was 83 percent. Compared with 97 percent for simulated patients B, the rate decreased by 14.4 percent, or 14 percentage points. Looking at the entire sample, the rate of an antibiotic being prescribed for simulated patient group, A, was 39 percent. Compared with 64 percent for simulated patient group, B, the rate decreased by 39.1 percent, or 25 percentage points.

Conditional on prescription, the rate for antibiotic prescribing for simulated patient group, A, was 47 percent. Compared with 66 percent for simulated patient group, B, the rate decreased by 28.8 percent, or 19 percentage points. As the symptoms in the chief complaint were not serious, many types of drug may have been unnecessary, increasing the possibility of side effects. However, 65 percent of simulated patient group, B, were prescribed three or more types of drugs, while only 47 percent did so for simulated patient group, A, reflecting an 18 percent decrease.

Panel B of Table 2 illustrates the differences in drug expenditures. Total expenditures, unconditional on prescription, for simulated patient group, A, was 105.84 RMB, significantly less than the 145.81 RMB total for simulated patient group, B. The expenditures for group A decreased by 39.97 RMB, which is 27.4 percent of the average expenditures of B. Though physicians were less willing to prescribe for A's absent sister than for B's, the drug expenditure per person, for both unconditional and conditional on prescriptions, was significantly lower for A than for B. The drug expenditure per person, unconditional on prescription, for simulated patients A was 55.77 RMB. Compared with the 83.74 RMB for simulated patients B, the expenditure decreased by 27.97 RMB or by 33.4 percent. The expenditure per person conditional on prescription for A was 67.35 RMB. Compared with 86.44 RMB for B, the expenditure decreased by 19.09 RMB, or 22.1 percent.

When grouped by physician title, the outcomes did not show significant difference from each other for most cases. One exception was the average types of drugs prescribed. The number was 2.97 for chief physicians and 2.61 for attending physicians.

Table 2
Comparison of health care utilization

	By Group		By Physician Title	
Variable	Group A	Group B	Chief	Attending
Panel A. Prescription				
Prescription rate	0.83**	0.97	0.89	0.90
Prescription rate for antibiotics (unconditional on prescription)	0.39**	0.64	0.44	0.54
Prescription rate for antibiotics (conditional on prescription)	0.47**	0.66	0.50	0.60
Types of drugs prescribed (conditional on prescription)	2.57	2.84	2.97*	2.61
One type of drugs prescribed (conditional on prescription)	0.06	0.06	0.03	0.07
Two types of drugs prescribed (conditional on prescription)	0.47**	0.29	0.34	0.39
Three or more types of drugs prescribed (conditional on prescription)	0.47*	0.65	0.63	0.54
Panel B. Drug Expenditure				
Total drug expenditures in RMB (unconditional on prescription)	105.84**	145.81	133.92	122.65
Total drug expenditures in RMB (conditional on prescription)	127.80	150.51	150.66	135.95
Physician prescribed drugs on behalf of an absent sister	0.75	0.81	0.72	0.80
Drug expenditure per person in RMB (unconditional on prescription)	55.77**	83.74	74.71	67.81
Drug expenditure per person in RMB (conditional on prescription)	67.35**	86.44	84.05	75.17

Note: Asterisks (***, **, *) donate that the difference between Group A and Group B or Chief and Attending physicians is significant at 1%, 5% and 10%, respectively.

4.3. The effects of patient knowledge on service quality

Table 3 illustrates the effects of patient knowledge on service quality. In our study design, there was no difference between simulated patient groups, A and B, before the intervention. In addition, the role of A and B and the sequence of their visits were allocated randomly. As a result, there should not be significant difference between simulated patient groups, A and B, before the intervention. This is indeed what we saw in the first two columns in panel A. However, after A's intervention in the medical procedure, significant differences emerged between how groups, A and B, were treated by the physician. For example, simulated patient group, A, received voluntary explanations on drug side effects from physicians for 6 percent of the cases, while simulated patient group, B, never received a voluntary explanation. The rate of physicians saying polite words such as, "You are welcome," after being thanked was 57 percent for A. Compared with 72 percent for B, the rate was lower by 20.8 percent, or 15 percentage points. As to the quality of service, simulated patient group, B, rated an average of 6.36 for their willingness to recommend the physician to their parents, while simulated patient group, A, rated an average of 5.36, reflecting a decrease of 1 point, or 15.7 percent of the rating given by B.

Again, we compared results between different groups of physicians. Before the intervention, chief physicians checked tonsils and used stethoscopes significantly more than attending physicians. Chief physicians conducted a tonsil check 100 percent of the cases, while attending physicians did this 91 percent of the time. Chief physicians used stethoscopes for 69 percent of the cases, while attending physicians did this only 28 percent of the time. After the intervention, chief physicians instructed patients on drug use 53 percent of the cases, whereas attending physicians did so in only 30 percent of the cases. The rate of chief physicians informing patients of a drug's side effects was 9 percent, while no attending physicians in our study did so.

In terms of service quality, chief physicians received significantly higher ratings than attending physicians for most of the responses. On the degree of care, chief physicians received a rating of 3.85, 0.54 point higher than the 3.31 for attending physicians. On professional competency, chief physicians received a rating of 3.85, 0.5 point higher than the 3.35 for attending physicians. On patient's satisfaction with information provided, chief physicians received a rating of 3.85, 0.85 point higher than the 3.00 for attending physicians. On patient's satisfaction with the visit, chief physicians received a rating of 3.95, 0.79 point higher than the 3.16 for attending physicians. On patient's willingness to recommend the physician to his/her parents, chief physicians received a rating of 7.30, 1.86 point higher than the 5.44 for attending physicians.

Table 3
Comparison of service experience

Variable	By Group: Group A	By Group: Group B	By Physician Title: Chief	By Physician Title: Attending
Panel A. Before Intervention				
Physician asks patient about coughing	0.75	0.78	0.81	0.75
Physician asks patient about sputum	0.38	0.39	0.47	0.35
Physician/nurse takes patient's temperature	0.13	0.13	0.14	0.12
Physician checks tonsil	0.95	0.92	1.00*	0.91
Physician uses a stethoscope	0.39	0.40	0.69***	0.28
Panel B. After Intervention				
Physician suggests a blood test (conditional on prescription)	0.55	0.41	0.50	0.47
Physician voluntarily explains the purpose of a blood test (conditional on prescription)	0.34	0.27	0.39	0.28
Physician asks about allergy (conditional on prescription)	0.68	0.73	0.59	0.75
Physician instructs on drug usage (conditional on prescription)	0.38	0.35	0.53**	0.30
Physician voluntarily informs patient of drug side effects (conditional on prescription)	0.06*	0.00	0.09***	0.00
Physician voluntarily suggests drinking more water, etc (conditional on prescription)	0.53	0.58	0.56	0.55
Physician responds with polite words after being thanked (conditional on prescription)	0.57*	0.72	0.58	0.67
Panel C. Service Evaluation (after outpatient visits)				
Degree of care from the physician (perceived by the patient)	3.34	3.52	3.85**	3.31
Physician's professional competency (perceived by the patient)	3.39	3.55	3.85**	3.35
Degree of respect from the physician (perceived by the patient)	3.30	3.57	3.75	3.34
Patient's satisfaction with information provided	3.07	3.32	3.85***	3.00
Patient's satisfaction with the visit	3.20	3.48	3.95***	3.16
Patient's willingness to recommend the physician to parents	5.36*	6.36	7.30***	5.44

Note: Asterisks (***, **, *) denote that the difference between Group A and Group B or Chief and Attending physicians is significant at 1%, 5% and 10%, respectively.

5. Conclusion

In this study, we conducted an audit method to control patient heterogeneity and study the effects of patient knowledge on health care utilization and service quality. We have three findings. First, a patients' knowledge on antibiotics can reduce the prescription rate from 97 percent for simulated patient group, B, to 83 percent for simulated patient group, A. In the case of a prescription, it also decreases the rate of antibiotic being prescribed from 66 percent for simulated patient group, B, to 47 percent for simulated patient group, A. Second, patient knowledge can reduce drug expenditures. The total drug expenditures, conditional on prescription, was 150.51 RMB for simulated patient group, B, while the amount was 105.84 RMB for simulated patient group, A. Third, patients with more knowledge on antibiotics received worse service from physicians. Simulated patient group, A, rated 3.20 out of a scale of 1 to 5 for their satisfaction with the visit, 0.28 point less than the 3.48 rated by simulated patient, group, B.

To summarize, the prescription rate of antibiotics in China is high and varies in different areas. There is large disparity, not only between urban and rural regions, but between urban cities as well. While physicians seem to be responsible for such antibiotic abuse, patients can exert a positive effect on excessive antibiotic prescribing with a show of knowledge about the drug. If patients have more knowledge on antibiotics, it can help reduce the moral hazard brought about by self-interested incentives for physicians. It may also decrease the probability of patients getting antibiotic prescriptions and the cost of drug expenditures. However, more knowledge may also adversely affect the quality of a physician's service. Compared with less-informed patients, well-informed patients received a worse quality of service from physicians.

Given the findings in our study, policies aiming to reduce antibiotic abuse should promote patient education on antibiotics and enforce stricter regulation on prescriptions made by physician. In addition, further research needs to be conducted to explore ways to alleviate the negative effect of patient knowledge on the quality of a physician's service.

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Appendix A

The drug price is calculated based on the simulated patients' prescriptions. In the studies in Jiangsu (stage 1) and Beijing (stage 2), testers obtained drug prices from the cashier. In the studies in Beijing (stage 1) and Nanjing (stage 1), drug prices were sometimes shown in the prescription. In cases where prices were not shown, we estimated the prices in the following ways:

1. We used drug prices from the website of Jiangsu Price Bureau or Beijing Municipal Commission of Development and Reform
2. If there were multiple specifications (i.e. dosage, packaging) of the prescribed drug, we used the average price of those of the same specification.
3. If we could not find the drug on the government website, we obtained the drug price using two search engines, Baidu and Google.
4. We multiplied the drug price with the prescribed dosage, and summed up the numbers to get the total expenditure.

Our estimates were sometimes higher and sometimes lower, but did not deviate much from the actual prices, because there were at most three drugs with the same name and type, all of which had similar prices. Our estimates for drug prices in Beijing in the first fieldwork may be slightly higher than actual drug prices because we used data collected from the website of Beijing Municipal Commission of Development and Reform, which only listed ceiling prices.