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PATIENT KNOWLEDGE AND ANTIBIOTIC ABUSE: EVIDENCE FROM AN AUDIT STUDY IN CHINA

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ABSTRACT

We ask how patient knowledge of appropriate antibiotic usage affects both physicians prescribing behavior and the physician-patient relationship. We conduct an audit study in which a pair of simulated patients with identical flu-like complaints visits the same physician. Simulated patient A is instructed to ask a question that showcases his/her knowledge of appropriate antibiotic use, whereas patient B is instructed to say nothing beyond describing his/her symptoms. We find that a patient's knowledge of appropriate antibiotics use reduces both antibiotic prescription rates and drug expenditures. Such knowledge also increases physicians' information provision about possible side effects, but has a negative impact on the quality of the physician-patient interactions.

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I. INTRODUCTION

China has a high rate of antibiotic usage for both inpatients and outpatients. Two thirds of inpatients use antibiotics in China, compared to about a third of inpatients in many other countries (Hu, Liu, and Peng, 2003). The World Health Organization has recommended that Chinese hospitals decrease the rate of inpatient antibiotic usage to 30% (Guo 2004); the Chinese Government has suggested a more modest reduction to a target rate of 50% (The Ministry of Health of the People's Republic of China, 2000). Antibiotic use is high among outpatients in China as well: forty to 60% use antibiotics (Dong et al. 1999; Zhang et al. 2008). In comparison, in the U.S., the outpatient rate of antibiotic use is between 15% and 18% (Roumie et al., 2005).

Antibiotic abuse has substantial costs. Perhaps the gravest concern is that it will contribute the rise of "superbugs" that are resistant to most or all forms of antibiotics and threaten global health. The Chinese have already seen increased antibiotic resistance compared to Western countries. In China in 1999 and 2001, the mean prevalence of resistance among hospital and community-acquired infections was 41% and 28%, respectively. Comparable figures for the U.S. were 17 to 20% and 13% (Zhang et al., 2006). Moreover, the high prevalence of antibiotic resistance in China is accompanied by a rapid growth in the rate of resistance. The annual growth rate was on average 22% between 1994 and 2000 in China, while the growth rate was only 6% between 1999 and 2002 in the U.S. (Zhang et al. 2006).

Resistant bacteria create immediate costs as well since treating them increases medical expenditures and they may lead to death from uncontrolled infections (Phelps,1989; Yao and Yang, 2008). A second immediate cost stems from adverse drug reactions. Between 2001 and 2005, Xiao et al. (2010) estimate that there were 14,738,000 incidents of moderate to severe antibiotic adverse drug reactions in China yearly, and that 150,000 patients died. Treating these reactions cost 2.91 to 13.93 billion RMB and led to estimated social productivity losses of about 340 million to 1.62 billion RMB yearly (Xiao et al. 2010).

Several reasons have been advanced for antibiotic abuse. One strand of the literature blames the consumer. The argument is that patients view antibiotics as a panacea, and therefore demand them even when they are unwarranted (Cars and Hakansson, 1995; Sun et al., 2009). Patients may also demand newer antibiotics, perceiving them to be more efficacious, or they may fail to follow dosage instructions (Bi, Tong, and Parton, 2000; Sun et al., 2009). If patients expect antibiotics, and doctors are pressed for time, they may find it easier to write a prescription than to explain to the patient why it is not necessary (Schwartz et al, 1998). On the supply side, physicians may overprescribe antibiotics because they lack professional knowledge about proper antibiotic usage (Yao and Yang, 2008; Sun et al., 2009) or because they want to prevent potential infections (Dar-Odeh et al., 2010).

However a third reason for antibiotic abuse that is likely to be particularly important in China, is that physicians have substantial monetary incentives to prescribe medications. In China, most outpatients are seen by doctors in hospital clinics. Hospitals rely heavily on drug sales to make a profit: Drug sales account for over 50% of all hospital revenues and antibiotic sales account for 47% of all drug sales (Chen, 2005; Gong, 2009). Kickbacks from pharmaceutical companies provide further economic incentives for physicians, with physicians receiving payments of up to 20% of the value of the prescription (Day, 2006; Yip and Hsiao, 2008). Thus doctors not only have an incentive to prescribe, they have an incentive to prescribe more expensive drugs, which are often the newer and more powerful antibiotics.

It is possible then that the high level of antibiotic abuse in China represents an egregious example of physician "induced demand". As Dranove (1988) argued, antibiotics are particularly ripe for demand inducement because they are unlikely to inflict harm on most patients, and because it is difficult for the patient to know for certain whether they are needed or not. However, it has been difficult to identify demand inducement in observational data given problems such as endogenous matching of doctors and patients, and unobserved patient characteristics. Recently, many observers have argued that small area variations in the fraction of patients receiving services are evidence of inappropriate use of medical care; but without further information it is impossible to know whether this interpretation is correct, or whether overuse in some areas is driven by the demand or the supply side.

This study proposes a new method for examining physician demand inducement and applies it to the problem of antibiotic abuse in China: We conduct an audit study with simulated patients.[1] We then run a field experiment to test the effectiveness of a simple intervention designed to reduce antibiotic abuse by having patients signal to doctors that they have information about inappropriate antibiotic use.

More specifically, we trained students to act as simulated patients with identical flu-like complaints. These patients were sent to physicians in hospital clinics for check-ups. In the first audit study, we chose two large cities and one rural area (a county in a coastal province) as study areas in order to assess the extent to which antibiotic abuse appears to result from

[1] There is a literature on "medical audit studies" but this usually refers to an analysis of a sample of patient records.

demand inducement. None of our simulated patients were sick, none described symptoms that merited the prescription of antibiotics, and none asked for antibiotics. Yet 65% of simulated patients in urban areas and 55% of simulated patients in rural areas received prescriptions for antibiotics. Moreover, doctors tended to prescribe more expensive drugs rather than cheaper "old-line" antibiotics: 24% of urban patients (28% of rural patients) received prescriptions for cephalosporin conditional on getting a prescription, whereas only 14% (15% rural) received prescriptions for penicillin.

These prescriptions represented a heavy financial burden for the average consumer. Drug expenditures per person were 84.18 RMB in City 1, 50.68 RMB in City 2 and 52.83 RMB in the rural area, amounts that represent 4.1%, 2.4% and 4.2% respectively of the average monthly personal income in each location.[2] Finally, after writing a prescription for the simulated patient, 85% of physicians in City 1 and 47% of physicians in City 2 prescribed for the simulated patient's absent sister when requested to do so.[3]

The field experiment was an audit study designed to see whether sending the physician a signal that the patient was informed about inappropriate antibiotic use would reduce prescription rates. We sent pairs of well-matched simulated patients, A and B, to the same physician, with a short time interval between their audits. The pair followed the same transcript except that following the physical examination, patient A said "I learned from the internet that simple flu/cold patients should not take antibiotics." Thus, A signaled to the physician that they had some knowledge of inappropriate antibiotic use, while B did not.

[2] These figures are drawn from the Statistical Yearbooks of the two cities for 2009 and the County Yearbook for 2009.

[3] Rural physicians were not asked to prescribe for an absent sister. Given the rural physician's lower volume of patients per day, we thought they might notice two such requests coming from otherwise identical patients.

We find that the signal reduced the probability of receiving an antibiotic prescription by 25 percentage points, from 64% for patient B to 39% for patient A. The signal also reduced drug expenditures from an average of 145.81 RMB for patient B to 105.84 RMB for patient A. Finally, patients who signaled knowledge of antibiotics received more information about possible drug side effects than apparently uninformed patients, but fewer polite responses from physicians.

Our paper makes two important contributions. First, by applying the audit study methodology which has been used in other contexts to medical care, we are able to show that a significant amount of antibiotic abuse in China is due to physician induced demand, which in turn is likely driven by strong financial incentives. To our knowledge, this is the first time an audit study with simulated patients has been applied to an examination of the appropriateness of medical care. Second, we show that a simple intervention designed to signal patient knowledge can dramatically reduce the abuse of antibiotics. It may be possible to achieve similar reductions in antibiotic use by for example, a widespread public advertising campaign noting that antibiotics are not appropriate for the treatment of simple colds and the flu, or by requiring hospitals to post notices with this information in examination rooms. If physician financial incentives are an important problem underlying the abuse, then regulation of physician prescribing behavior or more far-reaching reforms to the system of financing hospitals and physicians are also likely to be warranted.

The rest of the paper is organized as follows: Section II provides some background knowledge, Section III describes the study design, Section IV explains the empirical model, Section V presents the results of the study, and Section VI marks the conclusion.

II. BACKGROUND

In this section, we provide background on the induced demand literature, provide some discussion of the advantages and disadvantages of our audit study methodology, and offer a brief survey about the literature on patient "empowerment" that inspired our choice of intervention strategy.

Physician Induced Demand

As McGuire (2000) notes in his review of the literature on physician agency, "The basic premise behind PID (physician induced demand) is that physicians may exploit the information gap between themselves and patients (page 513)." However, there have been remarkably few attempts to test this assumption directly. Instead, most empirical tests of the PID theory either follow Fuchs (1978) and examine the effect of physician density on the consumption of procedures, or they examine the effect of physician fee changes on the volume of services rendered (e.g. Rice, 1983; McGuire and Pauly, 1991; Yip, 1998). Gruber and Owings (1996) take a somewhat different tack and examine the effect of patient availability on the use of Cesarean section for delivery.

All of these papers take as their starting point a model in which physicians trade off the income they can gain from inducing patients to consume unnecessary services against a cost of engaging in inducement. This cost can either be in terms of a direct reduction in utility, or an erosion of the physician's reputation (and his/her ability to induce demand in future).

Attempts to test these models empirically have run into many difficulties. For example, Dranove and Wehner (1994) debunk one popular instrumental variables approach, which is to use the local supply of physicians as an instrument. They show that using this instrument, childbirths appear to be induced, which is unlikely. Similarly, changes in physician fees can affect demand as well as supply, given that most patients face copayments (Heaton and Holland, 2009). A notable recent empirical test of PID is Iizuka (2007) who examines the prescription drug market in Japan. He finds that doctors' prescribing patterns are influenced by the size of the markup that they are allowed to charge on the drugs.

Another strand of the literature follows Wennberg and Gittelsohn (1973) and examines "small area variations" in the utilization of medical procedures. It has been shown that there are large variations in the use of some procedures, and that these variations are unrelated to average patient health outcomes (Sutherland, Fischer, and Skinner. 2009). These variations have been widely interpreted as evidence of excessive provision of medical care (e.g. Fuchs, 2004). However, Chandra and Staiger (2007) argue that the true picture is more complex since patients in high spending areas who need high-tech care are better off in those areas, while patients who would benefit from lower tech care may be worse off.

Pauly (1980) attempts to address the role of information by arguing that low income patients in big cities (where information about each physician may be less available) are most likely to suffer from demand inducement. Using micro-level data from 1970, he finds some evidence that this is the case. Bunker and Brown (1974) and Hay and Leahy (1982) attempt to examine the role of information by looking at the use of services by physicians and their families. Both find evidence that doctor's families are more likely to use services, which would seem to go against the information hypothesis. However, it is possible that doctors have access to better quality or lower cost services (through professional courtesies).

Through our audit study approach, we will provide evidence both on the extent to which antibiotic abuse is induced by physicians, and on the extent to which it depends on the information available to consumers.

Advantages and Disadvantages of the Audit Study Approach

Audit studies are used in numerous settings, especially where discrimination is suspected (Pager 2007). This method can isolate effects of a particular variable through the use of matched pairs of testers and random assignment. Moreover, an in-person audit can provide not only quantitative data on the outcomes of the audit, but also qualitative information on the process of the audit (Pager 2007). In our study we collect both quantitative data about the whether or not an antibiotic is prescribed, and qualitative information about the patient's experience.

Audit studies are not without potential weaknesses. A primary concern is effective matching (Heckman and Siegelman, 1993). In the context of our study, effective matching means that from the point of view of the physicians, pairs of simulated patients are identical except for their knowledge of antibiotics. We took two measures to achieve effective matching. First, we designed detailed protocols and provided extensive training to ensure that simulated patients dressed and behaved in a similar manner and gave the same chief symptoms. Second, in the experiment involving pairs of simulated patients, the roles of A and B were randomly assigned. Since the two students switch roles, we can include patient fixed effects in our models to further reduce the possibility that personal characteristics accounted for the different results between simulated patients A and B.

Another concern in an audit study is that testers' awareness of the experiment may affect their expectations and/or behaviors and thus influence the results. For example, in a study on racial discrimination in hiring, a black experimenter may be more nervous or less confident than a white experimenter due to the expectation of racial discrimination (Pager 2007). Therefore, any observed differences in hiring patterns between black and white testers could reflect subtle differences in their behavior.

Since our simulated patients could observe that the only difference between the scripts followed by patients A and B was the statement about antibiotics, we did tell them that the purpose of the experiment was to see if a statement reflecting antibiotic knowledge would affect prescription patterns. We tried to minimize the potential impact of this knowledge through training. As discussed further below, simulated patients were trained to dress properly, to strictly follow the standard protocol, and to behave in an even-mannered way during the outpatient visit so that, to the physicians, they differed only in terms of patient knowledge.

We also check that there is no difference in the physician's reaction to A and B prior to receiving the signal that Patient A is informed about appropriate antibiotic use. If A and B's behavior differed in a way that affected the doctor-patient interaction, then we might expect to see differences appearing during the initial patient examination. However, as we show below, there were no significant differences in the way doctors treated patients prior to patient A's comment about antibiotic use.

Background Literature on Patient Empowerment

As discussed above, our intervention focuses on signaling to the doctor that the patient is informed about appropriate antibiotic use in cold and flu patients. Our focus on information is a natural outgrowth of the literature on induced demand, which emphasizes information asymmetry. However, there is also a literature in medicine about patient education or "empowerment" which we briefly summarize here.

It has been argued that educating patients on medication options can increase the patients' authority over a range of decisions, particularly treatment choice (Angelmar and Berman 2007). Empirical studies on the effects of patient empowerment can be divided into two groups: a) Those that focus on effects on the prescription practices of physicians, and b) those that focus on effects on the patient-physician relationship.

Research has shown that patient empowerment can affect physicians' diagnosing and prescribing behavior. Some researchers have found that patient displays of knowledge can positively influence physicians' practices and improve patients' health. For example, Hollon et al. (2003) report that in comparison with matched control groups, women who are familiar with osteoporosis drugs due to Direct-to-Consumer Advertising (DTCA) are nine times more likely to receive a bone densitometry, which helps physicians diagnose osteoporosis at an earlier stage. Weissman et al. (2003) also note that the more patients know about medical drugs, the more likely it is that physicians will identify new conditions in patients who were previously either under-diagnosed or undertreated.[4]

A second line focus of the patient empowerment literature asks how patient knowledge affects the patient-physician relationship. Whereas some researchers argue that patient

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[4] Other researchers argue that patient knowledge does not necessarily either improve treatment or benefit health. For instance, Mintzes et al. (2003) find that even when physicians doubt the efficacy of drugs patients request, they still prescribe requested drugs more than 70% of the time. Moreover, patient requests can have a potentially harmful effect. Kravitz et al. (2005) discusses an example in which a physician prescribes a requested anti-depression medication, rather than doing a careful examination and discovering a patient's underlying hypothyroidism. However, our design explicitly abstracts from issues arising from patient requests for medication.

knowledge motivates more effective discussions between patients and physicians, others are skeptical of this claim, as they fear that patient knowledge both decreases patients' trust in physicians and erodes the authority of physicians (Maguire, 1999; Kravitz, 2000, Jagsi, 2007). By isolating the effect of information in our audit study, we provide new evidence on how patient knowledge affects the patient-physician relationship.

III. STUDY DESIGN

Our study includes two field audit studies. The first was conducted in City 1 and a rural county from January 2008 to March 2008 and in City 2 in January 2009. The goal of this first study was to assess the rate of inappropriate antibiotic usage for flu/cold patients. The second study was conducted in City 1 from November 2008 to February 2009. In this experiment, we use the audit study method to examine the effect of patient knowledge on health care utilization and service quality.

The First Audit Study

We began the first audit study by designing a standard protocol which appears in the Appendix. In the protocol, the chief complaint for all simulated patients is, "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 purposely chose very minor symptoms so that it would be difficult for physicians to determine if the infections were viral or bacterial without further tests.

Since antibiotics are only effective in treating infections caused by a bacterium, it is important for a physician to know the kind of infection a patient acquires before prescribing antibiotics. According to the official guidelines (Ministry of Health of the People's Republic of China, 2004), antibiotics should only be prescribed when bacterial infections are confirmed by a patient's symptoms and the results of blood or urine tests. Hence, doctors faced with these vague symptoms should not have prescribed antibiotics.

In the rural area, we restricted our sample to general public hospitals at the county and town level. In City 1 and City 2, we restricted our sample to general public hospitals with at least 800 beds. We restricted our sample to large general public hospitals because in China, most outpatient visits take place in hospitals rather than in clinics: In 2008, 61% of outpatient visits took place in hospitals versus 39% in clinics (Ministry of Health of the People's Republic of China 2009).[5] The equivalent of a U.S. primary care physician does not really exist, so a visit to a hospital or clinic is often the counterpart to a visit to a physician's office in the U.S. (Hsiao and Liu, 1996; Yip, Wang and Liu, 1998; Hew, 2006; Eggleston et al. 2008;). We excluded private hospitals because in 2008, 87% of hospital outpatient visits took place in public hospitals (Ministry of Health of the People's Republic of China, 2009). We excluded specialized public hospitals because in 2008, 91% of hospital outpatient visits took place in general hospitals (Ministry of Health of the People's Republic of China, 2009). Clearly, general public hospitals in China are the main medical service providers.

We obtained a list of all general public hospitals with more than 800 beds from the local Health Department. We randomly choose ten large general public hospitals in City 1 and eight

[5] According to the 2009 Yearbook of Health in People's Republic of China, hospitals included general hospitals, sanitariums, health service centers, urban/rural health centers; outpatient departments, women and children care agencies, and specialized centers. The numbers of outpatient visits treated in these settings were 1.7 billion, 1.5 million, 171 million, 828 million, 51 million, 131 million and 18 million people, respectively. In total, there were 2.9 billion outpatient visits in hospitals in 2008, accounting for 61 percent of all outpatient visits. Clinics included infirmaries, health service stations, village clinics, and they served 424 million, 84 million, and 1.4 billion outpatients respectively.

in City 2. Following a similar procedure, 52 general hospitals were randomly chosen in the rural area. Our budget permitted us to recruit 39 college students to serve as simulated patients, with an age range of 18 to 22 years. Specifically, we recruited 10 simulated patients in City 1, 8 in City 2, and 19 in the rural area. In City 1, each of the 10 students was assigned 10 hospital visits, resulting in an overall sample of 100 observations; in City 2, each student was assigned 8 hospital visits for a sample of 64 observations. Because hospitals were more spread out in the rural areas, and transportation was more difficult, in the rural area 9 students were each assigned 3 hospital visits and the remaining 10 students were each assigned 4 hospital visits, resulting in a total of 67 (9*3+10*4) visits. The total number of visits in the three sample areas was 231 (100+64+67). Of these, two observations had to be dropped (in City 2), one because the student went to the wrong hospital, and one because the student went to an Emergency Room rather than to the Department of Respiratory Diseases or the Department of Internal Medicine. In China, non-urgent care patients typically present at the department that they expect to be seen in. We instructed our simulated patients to go to the Department of Respiratory Diseases, or, if there was no such department, to the Department of Internal Medicine.

Simulated patients underwent nine hours of group instruction and individual practice, during which they received instructions on the transcript and how to behave, dress, etc. We also instructed them to give the chief complaint at a normal speech rate of around 22 seconds so that they did not speak too fast or too slow. The main goal was to standardize the simulated patients' performance and appearance. To ensure that simulated patients were well trained, after the group instruction and individual practice, simulated patients tested the protocol five times in out-of-sample hospitals before the actual implementation of the first audit study.

The protocol for the audit study is displayed in Figure I. First, the physician collects the chief complaint and a clinical history from the simulated patient. The patient does not claim nausea, sputum, or other clinical symptoms that are not included in the chief complaint, nor do they claim any previously related clinical history.

Second, the physician gives a physical examination, which is likely to include temperature taking, tonsil checks, auscultation, etc. Third, the physician diagnoses and decides whether or not to give a prescription. If the physician does prescribe medications, the simulated patient waits for three to four seconds for the physician to voluntarily inform him/her of any side effects. If the physician does not supply such information, the simulated patient asks for it.

Fourth, in the experiments in City 1 and City 2, the simulated patient asks the physician for a prescription for his/her "absent sister" who has similar symptoms. We did not ask this absent sister question in the rural area because rural hospital doctors see fewer patients per day, and a question about an "absent sister" is not a common one. We were concerned that having several patients repeat a rare question might seem strange to a physician and hence might influence their behavior. Fifth, the simulated patient thanks the physician before leaving the office..

If the simulated patient receives a prescription, we calculate drug expenditures as follows: In 17% of all cases the total drug expenditure is listed on the prescription; In 57% of all cases, simulated patients go to a pricing window to obtain total drug

expenditures. In the remaining 26% of all cases in which we did not obtain drug prices from the hospitals, we found them either on the website of the local Price Bureau or through Google or Baidu searches.[6]

Finally, we asked simulated patients to complete an on-site survey immediately after they finished each outpatient visit. The questions covered information about the physician and the complete check-up process, including inquiries the physician made, the physical examination, the diagnosis, and the type and price of the drugs prescribed (if applicable).

The Second Field Experiment

For our second field experiment, we recruited eight college students, four males and four females, from a local university as simulated patients. We randomly chose 16 large general public hospitals with over 800 beds out of the 23 hospitals within 13 miles of a major university as our sample hospitals. As in the first experiment, simulated patients underwent nine hours of group training and individual practice. This time, however, the four male and four female students were grouped into four matched pairs; in each pair, simulated patients A and B shared the same gender, a similar age, and physical appearance. Throughout our study, the pairing was fixed and each of the four pairs visited 16 physicians, resulting in 128 observations total. In order to investigate differences between chief and attending physicians, the first member of the pair to go in was instructed to ask for the chief physician in about one third of the pair visits.

Before each audit, the roles of A and B and the order of their visits to the hospital were randomly assigned within each pair. Since the roles of A and B were chosen randomly, each student played role A approximately as often as role B. As the sequence of their visits was also randomly assigned, simulated patient A visited the physician first or second with almost

[6] Baidu is the biggest Chinese search engine. Website: http://www.baidu.com.

equal frequency. Each member of a pair visited the physician in the same half day, either in the morning or in the afternoon. Unless they were requesting a chief physician, the "first in" patient did not request any particular physician. However, two hours after the first simulated patient visited a physician, the other member of the pair approached the registration desk to request the same physician.

During the outpatient visit, simulated patients reported the same chief complaint and followed the same procedures as in the first audit study. Unlike the first audit study, however, after the physical examination, A said "I learned from the internet that simple flu/cold patients should not take antibiotics. Is that correct?" Regardless of the reply the physician gave, A simply listened and nodded without further questions. In contrast, B did not say anything at this point in the visit. Thus, A and B played the role of the well-informed and less-informed patient, respectively.

To analyze the effects of patient knowledge on service quality, we had simulated patients complete an additional evaluation form in addition to the on-site summary form. After completing all the audits, simulated patients evaluated the service they received from each physician. They rated on a 1 to 5 scale (low to high) the service 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 own parents in the event that their parents had similar symptoms. A zero indicated that they were against recommending the physician while a 10 indicated that they would definitely recommend the physician.

IV. EMPIRICAL MODELS

Our first audit study asks whether the high rates of antibiotic use in China can be plausibly accounted for by physician behavior. Given that our young, healthy patients neither requested antibiotics nor gave symptoms that suggested that antibiotics were appropriate, a large and positive level of antibiotic prescription is a cause for concern. We also examine the data to see how frequently physicians prescribe more expensive classes of antibiotics rather than penicillin, and we look to see whether there are large differences in the prescription rate across areas, consistent with the literature on small-area variations in the U.S..

In the second experimental audit study, we can assess the effects of the information intervention by comparing the fraction of the time patient A received an antibiotic prescription to the fraction of time patient B received one. However, given that there are some observable differences between the simulated patients and physicians, and that practice patterns may vary from one hospital to another, we also estimate models that include patient characteristics, physician characteristics, hospital fixed effects and/or patient fixed effects. We also control for whether a patient was the first or second patient to see the doctor in all our models.

To be more specific, in order to analyze the data from the second experiment, we first estimate models of the following form:

(1) $Y_{ijk} = \alpha_0 + \alpha_1 RoleA_{ijk} + \alpha_2 X_i + \alpha_3 Z_j + \alpha_4 Go\_first_{ijk} + \varepsilon_{ijk}$

where i indicates the simulated patient, j indicates the physician, k indicates the hospital, Y_{ijk} is the outcome of interest for simulated patient i's visit with physician j in hospital k; $RoleA_{ijk}$ is a dummy equal to 1 if simulated patient i plays role A in the visit with physician j in hospital k, and 0 if he/she plays role B; X_i is a vector of control variables including the simulated patient's gender and age; Z_j is a vector of control variables including the physician j's gender, title, and a categorical variable for the physician's age, divided into four groups: 20-30, 30-40, 40-50 and 50+ years;[7] and Go_First_{ijk} is a dummy which equals 1 if simulated patient i visits physician j first in the pair at hospital k , and 0 if this simulated patient is second in the pair.

We next estimate models including hospital fixed effects. Our most restrictive models include patient fixed effects as well and have the following form:

(2) $Y_{ijk} = \beta_0 + \beta_1 RoleA_{ijk} + \beta_2 Z_i + \beta_3 Go\_first_{ijk} + \beta_4 \delta_i + \beta_5 \eta_i + \varepsilon_{ijk}$,

where δ_k is a vector of hospital fixed effects and η_i is a vector of patient fixed effects.

The parameter of interest in these models is β_1, which shows the effect of the patient's knowledge on the outcomes. When Y_{ijk} is a health care utilization measure, such as the prescription rate for antibiotics, we expect β_1 to be significantly negative if patient knowledge decreases utilization, and significantly positive if patient knowledge increases utilization. When Y_{ijk} is a measure of good service quality, such as whether physicians respond politely after being thanked, we expect β_1 to be significantly negative if patient knowledge degrades service quality, and significantly positive if patient knowledge improves service quality.

As chief physicians are more experienced than attending physicians, there may be systematic differences between the practices of chief and attending physicians. Chief physicians may react differently to patient knowledge for two reasons. First, in keeping with the induced demand literature examining the effects of physician fees, attending physicians have lower incomes than chief physicians and may therefore have a stronger incentive to give antibiotic prescriptions in order to increase their income. Alternatively, since attending physicians may be less knowledgeable than chief physicians, they may be more likely to make

[7] This age variable is based on the patient's assessment of the physician's age.

errors, such as prescribing antibiotics when antibiotics are unwarranted. In this case, they may also be less likely to provide information about side effects in response to simulated patients A's intervention.

We test to see whether patient knowledge has different effects on chief physicians and attending physicians by including an interaction term $RoleA_{ijk}*Attending_j$ in our model. The model then becomes:

(3) $Y_{ijk} = \gamma_0 + \gamma_1 RoleA_{ijk} + \gamma_2 Attending_i + \gamma_3 RoleA_{ijk}*Attending_j + \gamma_4 Z_i + \gamma_5 Go\_first_{ijk} + \gamma_6 \delta_i + \gamma_7 \eta_i + \varepsilon_{ijk}$.

The parameters of interest in model (3) are γ_1, and γ_3. The parameter γ_1 shows the main effect of patient knowledge on chief physicians; γ_3 shows the difference between the effects of patient knowledge on chief physicians and attending physicians; the sum of γ_1 and γ_3 shows the main effect of patient knowledge on attending physicians. If the effects are larger for attending physicians, then we would expect γ_3 to be significant and of the same sign as γ_1.

V. RESULTS

This section summarizes the results regarding physicians' antibiotic prescribing practices and their variations across the three study areas; the effects of patient knowledge on antibiotic prescribing; the effects of patient knowledge on physician service quality; and differences in outcomes between chief and attending physicians.

Physicians' Antibiotic Prescribing Practices

Table I summarizes baseline prescription rates from the first audit study. Antibiotic prescribing rates are alarmingly high in all three areas. It is remarkable that the rates are in line with the 40 to 60% rates reported in previous studies, suggesting that much of the antibiotic abuse in China may be accounted for by physician behavior without recourse to demand-side explanations (Dong et al., 1999; Zhang et al., 2008). Prescription rates are higher in urban areas with 64% of simulated patients receiving such a prescription in the two urban areas, compared to 55% in the rural area. We indicate statistically significant differences between average urban and rural areas with asterisks in the "average" column. Overall, 62% of the simulated patients received a prescription for an antibiotic. This high rate suggests that Chinese doctors make little distinction between patients with and without diagnoses that would merit antibiotic prescription.

Panel B focuses on the number and type of drugs that are prescribed conditional on a prescription. Most simulated patients actually received prescriptions for three or more drugs in urban areas. In rural areas, the majority received a prescription for two drugs. In terms of the types of drugs prescribed, 14% of patients received prescriptions for penicillin, while 25% received prescriptions for the more expensive and powerful cephalosporin. In general, penicillin is considered a "first line" drug for infection, and cephalosporin is a second line drug, meaning that it should only be used after penicillin has failed. Hence, prescription of cephalosporin represents a more serious example of antibiotic abuse than prescription of penicillin. Since cephalosporin is on average much more expensive than penicillin, doctors have a larger financial incentive to prescribe it.[8] In urban areas, 22% of patients also received

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[8] Penicillin and cephalosporin are actually classes of drugs, and there are many different types within each class, which all have different prices. However, in City 1 prices for a defined daily dose of penicillin vary from 2.80 RMB for Amoxicillan to 6.04 RMB for Ampicillin. For cephalosporin, the least expensive is Cefalexin at 5.24 RMB while the most expensive is Cefdinir (a "third line" antibiotic) at 76.84 RMB. We estimate that in our data, the average course of penicillin was about half the price of the average course of cephalosporin prescribed.

a prescription for Chaihu, which is not an antibiotic but a Chinese medicine commonly used to treat colds. Another striking finding in Panel B is that the abuse of cephalosporin appears to be much more common in City 2 and the rural area than in City 1, which is consistent with the large differences in medical care that have been observed across areas in countries such as the U.S.

Panel C of Table I shows that physicians are willing to prescribe for absent patients and that total drug expenditures are high. Note that physicians were only asked to prescribe for absent relatives in urban areas, and only if they had already prescribed for the simulated patient. As is shown in the top row, when the simulated patient requested medications on behalf of his/her absent sister, the physician gives a prescription 85% of the time in City 1, and 47% of the time in City 2.

Total drug expenditures are significantly higher in the urban areas than in the rural area, though this result is driven by high drug expenditures in City 1. For example, row (3) of Panel C shows that the total drug expenditure conditional on prescription is on average 151.51 RMB in City 1, more than twice the 52.68 RMB in the rural area. As the prices of the drugs differ little across study areas, the disparity in drug expenditures is driven mainly by different drug types, with physicians in City 1 prescribing more expensive drugs on average.

In Panel C, rows (2) and (3) show total drug expenditures, whereas rows (4) and (5) of Panel C show drug expenditures per person. If the physician does not prescribe for the simulated patient's absent sister, then drug expenditure per person equals total drug expenditure; if the physician does prescribe for the simulated patient's absent sister, then drug expenditure per person equals total drug expenditure divided by two. Rows (4) and (5) of

Panel C show that, even after taking into account the number of patients the physicians prescribes for, drug expenditures per person are high and fluctuate across the three study areas. As is shown in the bottom row, given that the physician prescribes, drug expenditure per person is 84.18 RMB in City 1, 50.68 RMB in City 2, and 52.68 RMB in the rural area. These expenditures are high compared to local living standards. They represent 4.1% of the 2,060 RMB monthly personal income in City 1, 2.4% of the 2,110 RMB personal income in City 2, and 4.2% of the 1,271 RMB personal income in the rural area, respectively.[9]

In summary, data from the first audit study demonstrates that: high rates of antibiotic abuse are likely due to physician induced demand, at least in our study areas. Two thirds of simulated patients received unwarranted prescriptions for antibiotic drugs; patients were likely to receive multiple drug prescriptions; and drug expenditures are high relative to personal incomes. Finally, there were large variations in prescribing patterns across study areas.

The Effects of Patient Knowledge on Antibiotic Abuse

Table II shows how patient knowledge affected antibiotic abuse. The first two columns in Table II present summary statistics by simulated patient group. Column (3), (4), (5) and (6) present OLS estimates of the parameter α_1 from a model without control variables, with control variables but without hospital or patient fixed effects, with control variables and hospital fixed effects, and with control variables and both hospital and patient fixed effects, respectively. A comparison across columns provides some assurance that the experimental design was correctly implemented: The additional controls should not affect the coefficient estimates, and in fact, including them has little impact on the estimates.

[9] These figures are taken from the year books for the two cities and the county for 2009.

Panel A of Table II shows that patient knowledge leads to significant decreases in prescription rates. Row (2) indicates that the overall probability that antibiotics were prescribed was 25 percentage points less for patient A than for patient B. Sixty-four percent of patient B's received a prescription for antibiotics, which is very similar to the rate estimated in our baseline audit, while only 39% of patient A's received a prescription. However, it is remarkable that even after patients had questioned the efficacy of antibiotic use, 39% of physicians still prescribed antibiotics.

Patient knowledge not only reduced prescription rates, but also significantly reduced the proportion of simulated patients receiving three or more types of drugs, as shown in Panel B of Table II. The first two columns of row (4) show that simulated patient A's received three or more types of drugs 47% of the time, compared to 65% of the time for patient B's. Row (3) suggests that most of these patients received prescriptions for two drugs instead of three.

The last three rows of Panel B show that physicians prescribed fewer antibiotics for more informed patients. In particular, they were significantly less likely to prescribe cephalosporin, the more advanced and expensive antibiotic. The point estimates suggest that they were correspondingly more likely to prescribe Chaihu, the Chinese cold remedy; however, this difference is not statistically significant.

Panel C of Table II illustrates the effects of patient knowledge on drug expenditures. Row (2) shows that total drug expenditures for Type A patients were 105.84 RMB, significantly less than the 145.81 RMB for Type B patients. Based on the summary statistics, patient knowledge decreases drug expenditure by 39.97 RMB, which is 27% of the expenditure for B. Drug expenditures per person are also significantly lower for A than for B. For example, row

(4) demonstrates that patient knowledge decreases drug expenditure per person unconditional on prescription by 27.96 RMB from 83.74 RMB to 55.77 RMB.

In summary, Panel A shows that patient knowledge significantly decreased both the overall prescription rate and antibiotic prescription rates, Panel B shows that patient knowledge significantly decreased the probability of receiving three or more types of drugs, and Panel C shows that patient knowledge significantly decreased drug expenditures.

The Effects of Patient Knowledge on Service Quality

Table III shows how patient knowledge affects service quality. Panel A illustrates the effects before the information intervention, while Panel B and C illustrate the effects after intervention.

To eliminate the potential effects of differences other than patient knowledge between simulated patients A and B, we matched simulated patients A and B, instructed them to report the same chief complaint; and randomly assigned the roles of A and B and the sequence of their visits. If these measures were effective, then simulated patients A and B should receive the same treatment prior to the information intervention. We can track this by checking to see whether the physician performed the same actions in both types of patient prior to the information intervention. Panel A shows that there are indeed no significant differences in physician behavior prior to the information intervention.

After simulated patient A's intervention, however, there are some significant differences in the way that physicians behave towards the two groups of patients, as is shown in Panel B. For example, row (3) of Panel B shows that Type A patients received voluntary explanations of potential drug side effects from physicians 6% of the time, whereas Type B patients were never given such explanations. However, patient knowledge seems to have a negative effect on the physicians' attitude, which is reflected in a lower probability of the physician responding politely after being thanked. The bottom row of Panel B shows a 20 percentage point difference in the probability of a polite response between Type A (57%) and Type B patients (73%).

As discussed above, our simulated patients were asked to rate the physicians after the outpatient visit. This section of our study may have the least external validity in that our patients knew that they were not sick, and that they were participating in a study of physician behavior. Hence, their situation was quite different from that of a standard patient. Still, like other similarly situated patients, they brought with them some expectations about how a physician should treat them, and it is presumably with reference to these expectations that they formed their subjective opinions of physician quality.

Note that if the simulated patients understood that the point of the experiment was to assess antibiotic abuse, then the fact that a physician improperly prescribed antibiotics should have caused them to lower their opinion of his or her professional competence. An experimental effect of this type would cause them to evaluate the doctors they saw while in the role of patient B more harshly, since physicians were much more likely to improperly prescribe antibiotics in experimental condition B. Thus, if such an experimental effect was the only source of differences in physician evaluations, we might expect that patient B's would be less satisfied than patient A's on average.

Panel C summarizes the ratings that simulated patients give physicians. The summary statistics in the first two columns show that physicians audited while the simulated patient was in role A received lower ratings on average. However, only the differences in the summary measure of whether the patient would be willing to recommend the physician to his/her own parents are statistically significant. This result is consistent with previous research that has suggested that the "recommendation question" is a more sensitive measure of patient satisfaction (Cheng, Yang and Chiang, 2003).

Differences Between Chief and Attending Physicians

Table IV explores differences in the effect of patient knowledge on the antibiotic prescribing patterns of chief and attending physicians. Columns (1), (3) and (5) present OLS estimates from the model with hospital fixed effects; columns (2), (4) and (6) present estimates from the model with hospital fixed effects and patient fixed effects.

The differences between the effects of patient knowledge on chief physicians and attending physicians are reflected in the coefficients on the interaction term $RoleA_{ijk}*Attending_j$ in columns (5) and (6). None of the coefficients are significantly different than zero. Overall, Table IV suggests that patient knowledge has little differential effect on chief and attending physicians with regard to health care utilization.

Table V illustrates the effects of patient knowledge on service quality by chief physicians and attending physicians. The main effects in columns (3) and (4) show that patients are more satisfied with chief physicians than with attending physicians on average. One indicator of lower quality is that attending physicians are much less likely to give patients any instructions about drug usage. In row (3) of Panel B, the estimates from our preferred model show that, given that the physician prescribes medication, patient knowledge increases the probability that a chief physician will voluntarily inform the patient about possible side effects by 24 percentage points.

The probability that an attending physician will offer such information is not affected. Hence, all of the increase in the probability of being given information about side effects is accounted for by the behavior of chief physicians.

VI. DISCUSSION AND CONCLUSIONS

We use the audit study method to examine the role physicians plays in inducing inappropriate use of antibiotics in China. Our results are of interest for several reasons. First, they demonstrate the feasibility and power of audit studies as a method for measuring induced demand. Our results provide unambiguous evidence that physicians in China often prescribe antibiotics when they are unwarranted; and that they tend to prescribe more expensive rather than less expensive antibiotics. They are also unlikely to instruct patients about the proper use of antibiotics, or to warn them about side effects, although chief physicians are somewhat better than attending physicians in this regard.

Our study focuses on the supply side rather than the demand side. It is certainly possible that patients demand inappropriate medications, or abuse the medications that they receive. However, the rates of doctor initiated antibiotic use we uncovered in our first audit study closely mirrors the rates of antibiotic use found in other Chinese studies. This finding suggests that doctor initiated antibiotic use may well explain the high Chinese rates of antibiotic abuse.

In a second contribution we show that having patients demonstrate knowledge of appropriate antibiotic use can dramatically reduce the abuse of these powerful medications.

Is educating patients and encouraging them to speak up a public policy that could be brought "to scale"? We show that from an individual patient's point of view, there are costs and benefits of challenging physicians by demonstrating knowledge. On the positive side, these patients are more likely to be given additional information about possible side effects, and they are less likely to be sold expensive medications that are unlikely to be efficacious. On the negative side, there is a deterioration in the quality of their interactions with the physician. It is possible that alternative interventions, such as placing posters about inappropriate antibiotic use and possible side effects in doctor's examining rooms, might have a more positive effect.

While our findings provide striking evidence about the extent of induced demand for antibiotics in China, we caution against drawing overly strong conclusions from our study. Audit studies have important advantages over other approaches to investigating induced demand in terms of separating supply and demand effects. However, our results are based on a small sample of doctors, in a small number of locations. Therefore, it will be important to assess the generalizabilitiy of our findings in other settings and with larger samples. Future research could also be directed at whether alternative interventions could be equally or more effective in reducing antibiotic abuse.

APPENDIX I: FIELD EXPERIMENT PROTOCOL

I. INTRODUATION

Two audit studies are described in this protocol. Both studies were conducted during the flu season. The first was conducted in a large city and one rural county from January 2008 to March 2008, and in a second city in January 2009. The purpose of this first experiment was to measure antibiotic prescription rates for symptoms resembling a simple cold in the three areas. The second audit study was conducted in one of the large cities between November 2008 and February 2009. The purpose of this audit study was to conduct an experiment examining the effect of patient knowledge on physician prescribing patterns and physician behavior.

The basic design of an audit study involves sending testers who follow a prescribed script to the people who are being audited. All of our testers presented with a set of vague cold/flu-like symptoms which are described in the script appended to this protocol. They did not ask for antibiotics or any other particular treatment. In the second audit study, we sent matched pairs of testers to visit the same physician, with a short time interval between their audits. This pair followed the same transcript as in the previous audit except that following the physical examination, patient A said "I learned from the internet that simple flu/cold patients should not take antibiotics" while patient B said nothing. Thus, A represented a well-informed patient and B a less-informed one. Note that whether the first or second patient played A or B was randomly assigned. Prescriptions and evaluation forms are collected after the audits.

Sections II and III describe the way in which hospitals and students were selected. Section IV describes how students were trained to play the role of a simulated patient. The fifth and sixth sections discuss physician-visiting procedures. Section VII provides transcripts of the physician visits. Section VIII summarizes criteria for discarding observations, if necessary. Section IX describes how testers were asked to evaluate their visits. Lastly, Section X describes how we collected further data about the medicines prescribed.

II. HOSPITAL SELECTION

All hospitals selected were large general public hospitals with more than 800 beds in cities, or with more than 400 beds in the rural area, excluding traditional Chinese medicine (TCM) institutions. We restrict our sample to large general public hospitals because in China, most outpatient visits take place in public general hospitals rather than in clinics; hospital outpatient visits are the analogue of visits to primary care physician's offices in the U.S. (Ministry of Health of the People's Republic of China 2009).

Specifically, we selected hospitals according to the following procedure. In the two cities, we obtained the list of all large general public hospitals with more than 800 beds from local Health Department statistics. We randomly chose nine large general public hospitals in City 1 and eight in City 2. In the rural area, we randomly chose 52 general public hospitals with more than 400 beds.

III. STUDENT SELECTION

Experiment 1

We recruited students by advertising in collegiate online forums one month before the recruitment (i.e. BBS[10]), offering a monetary compensation of 40 yuan per hour in rural settings or 60 yuan per hour in city settings. Students who responded were interviewed for suitability regarding time commitment. Specifically, we told them that they would visit approximately 8 hospitals as well as partake in some pre-experiment training and post-experiment surveying.

Due to time and budget constraints in different areas, we recruited 39 simulated patients who were college students between 18 and 22 years. Specifically, we recruited 10 simulated patients in the first city. Each of the 10 students was assigned 10 hospital visits, resulting in 100 observations; we recruited 8 simulated patients in the second city, and each of the 8 students was assigned 8 hospital visits. However, there were two cases that were not usable: In one the student went to the wrong hospital. In the second, the student went to an Emergency department rather than to a Department of Respiratory Diseases or Department of Internal Medicine. All students had been instructed to go to the Department of Respiratory Diseases (or in the absence of such a department, the Department of Internal Medicine) because that is

[10] Bulletin board system.

where most non-urgent cases are seen.

Finally, we recruited 19 simulated patients in the rural area. Nine students were each assigned three hospital visits and the remaining 10 students were each assigned four hospital visits, resulting in a total of 67 visits. The total number of visits in the three sample areas was 229 (see Table A. I). We chose more hospitals (52) because rural hospitals are not as busy so that multiple students reporting the same symptoms would be likely to stand out. We chose more students because the hospitals are far apart in rural areas so that it would not be practical to have the same student visit many hospitals.

Experiment 2

For this experiment, the procedures for student selection were exactly the same as those of experiment 1. Specifically, we recruited another eight college students, four males and four females, from City 1 as simulated patients. The students were matched by gender, height and weight into 4 fixed pairs. Each of the four pairs visited 16 physicians, resulting in 64 pairs of visits and 128 observations in total. In order to investigate differences between chief and attending physicians, around two thirds of pairs (48 pairs) visited attending physicians while the rest pairs (16 pairs) visited chief physicians.

IV. STUDENT TRAINING

Simulated patients underwent nine hours of group instruction and individual practice, during which they learned the goal of the audit study, how to conduct the study, etc. The training process was organized by Dr. Wanchuan Lin, Dr. Wei Zhang and research fellow Guoming Shi. As a graduate student in medical school, Guoming Shi is familiar with the Chinese hospital system. The training process progressed as follows:

1. The students were gathered in a room.
2. The students were asked to sign a pledge of confidentiality.
3. The research fellow explained the purpose of the study to the students.
4. Students were given voice recorders and instructed how to operate them. This was done in order to ensure procedural accuracy regarding students following the transcript during practice sessions.
5. Students were next instructed to read and memorize the distributed transcripts. The

transcripts included the patient's chief complaints, and potential doctor responses.

a) Transcripts are explained in further details in Section VI.

b) Students were asked to give the chief complaint at a normal speech rate of around 22 seconds so that they did not speak either too quickly or too slowly.

6. Students were separated into pairs and instructed to practice the memorized transcripts via role-play (i.e. one student plays the role of the "physician" while the other plays the role of the "patient").
7. Each student then practiced the script with either of the two principle investigators, Dr. Wanchuan Lin and Dr. Wei Zhang. Each student practiced individually with the principle investigator, isolated from the other students. This was done as a check on whether the student had memorized the entire transcript and could answer patient evaluation questions successfully.
8. To ensure that simulated patients were well trained, after the group instruction and individual practice, simulated patients tested the protocol five times in out-of-sample hospitals before the actual implementation of the first audit study. Each visit was recorded using the concealed voice recorder.
9. Students were given the patient evaluation questionnaire (see Section IX) and were told to memorize these questions and pay attention to them when visiting physicians.
10. Research assistant and the principle investigators then worked together to analyze the recordings of the visits in order to determine whether the standards of the experiment had been met. Conditions of analysis included:

    a) Faithfulness in adhering to the transcript.

    b) Quantification of speech rate.

11. Check to ensure completion of the patient evaluation questionnaires (please see Section IX). Students who turned in incomplete questionnaires were reminded to pay attention to the questions during their future experimental visits.
12. Neither the names of the hospitals nor the names of the audited physicians were recorded at any time, and the audio tapes were destroyed after they had been reviewed by the principal investigators as described above.

Students who did not perform adequately were asked to redo the in-field training.

V. PHYSICIAN-VISITING PROCEDURES IN EXPERIMENT 1

This section aims to summarize the simulated patients' physician visits, beginning with the patient registration process (i.e. which department of the hospital to visit and the patient's request for a physician) and ending with the termination of the examination (i.e. the writing of a prescription and the physician's goodbye). Detailed transcripts and patient evaluations can be found in Section VII and Section IX.

The Registration Process

All of the simulated patients were instructed to go to the Department of Respiratory Diseases, or in the absence of such a department, the Department of Internal Medicine.

In experiment 1, all of the simulated patients asked for an attending physician. The registration staff at the hospital assigned a physician after the simulated patients requested to see an attending physician in the Department of Respiratory Diseases (or in the absence of such a department, the Department of Internal Medicine). Please see transcription 1 (in Section VII) for further details.

Following the registration process, the visit followed the steps shown in the text as Figure I.

VI. PHYSICIAN-VISITING PROCEDURES IN EXPERIMENT 2

The only difference between experiment 1 and experiment 2 is in the Registration Process and Physical examination (Please refer to Figure I).

Registration Process

In experiment 1, all of the simulated patients asked for an attending physician. In experiment 2, however, simulated patients were told before visiting whether they should ask for a chief physician or an attending physician.

Physical Examination

In experiment 1, during the physical examination, simulated students say nothing about antibiotics; in experiment 2, when physicians are performing physical examinations, simulated patient A says "I learned from the internet that simple flu/cold patients should not take antibiotics. Is that correct?" while simulated patient B says nothing.

Visiting orders among these four pairs were determined before doing the experiment. Each pair individually decided on four days in which both students were free. Students visited 4 hospitals per day, with a total of 16 pair-visit or 32 individual visits. No sample hospital was visited by a pair more than once in three weeks.

Roles and the order in which each role-playing patient visited the physician were randomized in every instance. Before going to the hospital, the simulated patients were given a sheet with Table II, containing all the information about roles, the order of visits, etc. Specifically, the Case column represents the case number. The Date column represents the date on which the case took place. The Student ID column represents which pair of students executed any given case. The column marked "Random Variable 1" represents a random number generated for the purpose of assigning a student to role A or B. The Roles column shows the role assigned. "Random Variable 2" shows a random number generated for assigning the order of visits (whether A or B goes first). The Sequence column shows the sequence of visits that was assigned. The Random Variable 3 column shows a random number generated for assigning chief or attending physician request. The Physician column shows whether a chief or attending physician was supposed to be requested. The Hospital ID column shows the hospital assigned. The 16 hospitals in Table A.II were selected, numbered, and assigned to each pair.

There were two students in each pair: the first student and the second student. Using the Excel function "=rand()", a random number was generated for each simulated patient pair. If the generated number was less than 0.5 (< 0.5), first student was assigned role A and second student was assigned role B. Otherwise the first student was assigned role B and second student was assigned role A. This randomization was repeated for each distinct physician visit. Similar procedures were used to randomize the sequence of visits and whether they asked for a chief physician.

VII.THE TRANSCRIPT

This section provides the transcript of the template for each physician-visit.

Transcript 1 (Registration Process)

1. Hello, I don’t feel quite well. How can I register?
2. I want to see a/chief/attending physician. How much does it cost?
3. Where should I go?
4. Thank you.

Transcript 2 (Step 1: Physician Information Collection)

1. Hello, doctor!
2. For the last two days, I’ve been feeling fatigued. I have been having a low grade 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.
3. If the doctor asks about the following symptoms: dizziness, fever, throat-ache and poor appetite, patients should answer “yes”; if the doctor asks about a cough, simulated patients should answer “a little bit”
4. Answer NO if asked the following questions:

   Do you feel nauseous?

   Do you have any phlegm?

   Do you have any muscle soreness?

   Have you eaten anything bad or unclean recently?

   Are you currently taking any medications?

   Do you have medicine at home?

   Can you think of anything that might have induced your symptoms?
5. Answer “I’m not certain”/ “I don’t know” when asked questions you are not sure of.: e.g. Are you allergic to any medications?

Transcript 3 (Step 2: Physical Examination)

Doctor: I’ll give you a physical examination/I will now conduct a physical exam.

You: Okay.

Transcript 4 (Step 3: Physician’s Diagnoses and Explanation of Findings)

Doctor: I’ll prescribe […] for you.

You: Okay. (ask the physician for information regarding side effects of the medicine after 3-4 seconds if the physician does not voluntarily inform you of the side effects).

Transcript 5 (Step 4: Additional Medical Requests for an Absent Sister):

You: By the way, doctor, my sister is having similar symptoms. Could you prescribe some medicine for her as well?

Doctor: Yes/No.

Transcript 6 (Step 5: Departure)

You: Thank you! (Make sure to bring all notes and prescriptions with you as you leave).

Doctor: (Does the physician respond politely?).

VIII. CONDITIONS FOR DISCARDING OBSERVATIONS

The simulated patients did not conduct the survey in one of the selected hospitals.

1. The simulated patients did not go to the Department of Respiratory Diseases, or in the absence of such a department, the Department of Internal Medicine.
2. The simulated patients played the roles incorrectly. For instance, the patient assigned to play A actually played role B or vice versa (Experiment 2 only).
3. When the second member of the pair of patients arrived at the hospital, the first physician was no longer available (Experiment 2 only).

In practice, situations 3 and 4 did not arise.

IX. PATIENT EVALUATION

After completing all the audits, simulated patients were asked to evaluate their visit according to the following questionnaire. Note that when someone goes to the hospital in China, the doctor will often record information about the visit in a booklet that serves as an outpatient medical record. Hence, patients are also asked about this booklet below.

Registration Process

1: Was the registration staff polite? Did they include greetings such as “Hello”, “Please”, “You are welcome” etc.?

Step 1: Physician Information Collection

(Note, that the only information retained about physicians was their gender, and their approximate age).

2: What was the gender of the physician?

(1) Male (2) Female

3: What was the approximate age of the physician?

(1) 20-30 (2)30-40 (3) 40-50 (4) above 50

4A: Was there an outpatient medical record? (If there is, do not fill in any of your own patient information, i.e. name, age, etc. The purpose of this question is to determine whether the physician is kind enough to fill in the outpatient record on behalf of the patient.)

4B: If there was an outpatient medical record did the physician fill in your name, age etc. for you?

5A: Were you interrupted by the physician before you finished your chief complaints?

5B: If yes, how many times did he interrupt?

(1)1 time (2) 2 times (3) 3 times (4) 4 times (5) 5 and above

6: Did the physician ask whether or not you have cough symptoms?

7: Did the physician ask whether or not you have sputum?

Step 2 Physical Examination

8: Did the physician/nurse take your temperature?

9A: Did the physician examine your tonsils?

9B: If yes, did the physician give you some information about the examination□

10A: Did the physician use a stethoscope?

10B: If yes, did the physician give you some information about the examination□

Step 3 Physicians Diagnose and Explain Findings

11: Did the physician ask you whether you have a history of allergies?

12: Did the physician ask you whether you have cold medicine at home?

13A: Did the physician prescribe medication(s)?

13B: If yes, did the physician take initiative in telling you how to use the medicine? (i.e. before meals, after meals, how many times a day, how many pills a time, etc.)

13C: If yes, did the physician take initiative in telling you the side effects of the medicine?

13D: If no, did the physician explain after you asked him/her?

14: Did the physician take initiative in telling you to pay attention to certain things? (i.e. drink more, have more rest).

Step 4 Additional Medical Requests for an Absent Sister

15: Was the physician willing to prescribe medication for your "absent sister"?

Step 5 Departure

16: Did the doctor explain what disease you might have?

17: After you said "Thank you, doctor," did the physician respond to you with polite words like "You are welcome", etc?

Satisfaction Appraisement for Physician (scores)

Lastly, simulated patients evaluated the service they received from each physician. Service and degree of satisfaction were rated on a scale of 1 to 5 (low to high).

18: How considerate was your physician during your hospital visit?

(1)extremely inconsiderate (2)not very considerate (3)neutral (4)very considerate (5) Extremely considerate

19: How would you rate the medical capability of your doctor?

(1) very bad (2) bad (3) neutral (4) good (5) very good

20: How respectful was the physician of your opinions during the diagnosing process?

(1)very disrespectful (2)disrespectful (3)neutral (4)respectful (5)very respectful

21: Do you think the physician offered you enough information about your treatment and illness?

(1) definitely not enough (2) no (3) neutral (4) yes (5) definitely enough

22: Overall, how was your experience?

(1) extremely bad (2) very bad (3) neutral (4) very good (5) extremely good

23: Would you recommend this physician to your parents, given that they presented with the same symptoms? (Score between 0 and 10, exclude external factors such as travel inconvenience).

X. PRESCRIPTION ANALYSIS

All the simulated patients were asked to turn their prescriptions over to two research assistants who were hired by the medical department of Peking University. By analyzing these prescriptions, the research assistants obtained the following information:

1: The total number of drugs prescribed.

2: Whether antibiotics were prescribed.

3: If yes, the level of antibiotic prescribed where there are 3 levels:

1) unlimited medicine; 2) limited medicine; 3) specialized medicine.

4: The cost of the drugs prescribed.

5: Whether there were likely to be any adverse interactions between the medicines prescribed?

Costs were determined as follows. If the physician did not prescribe, then the drug expenditure was zero. If drugs were prescribed, expenditures were calculated in one of three ways: In some cases, the cost of the drug(s) was already listed on the prescription, so we could calculate the drug expenditure directly. If the physician didn't provide the price information on the prescription, patients obtained total drug costs from the hospital pharmacy. If we could not obtain drug prices from the hospital pharmacy, we searched for them either on the website of the local Price Bureau or through Google or Baidu.

After being analyzed, the prescriptions were destroyed.

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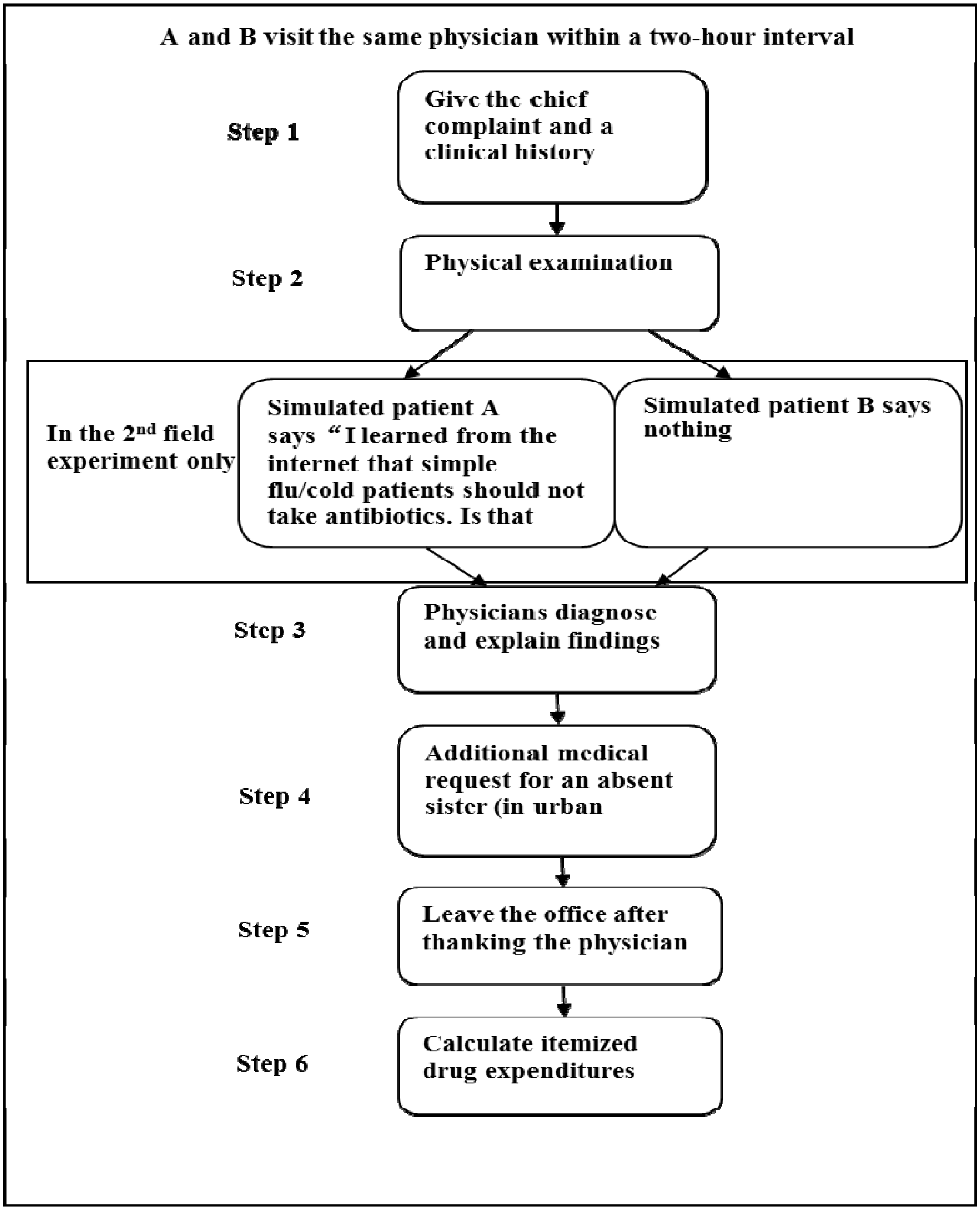

Figure I : Field Experiment Protocol

TABLE I

VARIATIONS IN BASELINE PRESCRIPTION RATES BY STUDY AREA

	All	Urban areas			Rural area
		City 1	City 2	Avg.	
	(1)	(2)	(3)	(4)	(5)
Panel A. Prescription rates					
Prescription rate	0.90	0.96	0.82	0.91	0.88
	[0.30]	[0.20]	[0.39]	[0.29]	[0.33]
Unconditional prescription rate for antibiotics	0.62	0.64	0.68	0.65***	0.55
	[0.49]	[0.48]	[0.47]	[0.48]	[0.50]
Prescription rate for antibiotics	0.69	0.67	0.82	0.72**	0.63
conditional on prescription	[0.46]	[0.47]	[0.39]	[0.45]	[0.49]
Panel B. Types of drugs (conditional on prescription)					
Number of drugs prescribed	2.69	2.92	2.57	2.80***	2.42
	[0.94]	[1.05]	[0.70]	[0.96]	[0.83]
One type of drug prescribed	0.06	0.06	0.04	0.05	0.07
	[0.23]	[0.24]	[0.20]	[0.23]	[0.25]
Two types of drugs prescribed	0.40	0.27	0.43	0.33***	0.58
	[0.49]	[0.45]	[0.50]	[0.47]	[0.50]
Three or more types of drugs prescribed	0.54	0.67	0.53	0.62***	0.36
	[0.50]	[0.47]	[0.50]	[0.49]	[0.48]
Three most commonly prescribed drugs in this study:					
Prescription rate for cephalosporin	0.25	0.19	0.35	0.24	0.25
	[0.43]	[0.39]	[0.48]	[0.43]	[0.44]
Prescription rate for chaihu	0.17	0.19	0.27	0.22***	0.05
	[0.38]	[0.39]	[0.45]	[0.41]	[0.22]
Prescription rate for penicillin	0.14	0.16	0.10	0.14	0.14
	[0.34]	[0.36]	[0.3]	[0.34]	[0.35]
Panel C. Drug expenditures					
Physician prescribes drug for absent sister	0.50	0.85	0.47	0.70***	N/A
	[0.50]	[0.36]	[0.50]	[0.46]	
Total drug expenditure in RMB (unconditional)	92.79	145.45	58.00	111.98***	46.39
	[88.69]	[99.18]	[40.05]	[92.05]	[58.43]
Total drug expenditure in RMB (conditional)	103.15	151.51	70.51	123.41***	52.68
	[87.61]	[96.55]	[32.51]	[89.02]	[59.57]
Unconditional drug expenditure per person (RMB)	66.87	84.18	50.68	72.56***	52.68
	[54.05]	[55.62]	[30.10]	[50.79]	[59.57]
Conditional drug expenditure per person (RMB)	66.87	84.18	50.68	72.56***	52.68
	[54.05]	[55.62]	[30.10]	[50.79]	[59.57]
Number of hospitals	83	23	8	31	52
Number of observations	229	100	62	162	67

Notes. Standard deviations are in brackets. 5. (***, **, *) denote that the difference between urban and rural areas is significant at the 1%, 5% and 10% level, respectively. If the physician does not prescribe for simulated patient's absent sister, drug expenditure per person equals total drug expenditure; if the physician prescribes for simulated patient's absent sister, drug expenditure per person equals total drug expenditure divided by two.

TABLE II

EFFECTS OF PATIENT KNOWLEDGE ON HEALTH CARE UTILIZATION

	Average for A	Average for B	Coefficient on Role A_{ijk}			
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Prescription rates						
Prescription rate	0.83***	0.97	-0.14***	-0.13***	-0.13**	-0.12**
			[0.05]	[0.05]	[0.05]	[0.05]
Prescription rate for antibiotics (unconditional on prescription)	0.39***	0.64	-0.25***	-0.23***	-0.23***	-0.22***
			[0.09]	[0.09]	[0.08]	[0.08]
Prescription rate for antibiotics (conditional on prescription)	0.47**	0.66	-0.19**	-0.19*	-0.18**	-0.17*
			[0.09]	[0.09]	[0.09]	[0.09]
Panel B. Types of drugs (conditional on prescription)						
Number of drugs prescribed	2.57	2.84	-0.27	-0.28	-0.26	-0.24
			[0.17]	[0.17]	[0.16]	[0.16]
One type of drug prescribed	0.06	0.06	-0.01	-0.01	0.00	0.00
			[0.05]	[0.05]	[0.05]	[0.05]
Two types of drugs prescribed	0.47**	0.29	0.18**	0.19**	0.18**	0.15*
			[0.09]	[0.09]	[0.08]	[0.09]
Three or more types of drugs prescribed	0.47*	0.65	-0.17*	-0.18*	-0.18**	-0.15*
			[0.09]	[0.09]	[0.08]	[0.09]
Prescription for cephalosporin	0.08*	0.19	-0.12*	-0.11*	-0.11*	-0.12*
			[0.06]	[0.07]	[0.06]	[0.06]
Prescription for chaihu	0.26	0.18	0.09	0.07	0.06	0.05
			[0.08]	[0.08]	[0.06]	[0.06]
Prescription for penicillin	0.11	0.18	-0.06	-0.08	-0.08	-0.07
			[0.07]	[0.07]	[0.06]	[0.06]
Panel C. Drug expenditures						
Physician prescribed drug on behalf of an absent sister	0.75	0.81	-0.06	-0.04	-0.03	-0.02
			[0.07]	[0.07]	[0.06]	[0.06]
Total drug expenditure in RMB (unconditional on prescription)	105.84**	145.81	-39.97**	-36.57**	-36.89**	-36.25**
			[17.07]	[17.41]	[15.46]	[15.89]
Total drug expenditure in RMB (conditional on prescription)	127.80	150.51	-22.71	-18.97	-16.24	-15.24
			[17.44]	[17.93]	[14.13]	[14.53]
Unconditional drug expenditure per person (RMB)	55.77***	83.74	-27.96***	-27.64***	-27.61***	-28.26***
			[9.37]	[9.67]	[8.91]	[9.12]
Conditional drug expenditure per person (RMB)	67.35**	86.44	-19.09**	-16.40*	-14.91*	-15.05*
			[9.62]	[9.81]	[8.19]	[8.35]
Control variables				√	√	√
Hospital fixed effects					√	√
Patient fixed effects						√

Notes. (***, **, *) denote that the difference between simulated patients A and B or the coefficient on "RoleA$_{ijk}$" is significant at the 1%, 5%

TABLE III

EFFECTS OF PATIENT KNOWLEDGE ON SERVICE QUALITY, BEFORE AND AFTER INFORMATION INTERVETION

	Average for Patient A	Average for Patient B	Coefficient on Role A_{ijk}			
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Before Intervention						
Physician asks patient about coughing	0.75	0.78	-0.03	-0.03	-0.03	0.00
			[0.08]	[0.08]	[0.07]	[0.07]
Physician asks patient about sputum	0.38	0.39	-0.02	0.01	0.00	0.00
			[0.09]	[0.09]	[0.08]	[0.08]
Physician/nurse takes patient's temperature	0.12	0.12	0.00	0.01	0.01	0.00
			[0.06]	[0.06]	[0.06]	[0.06]
Physician checks tonsils	0.95	0.92	0.03	0.04	0.03	0.04
			[0.04]	[0.04]	[0.04]	[0.04]
Physician uses a stethoscope	0.39	0.41	-0.02	-0.01	-0.01	-0.02
			[0.09]	[0.08]	[0.07]	[0.08]
Panel B. After Intervention (conditional on prescription)						
Physician asks about allergies	0.68	0.73	-0.05	-0.04	-0.05	-0.02
			[0.09]	[0.08]	[0.08]	[0.07]
Physician instructs on drug usage	0.38	0.35	0.02	0.03	0.01	0.03
			[0.09]	[0.09]	[0.09]	[0.08]
Physician voluntarily informs patient of drug side effects	0.06*	0.00	0.06*	0.05*	0.06*	0.06**
			[0.03]	[0.03]	[0.03]	[0.03]
Physician voluntarily suggests drinking more water, etc.	0.45	0.58	-0.12	-0.11	-0.11	-0.10
			[0.09]	[0.09]	[0.09]	[0.09]
Physician responds politely after being thanked	0.57*	0.73	-0.16*	-0.15*	-0.15*	-0.14*
			[0.09]	[0.08]	[0.08]	[0.08]
Panel C. Ratings of Service Evaluation (after outpatient visit)						
Degree of care from the physician (1-5: lowest-highest)	3.34	3.52	-0.18	-0.15	-0.13	-0.07
			[0.23]	[0.23]	[0.23]	[0.23]
Physician's professional competency (1-5: lowest-highest)	3.39	3.55	-0.16	-0.14	-0.13	-0.09
			[0.20]	[0.21]	[0.21]	[0.21]
Degree of respect from the physician (1-5: lowest-highest)	3.30	3.57	-0.27	-0.29	-0.29	-0.19
			[0.22]	[0.21]	[0.20]	[0.19]
Patient's satisfaction with information provided (1-5: lowest-highest)	3.07	3.32	-0.25	-0.21	-0.20	-0.12
			[0.25]	[0.24]	[0.24]	[0.24]
Patient's satisfaction with the visit (1-5: lowest-highest)	3.20	3.48	-0.27	-0.24	-0.22	-0.15
			[0.22]	[0.22]	[0.21]	[0.21]
Patient's willingness to recommend the physician to his/her own parents (0-10: will not recommend-high recommendation)	5.36*	6.36	-1.00*	-0.93*	-0.88*	-0.69
			[0.51]	[0.50]	[0.50]	[0.48]
Control variables				√	√	√
Hospital fixed effects					√	√
Patient fixed effects						√

Notes. (***, **, *) denote that the difference between simulated patients A and B or the coefficient on "Role A_{ijk}" is significant at the 1%, 5% and 10% level, respectively.

TABLE IV

EFFECTS OF PATIENT KNOWLEDGE ON HEALTH CARE UTILIZATION BY PHYSICIAN TITLE

	Coefficient on Role A_{ijk}		Coefficient on $Attending_j$		Coefficient on Role $A_{ijk} \times Attending_j$	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Prescription rates						
Prescription rate	-0.22**	-0.21**	-0.16*	-0.16*	0.12	0.13
	[0.10]	[0.09]	[0.09]	[0.09]	[0.11]	[0.11]
Prescription rate for antibiotics (unconditional on prescription)	-0.26	-0.22	-0.06	0.01	0.04	0.00
	[0.16]	[0.16]	[0.15]	[0.15]	[0.19]	[0.19]
Prescription rate for antibiotics (conditional on prescription)	-0.16	-0.13	0.03	0.08	-0.02	-0.06
	[0.18]	[0.18]	[0.16]	[0.16]	[0.20]	[0.21]
Panel B. Types of drugs (conditional on prescription)						
Types of drugs prescribed	-0.05	-0.04	-0.39	-0.33	-0.28	-0.27
	[0.31]	[0.33]	[0.28]	[0.29]	[0.37]	[0.38]
One type of drug prescribed	-0.09	-0.07	-0.07	-0.09	0.12	0.10
	[0.09]	[0.09]	[0.08]	[0.08]	[0.11]	[0.11]
Two types of drugs prescribed	0.12	0.06	0.08	0.08	0.08	0.12
	[0.17]	[0.18]	[0.15]	[0.16]	[0.20]	[0.21]
Three or more types of drugs prescribed	-0.03	0.01	-0.01	0.01	-0.20	-0.22
	[0.17]	[0.18]	[0.15]	[0.16]	[0.20]	[0.20]
Prescription for cephalosporin	-0.10	-0.11	0.11	0.12	-0.01	-0.01
	[0.12]	[0.13]	[0.11]	[0.11]	[0.14]	[0.14]
Prescription for chaihu	0.00	0.00	0.29***	0.28***	0.07	0.07
	[0.12]	[0.12]	[0.11]	[0.11]	[0.14]	[0.14]
Prescription for penicillin	-0.08	-0.09	0.13	0.15	0.00	0.03
	[0.12]	[0.12]	[0.10]	[0.11]	[0.13]	[0.14]
Panel C. Drug expenditures						
Physician prescribed drug on behalf of an absent sister	-0.03	-0.04	-0.11	-0.15	0.00	0.02
	[0.12]	[0.12]	[0.11]	[0.12]	[0.14]	[0.15]
Total drug expenditure in RMB (unconditional on prescription)	-76.26**	-81.33**	-44.44	-43.38	53.59	61.21*
	[30.20]	[31.20]	[27.97]	[28.79]	[35.40]	[36.57]
Total drug expenditure in RMB (conditional on prescription)	-27.83	-31.43	-6.59	-4.91	15.66	21.63
	[28.32]	[29.47]	[25.45]	[26.15]	[33.11]	[34.21]
Unconditional drug expenditure per person (RMB)	-50.23***	-53.13***	-19.87	-16.20	30.80	33.76
	[17.41]	[17.92]	[16.12]	[16.53]	[20.40]	[21.00]
Drug expenditure per person in RMB (conditional on prescription)	-18.89	-22.29	2.65	6.02	5.38	9.67
	[16.43]	[16.95]	[14.67]	[15.04]	[19.21]	[19.67]
Control variables	√	√	√	√	√	√
Hospital fixed effects	√	√	√	√	√	√
Patient fixed effects		√		√		√

TABLE V

EFFECTS OF PATIENT KNOWLEDGE ON SERVICE QUALITY BY PHYSICIAN TITLE

	Coefficient on A_{ijk}		Coefficient on $Attending_j$		Coefficient on $RoleA_{ijk} \times Attending_j$	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Physician asks patient about coughing	-0.01	-0.02	-0.08	-0.14	-0.02	0.03
	[0.13]	[0.13]	[0.12]	[0.12]	[0.16]	[0.15]
Physician asks patient about sputum	0.09	0.09	-0.19	-0.21	-0.13	-0.12
	[0.15]	[0.16]	[0.14]	[0.15]	[0.18]	[0.19]
Physician/nurse takes patient's temperature	-0.02	-0.01	-0.12	-0.16	0.04	0.02
	[0.11]	[0.11]	[0.10]	[0.10]	[0.13]	[0.13]
Physician checks tonsil	-0.02	-0.02	-0.14*	-0.15**	0.06	0.08
	[0.08]	[0.08]	[0.07]	[0.07]	[0.09]	[0.09]
Physician uses a stethoscope	0.17	0.18	-0.48***	-0.49***	-0.25	-0.27
	[0.14]	[0.15]	[0.13]	[0.14]	[0.17]	[0.17]
Panel B. After Intervention (conditional on prescription)						
Physician asks about allergies	0.03	0.08	0.12	0.02	-0.11	-0.14
	[0.16]	[0.14]	[0.14]	[0.12]	[0.18]	[0.16]
Physician instructs on drug usage	0.02	0.04	-0.25	0.31**	-0.01	-0.02
	[0.17]	[0.16]	[0.15]	[0.14]	[0.20]	[0.19]
Physician voluntarily informs patient of drug side effects	0.21***	0.24***	-0.01	-0.01	-0.21***	-0.24***
	[0.06]	[0.06]	[0.05]	[0.05]	[0.07]	[0.06]
Physician voluntarily suggests drinking more water, etc.	-0.17	-0.18	-0.25	-0.27*	0.08	0.11
	[0.17]	[0.18]	[0.16]	[0.16]	[0.20]	[0.21]
Physician responds with polite words after being thanked	-0.24	-0.30*	-0.03	-0.04	0.12	0.22
	[0.16]	[0.16]	[0.15]	[0.14]	[0.19]	[0.19]
Panel C. Service Evaluation (after outpatient visits)						
Degree of care from the physician	0.05	0.10	-0.74*	-0.87**	-0.24	-0.21
	[0.49]	[0.47]	[0.43]	[0.42]	[0.55]	[0.54]
Physician's professional competency	0.00	-0.02	-0.63	-0.72*	-0.18	-0.08
	[0.45]	[0.44]	[0.39]	[0.39]	[0.50]	[0.50]
Degree of respect from the physician	-0.15	-0.13	-0.66*	-0.83**	-0.18	-0.07
	[0.44]	[0.41]	[0.38]	[0.36]	[0.49]	[0.46]
Patient's satisfaction with information provided	-0.12	-0.16	-1.15**	-1.31***	-0.10	0.05
	[0.51]	[0.50]	[0.45]	[0.44]	[0.58]	[0.57]
Patient's satisfaction with the visit	-0.13	-0.16	-1.03**	-1.17***	-0.11	0.00
	[0.46]	[0.44]	[0.40]	[0.38]	[0.51]	[0.50]
Willingness to recommend the physician to a parent	-0.35	-0.49	-2.27**	-2.66***	-0.68	-0.26
	[1.07]	[1.00]	[0.939]	[0.878]	[1.208]	[1.134]
Control variables	√	√	√	√	√	√
Hospital fixed effects	√	√	√	√	√	√
Patient fixed effects		√		√		√

Note. 1. (***, **, *) denote statistical significance at the 1%, 5% and 10% level, respectively.

TABLE A.I.
STUDENT ASSIGNMENT AND NUMBER OF OBSERVATIONS

	City 1: 10 Students	City 2: 8 Students	Rural area: 19 Students
Specific Arrangement	10 Students Assigned 10 Hospital	8 Students Assigned 8 Hospital (2 Unusable Observations)	9 Students Assigned 3 Hospital
			10 Students Assigned 4 Hospital
	39 Students in total		
Obeservation	Beijing: 100 Observations (10*10)	Nanjing: 62 Observations (8*8-2)	Rural area:67 Observations (9*3+10*4)
	229 Observations in total		

TABLE A.II.

DETERMING THE TOLE AND ORDER OF SIMULATED PATIENTS

Case	Date	Student ID (Each Pair)	Random Variable 1 for Deciding the Roles	Roles	Random Variable 2 for Deciding the Sequences	Sequence	Random Variable 3 for Deciding the Physicians	Physicians	Hospital ID (Pre-Scheduled)
1	December 1st	1,2	0.137	1=A□ 2=B	0.211	A First	0.232	Chief Physician	A
2	December 1st	1,2	0.643	1=B□ 2=A	0.564	B First	0.098	Chief Physician	B
3	December 1st	1,2	0.558	1=B□ 2=A	0.265	A First	0.595	Attending Physician	C
4	December 1st	1,2	0.605	1=B□ 2=A	0.948	B First	0.353	Attending Physician	D
5	December 2nd	1,2	0.684	1=B□ 2=A	0.277	A First	0.807	Attending Physician	E
6	December 2nd	1,2	0.109	1=A□ 2=B	0.118	A First	0.102	Chief Physician	F
7	December 2nd	1,2	0.618	1=B□ 2=A	0.408	A First	0.577	Attending Physician	G
8	December 2nd	1,2	0.061	1=A□ 2=B	0.722	B First	0.109	Chief Physician	H
9	December 4th	1,2	0.555	1=B□ 2=A	0.872	B First	0.975	Attending Physician	I
10	December 4th	1,2	0.871	1=B□ 2=A	0.461	A First	0.216	Chief Physician	J
11	December 4th	1,2	0.255	1=A□ 2=B	0.422	A First	0.261	Attending Physician	K
12	December 4th	1,2	0.045	1=A□ 2=B	0.894	B First	0.165	Chief Physician	L
13	December 6th	1,2	0.424	1=A□ 2=B	0.058	A First	0.761	Attending Physician	M
14	December 6th	1,2	0.898	1=B□ 2=A	0.676	B First	0.371	Attending Physician	N
15	December 6th	1,2	0.522	1=B□ 2=A	0.715	B First	0.380	Attending Physician	O
16	December 6th	1,2	0.841	1=B□ 2=A	0.699	B First	0.968	Attending Physician	P
1	December 27th	3,4	0.995	3=B□ 4=A	0.472	A First	0.287	Attending Physician	A
2	December 27th	3,4	0.488	3=A□ 4=B	0.899	B First	0.944	Attending Physician	B
3	December 27th	3,4	0.071	3=A□ 4=B	0.400	A First	0.557	Attending Physician	C
4	December 27th	3,4	0.091	3=A□ 4=B	0.008	A First	0.355	Attending Physician	D
5	December 29th	3,4	0.204	3=A□ 4=B	0.820	B First	0.221	Chief Physician	E
6	December 29th	3,4	0.586	3=B□ 4=A	0.188	A First	0.627	Attending Physician	F
7	December 29th	3,4	0.062	3=A□ 4=B	0.405	A First	0.583	Attending Physician	G
8	December 29th	3,4	0.986	3=B□ 4=A	0.459	A First	0.368	Attending Physician	H
9	December 30th	3,4	0.348	3=A□ 4=B	0.791	B First	0.252	Attending Physician	I
10	December 30th	3,4	0.932	3=B□ 4=A	0.416	A First	0.344	Attending Physician	J
11	December 30th	3,4	0.634	3=B□ 4=A	0.448	A First	0.133	Chief Physician	K
12	December 30th	3,4	0.700	3=B□ 4=A	0.132	A First	0.885	Attending Physician	L
13	December 31th	3,4	0.540	3=B□ 4=A	0.669	B First	0.808	Attending Physician	M
14	December 31th	3,4	0.926	3=B□ 4=A	0.381	A First	0.028	Chief Physician	N
15	December 31th	3,4	0.482	3=A□ 4=B	0.379	A First	0.870	Attending Physician	O
16	December 31th	3,4	0.675	3=B□ 4=A	0.986	B First	0.488	Attending Physician	P

Notes. (1)If random variable 1 is less or equal to 0.5,then the role assignment is "1=A,2=B".If random variable 1 is more than 0.5, then the role assignment is "1=B,2=A". (2)If random variable 2 is less or equal to 0.5, then the sequence is "A First". If random variable 2 is more than 0.5, then the sequence is "B First".(3)If random variable 3 is less to equal to 0.25, then we choose chief physicians. If random variable 3 is more than 0.25, we choose attending physician.