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ABSTRACT

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 who displays 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. Our results suggest that antibiotics abuse in China is not driven by patients actively demanding antibiotics, but is largely a supply-side phenomenon.

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1. 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 et al., 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: in a random sample of 1320 rural outpatient visits, Dong et al. (1999) found that on average 1.47 antibiotics were prescribed per visit. In comparison, in the U.S., 18% of all outpatient visits resulted in an antibiotics prescription in 1995–1996, a proportion that declined to 15% in 2001–2002 (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. A study of the resistance patterns of several common bacteria in China in 1999 and 2001 found that the mean prevalence of resistance among hospital acquired infections was 41% (with a range from 22% to 77%). Among community-acquired infections it was 22% (with a range of 15–39%) (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 2.91–13.93 billion RMB (about 0.43–2.04 billion \$U.S.)¹ and led to estimated social productivity losses of about

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¹ One RMB was equal to approximately 0.1462 \$U.S. in January 2009.

340 million to 1.62 billion RMB (about 49.71 million to 0.24 billion \$U.S.) yearly (Xiao et al., 2010).

Several reasons have been advanced for antibiotic abuse. One strand of the literature focuses on the demand side and 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 et al., 2000). 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), because they want to prevent potential infections (Dar-Odeh et al., 2010), or simply because they believe that is what patients want (Bennett et al., 2010).

However a fourth “supply-side” reason for antibiotic abuse is likely to be particularly important in China: hospitals and physicians have substantial monetary incentives to prescribe medications. In China, most outpatients are seen by doctors in hospital clinics. The central government sets hospital fees at a low level, and historically provided transfers to hospitals to cover the difference between costs and fees (Hsiao, 1996; Eggleston et al., 2008a). Starting in the early 1980s, the government began decreasing financial support to hospitals but did not allow them to increase fees (Yip and Hsiao, 2008). Instead, hospitals are allowed to set higher prices for certain technology-intensive procedures and diagnostic tests. More importantly, hospitals are allowed to add a 15% markup to drug sales (Liu et al., 2000; Eggleston and Yip, 2004; Yip and Hsiao, 2008). Drug sales now account for over 50% of all hospital revenues and antibiotics account for 47% of all drug sales (Chen, 2005; Gong, 2009). While doctors are generally salaried employees, their performance bonuses often depend on the volume of revenues generated (Tang et al., 2007).²

Kickbacks from pharmaceutical companies can provide further economic incentives for physicians to prescribe medication, with physicians receiving payments of up to 20% of the value of the prescription (Yip and Hsiao, 2008).³ These incentives mean that 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 that should be reserved for more dangerous infections.

We conduct an audit study to examine the problem of overprescription of antibiotics in China. By eliminating demand side factors, we show that supply side factors can fully account for the high rate of antibiotic abuse in China. 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 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 physician behavior. 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. By construction, *all* of these cases represent overuse of antibiotics that were driven by the supply, rather than the demand side of the market.

Moreover, doctors tended to prescribe more expensive and powerful antibiotics 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. This pattern is likely to exacerbate the problem of growing antibiotic resistance.

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 (about 12.31, 7.41 and 7.73 \$U.S. respectively), amounts that represent 2.4–4.2% of the average monthly personal income in each location.⁴ 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.

The next part of our study was a field experiment 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.

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 (about 21.32 \$U.S. for patient B and 15.48 \$U.S. 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 contributions. First, we are able to show that antibiotic abuse in China is not driven by patients actively demanding antibiotics, but is largely a supply-side phenomenon. We cannot rule out sheer physician incompetence, or mistaken beliefs about the extent to which consumers demand antibiotics as alternative explanations, but given the significant financial incentives that doctors have to prescribe, physician-induced demand is a likely explanation.

Second, and regardless of the source of the supply-side problem, we show that a simple intervention in which patient's display of knowledge about appropriate antibiotic use 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

² There has been some attempt to separate prescribing and dispensing in “grass-roots” providers such as community centers after 2009, but this has not affected hospitals.

³ One source states, “For the pharmaceutical ‘Aztreonam’, from an unknown manufacturer and priced at 32.3 RMB per box, doctors’ commissions are 20%, or approximately 6.5 RMB per box. The First Hospital of Ningbo City sold 4079 boxes, for sales of 131,751.7 RMB. 3255 boxes were for inpatient use, and 824 boxes for outpatient use. 3600 of those boxes were sold with kickbacks, for an approximate 23,755 RMB paid out” (http://news.ifeng.com/society/1/detail_2010_05/27/1557378_0.shtml).

⁴ These figures are drawn from the Statistical Yearbooks of the two cities for 2009 and the County Yearbook for 2009.

or more far-reaching reforms to the system of financing hospitals and physicians are also likely to be warranted.⁵

The rest of the paper is organized as follows: Section 2 provides some background knowledge, Section 3 describes the study design, Section 4 explains the empirical model, Section 5 presents the results of the study, and Section 6 marks the conclusion.

2. 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.

2.1. Physician induced demand and alternative supply-side hypotheses

Studies of physician induced demand (PID) 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 from harming patients or behaving in an inappropriate way, or an erosion of the physician's reputation (and his/her ability to induce demand in future).

Dranove (1988) argues that 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. Therefore, by prescribing antibiotics, it is possible for the physician to increase profits while causing little direct harm to most patients.

McGuire (2000) offers an overview of attempts to test the PID model. Many 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).⁶

Attempts to test these models empirically have run into many difficulties. For example, Dranove and Wehner (1994) show that areas with more obstetricians have more childbirths but that it is unlikely that this is a causal relationship. Similarly, changes in physician fees can affect demand as well as supply, given that most patients face copayments (Heaton and Helland, 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. There are large variations in the use of some procedures, and that these variations are unrelated to average patient health outcomes (Sutherland et al., 2009). These variations have been widely interpreted as evidence of excessive provision of medical care (e.g. Fuchs, 2004).⁷

More fundamentally, even with irrefutable proof that doctors overprescribe, or that they respond to economic incentives, it is

difficult to observe their motives or to prove that they are trading off patient benefits against profits as the PID posits. Doctors may simply be incompetent, or may have mistaken beliefs about what patients want.

However, from a policy standpoint, it may be more important to determine how doctor behavior can be corrected than to ascertain the doctor's motivation. In principal, providing consumers with information could improve outcomes whether over prescription of antibiotics is caused by incompetence, mistaken beliefs about patient desires, or induced demand.

There have been very few attempts to look directly at the role of information. Pauly (1980) argues that low income patients in big cities (where information about each physician may be less available) are most likely to suffer from demand inducement. Bunker and Brown (1974) and Hay and Leahy (1982) look at the use of services by physicians and their families, arguing that they are likely to be particularly well informed. 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 a supply-side phenomenon, and on the extent to which it depends on the information available to consumers.

2.2. Audit studies of medical care

The audit study methodology is not common in health care, but has been used before. In one of the earliest studies, Woodward et al. (1985) propose using trained actors to measure physician performance. Schulman et al. (1999) use an audit with trained actors to examine difference in the care received by race and gender. Feldman et al. (2006) conduct an interesting audit asking whether patient's request for medication prevent physicians from properly diagnosing depression. We are only aware of one previous published study that used an audit to examine inappropriate prescription of drugs: Tamblyn et al. (1997) study Canadian physicians treating gastrointestinal problems and found that unnecessary prescriptions were made in about 40% of cases.⁸ Since the physicians in this study had no direct monetary incentive to prescribe, this example suggests that the other supply side factors discussed above may be important.

Lu (2011) has recently conducted an audit study by posing as a “family member” of imaginary elderly patients with diabetes and hypertension in Beijing. She finds that doctors prescribe more expensive drugs for insured patients than for uninsured patients when the doctors are told that the drugs will be purchased in the doctor's own hospital, but not otherwise (because they lived far away).

2.3. 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

⁵ However, Jacobson et al. (2010) caution that payment reforms may have unintended consequences in terms of access to care and the types of treatments patients receive.

⁶ Gruber and Owings (1996) take a somewhat different tack and examine the effect of patient availability on the use of Cesarean section for delivery.

⁷ 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.

⁸ There is a literature on “medical audit studies” but this usually refers to an analysis of a sample of patient records.

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 part of the study 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 the 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 reactions 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 prior to the information disclosure, 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.

2.4. 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 about 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.⁹

A second line focus of the patient empowerment literature asks how patient knowledge affects the patient–physician relationship. Some researchers argue that patient knowledge motivates more effective discussions between patients and physicians, while others are skeptical of this claim fearing that patient knowledge both decreases patients' trust in physicians and erodes the authority of physicians (Maguire, 1999; Kravitz, 2000; Jagsi, 2007). Of course, the later effect may be particularly likely if the patient's knowledge appears to undermine or question the physician's recommendation. By isolating the effect of a display of information in our audit study, we provide new evidence on how a patient demonstration of knowledge affects the patient–physician relationship.

3. 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.

3.1. The baseline audit

We began the study by designing a standard protocol which appears in Appendix A. 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 official guidelines (Ministry of Health of the People's Republic of China et al., 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 and any antibiotic prescription represents antibiotic abuse.

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

⁹ 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.

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).¹⁰ 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 et al., 1998; Hew, 2006; Eggleston et al., 2008b). 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 10 large general public hospitals out of 23 hospitals in City 1 and 8 out of 22 hospitals in City 2. Following a similar procedure, in the rural area, we chose 52 township hospitals out of 89 township hospitals with more than 20 beds. For experiment 1, our budget permitted us to recruit 37 college students to serve as simulated patients, with an age range of 18–22 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. One advantage of having a relatively small number of simulated patients is that we can estimate models with patient specific fixed effects.

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 ($9 \times 3 + 10 \times 4$) 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 9 h 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 take about 22 s to give the chief complaint (about 54 Chinese words), to ensure that they did not speak too fast or too slow. The main goal was to standardize the simulated patients' performance and appearance. Hence, patients were matched on gender, age, and physical 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 Fig. 1. First, the physician collects the chief complaint and a clinical history

¹⁰ 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% 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.

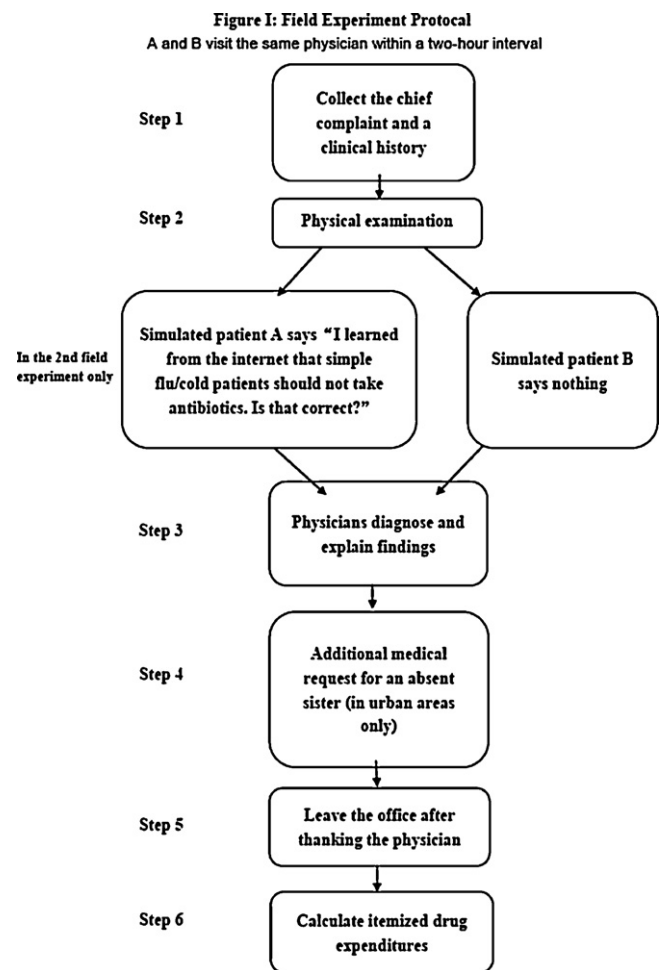


Fig. 1. Field Experiment Protocol.

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 3–4 s for the physicians 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 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.¹¹

Finally, we ask simulated patients to complete an on-site survey immediately after they finished each outpatient visit. The questions cover 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).

3.2. The experiment

For the experimental part of our audit study, 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 as our sample hospitals. As in the first experiment, simulated patients underwent 9 h 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, around two thirds of pairs (48 pairs) visited attending physicians while the rest pairs (16 pairs) visited chief physicians.

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 equal frequency. Each 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, 2 h 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 1–5 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.

4. Empirical models

Our baseline 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 experimental part of the 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:

$$Y_{ijk} = \alpha_0 + \alpha_1 \text{RoleA}_{ijk} + \alpha_2 X_i + \alpha_3 Z_j + \alpha_4 \text{Go_first}_{ijk} + \varepsilon_{ijk} \quad (1)$$

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+ years¹²; 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:

$$Y_{ijk} = \beta_0 + \beta_1 \text{RoleA}_{ijk} + \beta_2 Z_i + \beta_3 \text{Go_first}_{ijk} + \beta_4 \delta_k + \beta_5 \eta_i + \varepsilon_{ijk}, \quad (2)$$

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 physi-

¹¹ Baidu is the biggest Chinese search engine. Website: <http://www.baidu.com>.

¹² This age variable is based on the patient's assessment of the physician's age.

cians, they may be more likely to make 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 $\text{RoleA}_{ijk} \times \text{Attending}_j$ in our model. The model then becomes:

$$Y_{ijk} = \gamma_0 + \gamma_1 \text{RoleA}_{ijk} + \gamma_2 \text{Attending}_i + \gamma_3 \text{RoleA}_{ijk} \times \text{Attending}_j + \gamma_4 Z_i + \gamma_5 \text{Go_first}_{ijk} + \gamma_6 \delta_k + \gamma_7 \eta_i + \varepsilon_{ijk}. \quad (3)$$

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 .

Finally, we use models similar to (3) to ask whether the effects of the intervention differed with physician age or gender.

5. Results

This discussion 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 the differences in outcomes between chief and attending physicians, male and female physicians, and with physician age.

5.1. Physicians' antibiotic prescribing practices

Table 1 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 40–60% 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). 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

Table 1
Variations in baseline prescription rates by study area.

	All	Urban areas			Rural area
	(1)	City 1	City 2	Avg.	(5)
Panel A. Prescription rates					
Prescription rate	0.90 [0.30]	0.96 [0.20]	0.82 [0.39]	0.91 [0.29]	0.88 [0.33]
Unconditional prescription rate for antibiotics	0.62 [0.49]	0.64 [0.48]	0.68 [0.47]	0.65*** [0.48]	0.55 [0.50]
Prescription rate for antibiotics conditional on prescription	0.69 [0.46]	0.67 [0.47]	0.82 [0.39]	0.72** [0.45]	0.63 [0.49]
Panel B. Types of drugs (conditional on prescription)					
Number of drugs prescribed	2.69 [0.94]	2.92 [1.05]	2.57 [0.70]	2.80*** [0.96]	2.42 [0.83]
One type of drug prescribed	0.06 [0.23]	0.06 [0.24]	0.04 [0.20]	0.05 [0.23]	0.07 [0.25]
Two types of drugs prescribed	0.40 [0.49]	0.27 [0.45]	0.43 [0.50]	0.33*** [0.47]	0.58 [0.50]
Three or more types of drugs prescribed	0.54 [0.50]	0.67 [0.47]	0.53 [0.50]	0.62*** [0.49]	0.36 [0.48]
Three most commonly prescribed drugs in this study:					
Prescription rate for cephalosporin	0.25 [0.43]	0.19 [0.39]	0.35 [0.48]	0.24 [0.43]	0.25 [0.44]
Prescription rate for Chaihu	0.17 [0.38]	0.19 [0.39]	0.27 [0.45]	0.22*** [0.41]	0.05 [0.22]
Prescription rate for penicillin	0.14 [0.34]	0.16 [0.36]	0.10 [0.3]	0.14 [0.34]	0.14 [0.35]
Panel C. Drug expenditures					
Physician prescribes drug for absent sister	0.50 [0.50]	0.85 [0.36]	0.47 [0.50]	0.70*** [0.46]	N/A
Total drug expenditure in RMB (unconditional)	92.79 [88.69]	145.45 [99.18]	58.00 [40.05]	111.98*** [92.05]	46.39 [58.43]
Total drug expenditure in RMB (conditional)	103.15 [87.61]	151.51 [96.55]	70.51 [32.51]	123.41*** [89.02]	52.68 [59.57]
Unconditional drug expenditure per person (RMB)	66.87 [54.05]	84.18 [55.62]	50.68 [30.10]	72.56*** [50.79]	52.68 [59.57]
Conditional drug expenditure per person (RMB)	66.87 [54.05]	84.18 [55.62]	50.68 [30.10]	72.56*** [50.79]	52.68 [59.57]
Number of hospitals	70	10	8	18	52
Number of observations	229	100	62	162	67

Notes. Standard deviations are in brackets. 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. One RMB was equal to approximately 0.1462 \$U.S. in January 2009.

** The difference between urban and rural areas is significant at the 5% level.

*** The difference between urban and rural areas is significant at the 1% level.

Table 2
Effects of patient knowledge on health care utilization.

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

Notes. Chaihu is a Chinese medicine commonly used to treat colds (the English name is Bupleurum Root). One RMB was equal to approximately 0.1462 \$U.S. in January 2009.

* The difference between simulated patients A and B or the coefficient on "RoleA_{ijk}" is significant at the 10% level.

** The difference between simulated patients A and B or the coefficient on "RoleA_{ijk}" is significant at the 5% level.

*** The difference between simulated patients A and B or the coefficient on "RoleA_{ijk}" is significant at the 1% level.

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.¹³ In urban areas, 22% of patients

also received a prescription for Chaihu, which is not an antibiotic but a Chinese medicine commonly used to treat colds (the English name is Bupleurum Root). 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.¹⁴

Panel C of Table 1 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.

We estimate that in our data, the average course of penicillin was about half the price of the average course of cephalosporin prescribed.

¹⁴ At the time of the study, City 2 had adopted a program designed to curb demand inducement by allowing hospitals to keep 40% of the revenues generated by their in-house pharmacies rather than 100%. It is possible that some of the differences observed across the cities are due to this program, although the differences do not go in a consistent direction. For instance, doctors in City 2 are more likely to prescribe cephalosporin, but prescribe less expensive drugs overall than those in City 1.

¹³ Penicillin and cephalosporin are actually two classes of drugs, and there are many different drugs 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 Amoxicillin 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.

Table 3
Effects of patient knowledge on service quality, before and after information intervention.

Dependent variable	Average for Patient A (1)	Average for Patient B (2)	Coefficient on RoleA _{ijk}			
			(3)	(4)	(5)	(6)
Panel A. Before intervention						
Physician asks patient about coughing	0.75	0.78	-0.03 [0.08]	-0.03 [0.08]	-0.03 [0.07]	0.00 [0.07]
Physician asks patient about sputum	0.38	0.39	-0.02 [0.09]	0.01 [0.09]	0.00 [0.08]	0.00 [0.08]
Physician/nurse takes patient's temperature	0.12	0.12	0.00 [0.06]	0.01 [0.06]	0.01 [0.06]	0.00 [0.06]
Physician checks tonsils	0.95	0.92	0.03 [0.04]	0.04 [0.04]	0.03 [0.04]	0.04 [0.04]
Physician uses a stethoscope	0.39	0.41	-0.02 [0.09]	-0.01 [0.08]	-0.01 [0.07]	-0.02 [0.08]
Panel B. After intervention (conditional on prescription)						
Physician asks about allergies	0.68	0.73	-0.05 [0.09]	-0.04 [0.08]	-0.05 [0.08]	-0.02 [0.07]
Physician instructs on drug usage	0.38	0.35	0.02 [0.09]	0.03 [0.09]	0.01 [0.09]	0.03 [0.08]
Physician voluntarily informs patient of drug side effects	0.06 [*]	0.00	0.06 [*] [0.03]	0.05 [*] [0.03]	0.06 ^{**} [0.03]	0.06 ^{**} [0.03]
Physician voluntarily suggests drinking more water, etc.	0.45	0.58	-0.12 [0.09]	-0.11 [0.09]	-0.11 [0.09]	-0.10 [0.09]
Physician responds politely after being thanked	0.57 [*]	0.73	-0.16 [*] [0.09]	-0.15 [*] [0.08]	-0.15 [*] [0.08]	-0.14 [*] [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 [0.23]	-0.15 [0.23]	-0.13 [0.23]	-0.07 [0.23]
Physician's professional competency (1–5: lowest–highest)	3.39	3.55	-0.16 [0.20]	-0.14 [0.21]	-0.13 [0.21]	-0.09 [0.21]
Degree of respect from the physician (1–5: lowest–highest)	3.30	3.57	-0.27 [0.22]	-0.29 [0.21]	-0.29 [0.20]	-0.19 [0.19]
Patient's satisfaction with information provided (1–5: lowest–highest)	3.07	3.32	-0.25 [0.25]	-0.21 [0.24]	-0.20 [0.24]	-0.12 [0.24]
Patient's satisfaction with the visit (1–5: lowest–highest)	3.20	3.48	-0.27 [0.22]	-0.24 [0.22]	-0.22 [0.21]	-0.15 [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 [*] [0.51]	-0.93 [*] [0.50]	-0.88 [*] [0.50]	-0.69 [0.48]
Control variables						
Hospital fixed effects				✓	✓	✓
Patient fixed effects					✓	✓

* The difference between simulated patients A and B or the coefficient on "RoleA_{ijk}" is significant at the 10% level.

** The difference between simulated patients A and B or the coefficient on "RoleA_{ijk}" is significant at the 5% level.

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 prescribe 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, representing 2.4–4.1% of personal monthly income in each area.

In summary, data from the first part of our audit study demonstrate that: high rates of antibiotic abuse are likely due to physician behavior, 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 were high relative to personal incomes.

5.2. The effects of patient knowledge on antibiotic abuse

Table 2 shows how patient knowledge affected antibiotic abuse. The first two columns in Table 2 present summary statistics by simulated patient group. These show that Patient A had significantly fewer prescriptions than Patient B (.83 vs. .97) and that the difference in prescription rates was especially large for antibiotics (.39 for A vs. .64 for B).

Columns (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.

Table 4
Effects of patient knowledge on health care utilization by physician title.

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

Notes. One RMB was equal to approximately 0.1462 \$U.S. in January 2009.

- * Statistical significance at the 10% level.
- ** Statistical significance at the 5% level.
- *** Statistical significance at the 1% level.

Panel A of Table 2 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 2. 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 2 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 27.97 RMB from 83.74 RMB to 55.77 RMB.

In summary, Panel A shows that displays of patient knowledge significantly decreased both the overall prescription rate and antibiotic prescription rates, Panel B shows that a display of 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.

5.3. The effects of patient knowledge on service quality

Table 3 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

Table 5
Effects of patient knowledge on service quality by physician title.

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

* Statistical significance at the 10% level.

** Statistical significance at the 5% level.

*** Statistical significance at the 1% level.

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 difference

in the summary measure of whether the patient would be willing to recommend the physician to his/her own parents is statistically significant. This result is consistent with previous research that has suggested that the “recommendation question” is a more sensitive measure of patient satisfaction than some others (Cheng et al., 2003).

5.4. Differences between chief and attending physicians

Table 4 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 $\text{Role}_{ijk} \times \text{Attending}_j$ in columns (5) and (6). None of the coefficients are significantly different than zero. Overall, Table 4 suggests that patient knowledge has little differential effect on chief and attending physicians with regard to health care utilization.

Table 5 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.

5.5. Differences between older and younger and between male and female physicians

We have also investigated differences in prescribing patterns between different types of physicians. We did not find any systematic difference by age, either in the probability of prescribing antibiotics, or in the effect of the information intervention. In contrast, we found that female physicians were less likely to prescribe antibiotics to begin with, but that males were more affected by the intervention.

6. Discussion and conclusions

We use the audit study method to examine the role physicians play in inappropriate use of antibiotics in China. Our results are of interest for several reasons. First, they demonstrate the power of audit studies in health care markets. 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 the rate closely mirrors 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. One question our study does not answer is whether educating real patients would also encourage them to speak up. Perhaps additional interventions beyond education are necessary to get patients to challenge physicians. 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 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 overall effect.¹⁵

While our findings provide striking evidence about the extent to which antibiotics are excessively prescribed in China and the potential benefits of informed consumers, we caution against drawing overly strong conclusions from our study. Audit studies have important advantages over other approaches to investigating health care markets 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 generalizability 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 effectively in reducing antibiotic abuse, and at whether a similar intervention would work in other settings, such as India, which also has an important problem with antibiotic abuse (Das and Hammer, 2007).

Appendix A. Field Experiment Protocol

A.1. Introduction

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

¹⁵ It would also be interesting to know if a patient's display of knowledge about something that did not directly threaten physician incomes, like hand-washing, would have a similar negative effect on doctor-patient interactions.

Table A.1
Student assignment and number of observation (experiment 1).

	City 1: 10 students	City 2: 8 students	Rural area: 19 students
Specific arrangement	10 students assigned to 10 hospitals	8 students assigned to 8 hospitals (2 unusable observations) 37 students in total	9 students assigned to 3 hospitals 10 students assigned to 4 hospitals
Observation	City 1: 100 observations (10 × 10)	City 2: 62 observations (8 × 8 – 2) 229 observations in total	Rural area: observations (9 × 3 + 10 × 4)

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 A.2 and A.3 describe the way in which hospitals and students were selected. Section A.4 describes how students were trained to play the role of a simulated patient. The fifth and sixth sections discuss physician-visiting procedures. Section A.7 provides transcripts of the physician visits. Section A.8 summarizes criteria for discarding observations, if necessary. Section A.9 describes how testers were asked to evaluate their visits. Lastly, Section A.10 describes how we collected further data about the medicines prescribed.

A.2. Hospital selection

A.2.1. Experiment 1

All hospitals selected were large general public hospitals with more than 800 beds in cities, or with more than 20 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 ten out of 23 large general public hospitals in City 1 and 8 out of 22 large public hospitals in City 2. In the rural area, we randomly chose 52 township hospitals out of 89 township hospitals with more than 20 beds.

A.2.2. Experiment 2

We randomly chose 16 large general public hospitals with over 800 beds out of the 23 hospitals as our sample hospitals.

A.3. Student selection

A.3.1. Experiment 1

We recruited students by advertising in collegiate online forums 1 month before the recruitment (i.e. BBS¹⁶), 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 37 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 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.1). 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.

A.3.2. 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.

A.4. Student training

Simulated patients underwent 9 h 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.

¹⁶ Bulletin board system.

Table A.2

Determining the role and order of simulated patients in the first pair.

Case	Date	Random variable 1 for deciding the roles	Roles assigned	Random variable 2 for deciding the order	Order assigned	Random variable 3 for deciding the physicians	Type of physician to be demanded	Hospital ID (pre-scheduled)
1	12/01/2008	0.137	1 = A, 2 = B	0.211	A First	0.282	Attending	A
2	12/01/2008	0.443	1 = A, 2 = B	0.564	B First	0.098	Chief	B
3	12/01/2008	0.558	1 = B, 2 = A	0.265	A First	0.595	Attending	C
4	12/01/2008	0.605	1 = B, 2 = A	0.948	B First	0.353	Attending	D
5	12/02/2008	0.684	1 = B, 2 = A	0.277	A First	0.807	Attending	E
6	12/02/2008	0.109	1 = A, 2 = B	0.118	A First	0.102	Chief	F
7	12/02/2008	0.618	1 = B, 2 = A	0.408	A First	0.577	Attending	G
8	12/02/2008	0.061	1 = A, 2 = B	0.722	B First	0.109	Chief	H
9	12/04/2008	0.555	1 = B, 2 = A	0.872	B First	0.975	Attending	I
10	12/04/2008	0.871	1 = B, 2 = A	0.461	A First	0.216	Chief	J
11	12/04/2008	0.255	1 = A, 2 = B	0.422	A First	0.261	Attending	K
12	12/04/2008	0.045	1 = A, 2 = B	0.894	B First	0.165	Chief	L
13	12/06/2008	0.424	1 = A, 2 = B	0.058	A First	0.761	Attending	M
14	12/06/2008	0.898	1 = B, 2 = A	0.676	B First	0.371	Attending	N
15	12/06/2008	0.522	1 = B, 2 = A	0.715	B First	0.380	Attending	O
16	12/06/2008	0.841	1 = B, 2 = A	0.699	B First	0.968	Attending	P

Notes. (1) If the random variable 1 was less than or equal to 0.5, then student 1 was assigned role A, otherwise, student 2 was assigned role A. (2) If the random variable 2 was less than or equal to .5, then the patient playing role A went first. (3) If the random variable 3 was less than or equal to .25, then the patient asked for the chief physician.

- (a) Transcripts are explained in further details in Section A.6.
- (b) Students were asked to give the chief complaint at a normal speech rate of around 22 s 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 A.9) and were told to memorize these questions and pay attention to them when visiting physicians.
10. The principal investigators then worked with a research assistant to analyze the recordings of the visits in order to determine whether the standards of the experiment had been met. We evaluated:
 - (a) Faithfulness in adhering to the transcript.
 - (b) Whether the speech rate was too fast or too slow.
11. Check to ensure completion of the patient evaluation questionnaires (please see Section A.9). 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.

A.5. 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 Sections A.7 and A.9.

A.5.1. 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 A.7) for further details.

Following the registration process, the visit followed the steps shown in the text as Fig. 1.

A.6. 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 Fig. 1).

A.6.1. 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.

A.6.2. 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 3 weeks.

The roles and the order in which each simulated patient visited the physician were randomized in every instance. Before going to the hospital, the simulated patients were given a sheet like that in Table A.2. Table A.2 shows all the information about roles, the order of visits, and the type of physician that should be requested for the first pair of students. Specifically, the Case column represents the case number. The Date column represents the date on which the case took place. The column marked "Random Variable 1" shows a random number that was generated for the purposes of assigning each student to role A or B. 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.

Similarly, "Random Variable 2" shows a random number generated for assigning the order of visits (whether A or B goes first). The Order column shows the actual order of visits that was assigned. The Random Variable 3 column shows a random number generated for assigning chief or attending physician request. If the number was less than .25, then the patient was to ask for a Chief physician rather than for the Attending. The Physician column shows whether a chief or attending physician was supposed to be requested. The Hospital ID column shows the hospital assigned. Each pair went to all 16 hospitals in this experiment.

A.7. 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 unclear 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, for example, 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. During physical examination, patient A said, "I learned from the internet that simple flu/cold patients should not take antibiotics."

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 s 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?).

A.8. Conditions for discarding observations

In principal, there were 3 reasons for potentially discarding observations:

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, situation 3 did not arise.

A.9. 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 Appraisalment 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).

A.10. 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 did not 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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