Identifying the Effects of the Rational Drug Use System Implementation on Medical Quality

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Abstract. Irrational usage of drugs, such as the over usage or the inadequate usage of drugs and their misguided usage, is still an important problem plaguing the world’s healthcare industry. The Rational Drug Use System (RDUS) provides doctors and patients with the functions of drug usage monitoring, medical information consultation and prescription medication support. From a comprehensive perspective of both the doctors and patients, our study explores the influence of RDUS implementation on medical quality. We collected data from a large 3A-class hospital in China, including data from two-years before and after the implementation of the RDUS. Through empirical research, it was verified that the implementation of the RDUS can effectively improve the medical quality. Specifically, the results indicated that the severity of a disease and the degree of irrational drug usage in hospital departments both played a positive regulatory role in the influence of the RDUS on medical quality. The results render certain theoretical and practical implications for standardizing rational drug usage behavior and promoting the effective application of the RDUS.

1. Introduction

As early as 1985, the World Health Organization (WHO) at the Nairobi Conference, stressed that the Rational Drug Use emphasizes that patients’ usage of drugs is suitable for their clinical needs, and that the dosage and the course of treatment conform to the individual conditions of patients, while the costs are the lowest for patients and society. Thus the RDU has become an important issue pertaining to worldwide health concerns. The over usage or the inadequate and wrong usage of drugs has led to the waste of scarce resources and widespread health hazards [1].

In order to solve the problem of irrational drug usage, China set forward a rational drug use policy in 2009. However, the implementation effects of the policy are not significant, mainly because it is unable to control and supervise the irrational drug usage behavior. To solve this problem, researchers and relevant departments have proposed many measurements for rational drug usage interventions, e.g., essential drug list programs, standard treatment guidelines, hospital pharmacy and treatment committees, rational drug usage training for medical staff, training for drug sales personnel. Empirical studies have illustrated that the essential drug list has a positive impact on rational drug usage behavior, however, some interventions are ineffective, such as drug usage guidelines, the dissemination of prescription information, and so on. Practical studies based on a variety of interventions have found that the long-term monitoring of rational drug usage is critical.

Although previous studies have proved that the RDUS has a restraining effect on doctors’ drug usage behavior [2], however, few studies have measured the comprehensive impact of the implementation of the RDUS on the medical quality between patients and doctors. Therefore, the authors of our
research cooperated with a large 3A-class hospital in Beijing to verify whether the implementation of the RDUS can help alleviate the problem of irrational drug usage, and thus have a positive effect on medical quality. At the same time, in order to further test the differences of this effect, our study explores the moderation of the severity of diseases and the degree of irrational drug usage of different departments on the application effects of the RDUS. Therefore, through empirical research, our study explores: (Q1) Can the implementation of the RDUS improve the quality of medical care between doctors and patients? (Q2) How do different departments/diseases affect the application effects of the RDUS?

The rest of this paper proceeds as follows. In the next section, we present a brief overview of prior research on rational drug usage and present the hypotheses of this study. Subsequently, we introduce the research design, research environment and the definition of the variables. Thirdly, we analyse the results of our study. This is followed by a discussion of our findings and their implications for IS research and practice. We end with a Conclusion.

2. Hypotheses

2.1. The Rational Drug Use System

Relevant studies have shown that the RDUS can provide the supervision of doctors’ medication behaviors by real-time warnings, and prompting and displaying doctors’ medication behaviors [3]. It helps in avoiding excessive consumption and the wastage of medical resources, and thereby ensures the dispensing of the right amount of medication. Therefore, ensuring the right amount of medication is to ensure the quality of medical care. In addition, the RDUS can also provide medication guidelines and prescription support for doctors other than the supervision of doctors’ medication behaviors. By using the RDUS, clinical pharmacists can provide timely communication and negotiate with attending doctors, so as to reduce and avoid unnecessary wrong medical advice. Therefore, the RDUS can ensure both the dispensation of the right amount of medication and the rationality of drug usage, in order to reduce patients’ health risks and improve medical quality. Moreover, The RDUS can provide the medication consultation services for patients, while it is also helpful for patients to understand doctors’ rational drug usage behaviors.

In conclusion, the RDUS is able to not only supervise doctors’ medication behaviors and support their dispensing of prescriptions, it can also improve the patients’ medicine literacy and the understanding of doctors’ prescriptions. Thus, the RDUS plays a positive role in the health of patients and improves the quality of medical services. Thus we hypothesize that:

**Hypothesis 1 (H1).** The usage of the RDUS has a positive impact on medical quality.

2.2. The Moderating Effects of the Severity of a Disease

It is well known that the different departments of a hospital have different characteristics, and the types and severity of diseases that departments treat are also different. The more severe the disease, the more complex is the treatment process. In these complex diagnoses and treatment processes, some doctors cannot read and browse all patients’ medical records within a short time, resulting in a large increase in the probability of doctors’ medication errors, which will result in high health risks and even life-threatening situations [4]. Moreover, the consequences of such medical accidents occurring in different departments will also be different. If it occurs in a department which treats serious illnesses, the adverse consequences of such an accident may not be restored or reversed. Accordingly, the system for the rational usage of drugs in the treatment process will play a greater role in the departments treating more severe diseases, and hence the risks of accidents, which will weaken the medical quality, may be reduced. Therefore, we propose the following hypothesis:

**Hypothesis 2 (H2).** The severity of diseases that a hospital department treats positively moderates the effect of the RDUS on medical quality.
2.3. The Moderating Effects of the Severity of a Disease

Different hospital departments have different specialized characteristics and personnel composition, and their cultural content and cultural constructions are also different. Due to the different cultural content and construction of each department, the standard degree of rational drug usage of each department is also different. In addition, there are great differences in the diagnosis and treatment system and even the income sources of each department, which also leads to different degrees of unreasonable medication behavior in each department. For example, some departments that are more dependent on drug revenue to generate income may have more common and serious irrational drug usage behaviors such as prescribing large prescriptions and drug overdoses, which also means that the degree of irrational drug usage is different in different departments. Thus, we hypothesize that:

**Hypothesis 3 (H3).** The degree of irrational drug usage of a department positively moderates the effect of the RDUS on the medical quality of a hospital department.

According to the above inferences and assumptions, the research model of this paper is constructed as shown in Figure 1.

![Research Model](image)

**Figure 1. Research Model**

3. Research Design

3.1. Experimental Environment

Our research context is based on a large public hospital known for integrating medical treatment, teaching, scientific research, and disease prevention. This hospital is established in a developed city: Beijing, the capital of China, in 1972. There are more than 60 medical departments in the hospital and it treats more than 60,000 patients per year. In March 2014, a RDUS system was implemented in this hospital and was designed to respond to the National Rational Drug Use Policy of 2009, which provides a natural chance for analysing the effects of the RDUS.

From an ethical viewpoint, we negotiated with public officials and hospital administrators on the conditions for our study and data requirements. With the consent of the government officials and the hospital administrators, we were able to access the hospitalization database after providing information on privacy protection and addressing the research questions on the impacts of the RDUS on medical quality by using the hospitalization data of this public hospital.

3.2. Data and Variables

The panel data includes diagnostic information for each department in the hospital from January 2013 to December 2015, and spanning the implementation of the RDUS on March 2014, such as inpatient numbers, the name of each department, treatment time, various medical fees, the usage of antibiotics, and so on. The data provides an opportunity for us to further explore the medical problems in China's public hospitals. We will use this data to develop econometric models to do a deep analysis of the impacts of the RDUS on medical quality at the departmental-level.

Based on our study, Table 1 presents the definition of all variables.
Table 1. Descriptions of Variables

| Variable type       | Variable name | Description                                                                 |
|---------------------|---------------|-----------------------------------------------------------------------------|
| Dependent variable  | hospital_stay | The average length of stay for the inpatient in a certain department within a certain month |
| Independent variable| Aftertreatment| If this department is affected by the system: 1; otherwise: 0               |
| Moderating variable | Mortality     | The percentage of inpatients who died after leaving the hospital in a certain department within a month |
|                     | antibiotics_using | If the antibiotic usage of this department within a month is excessive: 1; otherwise: 0 |
| Control variable    | Patients      | The number of patients in a certain department within a month               |

After data processing, the data included 888 hospitalization records at the departmental-level and the observation period was 12 months before and after the implementation of the RDUS. The descriptive statistical analysis of variables used in this chapter is shown in Table 2.

Table 2. Statistical Description of Variables

| Variables             | Obs. | Mean   | Std. Dev. | Min  | Max    |
|-----------------------|------|--------|-----------|------|--------|
| hospital_stay         | 888  | 12.931 | 13.633    | 0    | 124.615|
| Aftertreatment        | 888  | .606   | .489      | 0    | 1      |
| Patients              | 888  | 71.628 | 64.291    | 0    | 365    |
| Mortality             | 888  | .032   | .094      | 0    | .727   |
| antibiotics_using     | 888  | 1.427  | .495      | 1    | 2      |

4. Research Model and Results

4.1. Research Model
To test our hypotheses on the effects of the RDUS on medical quality, we formulated four models to examine how the medical quality changed after the system was implemented. The first model which explores the impacts of the RDUS is formulated as follows:

$$\ln(hospital\_stay_t) = \beta_0 * aftertreatment_t + \varepsilon_t$$  (4-1)

Next, we built our second model by adding the number of the patients as the control variable on the basis of the first model:

$$\ln(hospital\_stay_t) = \beta_0 * aftertreatment_t + \beta_1 * \ln(patients_t) + \varepsilon_t$$  (4-2)

Following that, we tried to explore how the severity of each department’s diseases moderated the impacts of the RDUS on the medical quality and formulated our third model thus:

$$\ln(hospital\_stay_t) = \beta_0 * aftertreatment_t + \beta_1 * \ln(hospital\_stay_t) + \beta_2 * mortality\_rate_t + \varepsilon_t$$  (4-3)

Finally, we took into consideration the interactions of the department’s antibiotic using’ on the appearance of the RDUS and completed our final model as follows:

$$\ln(hospital\_stay_t) = \beta_0 * aftertreatment_t + \beta_1 * \ln(hospital\_stay_t) + \beta_2 * antibiotic\_using_t + \beta_3 * aftertreatment_t * antibiotic\_using_t + \varepsilon_t$$  (4-4)

Let $i = 1, 2, ..., N$ be the index of the department.

4.2. Empirical Results
The regression results which we derived using ordinary least squares are presented in Table 4. In Columns1 to 4, we indicate the results of Models 1 to 4, respectively.

First, we show the results which indicate only the independent variable in Column 1 of Table 4. From this column, we can observe that the estimated coefficients are negative ($\beta=-0.066, p<0.01$). According to this statistically significant result, we have evidence to indicate that the average length of a hospital stay decreased about 6.6% after the implementation of the RDUS. Moreover, after adding the patient numbers of the department as the control variable in Column 2, we observe that the coefficients increased minimally and the result was also statistically significant ($\beta=-0.064, p<0.01$). Thus,
from the results of the two columns in Table 4, we can postulate that the RDUS can reduce the average length of a patient’s hospital stay and has positive impacts on medical quality.

Next, we added the mortality rate and the antibiotic using of the department to moderate the impacts of the RDUS on medical quality.

In Column 3 we show the results of Model 3 which used the mortality rate as the interactions on the aftertreatment. From the result, we can see that the estimated coefficient of aftertreatment*mortality_rate is negative and statistically significant (β=-0.206, p<0.1). As we mentioned previously, the mortality rate does measure the severity of a department’s disease. From the above analysis, we postulate that the severity of a disease has a positive moderation effect on the relationship between the RDUS and medical quality.

Finally, we present the results of Model 4 in the last column of Table 3. From the results in this column we can perceive that the coefficient of aftertreatment*antibiotic_using is also negative and significant (β=-0.057, p<0.1) which means that the antibiotic using of the department also has a positive moderation effect on the relationship between the RDUS and medical quality.

### Table 3. Parameter Estimates of Models *

|                      | Model 1   | Model 2   | Model 3   | Model 4   |
|----------------------|-----------|-----------|-----------|-----------|
| **Aftertreatment**   | -0.066*** | -0.064*** | -0.052**  | -0.025    |
|                      | (0.022)   | (0.024)   | (0.021)   | (0.024)   |
| **Mortality**        | 0.010     |           |           |           |
|                      | (0.172)   |           |           |           |
| aftertreatment*mortality | -0.206*  |           |           |           |
|                      | (0.120)   |           |           |           |
| **antibiotic_using**|           | -0.050    |           |           |
|                      |           | (0.032)   |           |           |
| aftertreatment*antibiotic_using | -0.057*  |           |           |           |
|                      |           | (0.035)   |           |           |
| **Constant**         | 2.448***  | 2.915***  | 2.670***  | 2.531***  |
|                      | (0.103)   | (0.436)   | (0.187)   | (0.115)   |
| Control              | N         | Y         | Y         | Y         |
| Individual FE        | N         | N         | N         | N         |
| R-squared            | 0.019     | 0.018     | 0.031     | 0.053     |
| N                    | 888       | 798       | 843       | 888       |

*p<0.10, ** p<0.05, *** p<0.010

### 5. Discussion

#### 5.1. Key findings

This study mainly explored the impact of the RDUS on medical quality. Firstly, we found that the implementation of the RDUS has a positive and significant impact on medical quality. Secondly, this study also explored the moderating role of the severity of diseases and the degree of irrational drug usage regarding the impact of the RDUS on medical quality. Moreover, we found that the severity of a disease strengthens the impact of the RDUS on medical quality. At the same time, the degree of irrational drug usage also strengthens the impact of the RDUS on medical quality.

#### 5.2. Theoretical Implications

More in-depth theoretical and practical exploration is still needed in the study of rational drug usage. Based on the empirical results of our study, we present the following theoretical contributions. Firstly, previous studies have proved that a rational drug usage policy can alleviate drug abuse, but the impact is difficult to quantify. An empirical research method was used to explore the impact of the RDUS on
medical quality, and the effect was quantified by our empirical data. Secondly, by synthesizing the impacts on doctors’ behavior, we considered the role of the patients involved in irrational drug usage and examined the comprehensive impacts of medical quality in this context. On the basis of the effective effect of the RDUS on doctors’ attitude towards patients’ drug usage behavior, this study stresses the positive influence of the RDUS on patients. In addition, this study examined the different effects of the RDUS on medical quality in different departments, and verified the existence of the differences between the severity of diseases and the standards of irrational drug usage, which provided a theoretical basis for further exploring the mechanism of the RDUS.

5.3. Practical Implications
This study also provides relevant practical implications. Firstly, the research results verified that the implementation of the RDUS can improve medical quality (that is, it reduces the average length of stay of patients), and proves the effectiveness and necessity of the implementation of the RDUS in hospitals. It is helpful in furthering the implementation of a rational drug usage policy, and promoting the application of the RDUS in hospitals, and improving patients' drug usage awareness. Secondly, by identifying the important role of patients practising rational drug usage, it is emphasized that while standardizing doctors' drug usage behavior, hospitals and society need to also pay attention to improving patients' drug usage awareness, so as to help them in avoiding irrational drug usage behaviour and doctor-patient conflicts caused by patients’ misunderstandings. Finally, the results indicate that the more serious a disease, the lower would be the standard of rational drug usage, and hence the more serious would be the irrational drug usage. Therefore, the results of this study also suggest that hospital managers should strengthen the strict supervision of their departments to avoid the overflow of drug abuse.

6. Conclusion
In this paper, we explored the impacts of the application of the RDUS on medical quality. We quantified the influence of the RDUS on the quality of medical care from a comprehensive perspective of doctors and patients. From the empirical results, we found that the implementation of the RDUS can effectively improve medical quality. In addition, we also explored the moderating of the severity of diseases and the degree of irrational drug usage. Our study purports that both the severity of a disease and the degree of irrational drug usage positively moderates the effect of the RDUS on medical quality.

Acknowledgements
This study was partially funded by the National Natural Science Foundation of China (71871073, 71871074, 71801062) and China Postdoctoral Science Foundation (2018M640301, 2019T120278).

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