

# Analysis of the characteristics of diabetic retinopathy inpatient records in 94 grade IIIA hospitals in China over 14 year

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## Research article

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# Abstract

**Background** To investigate the characteristics of epidemiology, clinical treatment and economic cost structure of inpatients with diabetic retinopathy (DR) in Chinese grade IIIA hospitals. **Methods** Data from the medical record home page (IMRHP) of all inpatients with DR from October 2001 to September 2014 were retrieved from the information management center system of 94 grade IIIA hospitals. **Results** A total of 65,759 inpatients with DR (71,686 eyes) were enrolled, accounting for 14.00% of all ophthalmology hospitalizations. During the 14-year period, the average length of hospitalization of DR inpatients and the average preoperative time dropped by 49.74% and 48.09%, respectively ( $p < 0.001$ ). The proportion of vitrectomies increased from 10.53% to 15.62%, and the proportion of intravitreal injections increased from 0% to 4.84%. The average hospitalization cost in 2014 was 2.2 times greater than in 2001, but the increase was lower than that of the per capita annual income in China. **Conclusions** The number of inpatients, the number of surgeries, and hospitalization costs show a significant upward trend. The statistics of the IMRHP data can provide reasonable suggestions and scientific support for the prevention and treatments of DR.

## Background

Curative measures for diabetes are still unavailable [1], and this chronic metabolic disease carries a high economic burden [2]. In 2015, the number of people affected by diabetes worldwide was about 415 million, and the International Diabetes Federation (IDF) predicted that this number would rise to 642 million in 2040 [3]. In addition to controlling blood glucose level, diabetic patients need to constantly prevent complications. Diabetic retinopathy (DR), a typical diabetic microvascular complication, can occur in almost all patients with diabetes after a sufficiently long course. DR is marked by vascular changes in different retinal layers, which may cause macular edema, macular ischemia and neovascularization, ultimately leading to visual impairment. DR is the leading cause of visual impairment in adults above working age, in particular in China [4-6]. Intensive management of diabetes, laser surgery, and vitreous cavity medication and surgery are the existing treatment options, and the last three need to be performed in hospitals [7].

In recent years, statistical management represented by the medical record home page management system has played an important role, as modern management techniques continue to extend in both breadth and depth of applications in hospitals. The items in the inpatient medical record home page (IMRHP) cover almost all the basic information about patients. Therefore, their analysis can provide the most direct decision-making basis for the diagnosis and treatment of diseases. In this study, the data mining technology of IMRHP was used to obtain information about DR inpatients in multi-center grade IIIA hospitals nationwide, and the characteristics of epidemiology, inpatient diagnosis and treatment, and economic costs were analyzed to provide data support based on a large sample for more effective prevention and treatment of DR in China.

## Methods

With the help of the Information Center of Logistics Support Department of the Central Military Commission, the IMRHP databases of 94 grade IIIA hospitals from October 2001 to September 2014 were searched, according to the International Classification of Diseases (ICD-9 and ICD-10) [8]. Data about inpatients diagnosed with "diabetic retinopathy" were collected for retrospective statistical analysis, including gender, age, admission mode, eye, diagnosis, time of admission, number of hospitalizations, length of hospital stay, surgery, cost, etc. The number of ophthalmic inpatients and inpatients with type 1 and type 2 diabetes in the same period, and inpatients with the diagnosis of vitreous hemorrhage, retinal detachment (RD), and neovascular glaucoma (NVG) were respectively counted and statistically analyzed. The exclusion criteria were: patients with other diseases not related to diabetes or incomplete clinical data. The study was submitted to and approved by the Medical ethics committee of Chinese PLA General Hospital.

In this study, GraphPad Prism was used for data collation and mapping and SPSS 23.0 was used to perform independent sample t-tests. The count variables were expressed as frequency, rate and composition ratio. The continuous variables were statistically described as mean  $\pm$  standard deviation.

## Results

A total of 53,587 patients were screened in this study, and 65,759 person-times were analyzed (32,257 males; 33,502 females) and 71,686 eyes (49.3% were left eyes and 50.7% right eyes) were selected (Fig. 1a), including 3,936 emergency admissions and 76 hospital transfers. During the same period, the number of ophthalmic inpatients was 469,840, and that of diabetic inpatients was 859,516. DR patients accounted for 14.00% of ophthalmology hospitalizations and 7.65% of diabetes hospitalizations.

### 3.2 Time distribution

According to the discharge time, DR patients were evenly distributed during the year, with 15,039 person-times in spring, 17,564 in summer, 16,092 in autumn, and 17,064 in winter.

### 3.3 Hospitalization frequency and hospitalization days of patients with DR.

The average hospitalization frequency of the 53,587 inpatients was 1.23 times, and 45,685 patients were hospitalized only once, accounting for 69.47% of all DR patients. Among them, 39 patients were hospitalized more than 10 times, and the length of hospital stay increased with the number of hospitalizations (Table 1). From 2001 to 2014, the hospital stay length and the preoperative time of DR

patients in these 94 hospitals decreased statistically ( $p < 0.001$ ). The average hospital stay decreased from 21.07 days to 10.59 days, i.e. by 49.74%; the average preoperative time decreased from 10.19 days to 5.29 days, i.e. by 48.09% (Fig. 1b).

### 3.4 Age distribution

The youngest patient with DR was 12 years old, and the oldest was 108 years old; the average age was  $58.88 \pm 11.85$  years. Among these patients, 98.55% were aged between 20 and 80 years old, 58.77% were 40 to 60 years old, and 20% were 20 to 40 years old (Table 2).

### 3.5. Surgery

Two surgical procedures are available for treating DR: intravitreal injection and vitrectomy, the latter being more common than the former (Table 3). After 2001, the number of surgeries for inpatients continued to increase, with the proportion of vitrectomies rising from 10.53% to 15.62% and that of intravitreal injections from 0% to 4.84% (Fig. 1c, 1d, 1e). The number of vitrectomies in 2013 was 2.84 times that in 2002 and the number of combined lens surgery operations also increased rapidly. Unfortunately, 39 patients (39 eyes, 0.06%) underwent enucleation due to eyeball atrophy.

### 3.6. Complications

Data about patients with three common and serious complications of DR (vitreous hemorrhage, RD, NVG) were collected, and included 3,377 cases, 778 cases, and 614 cases, respectively. The average age of those patients was  $54.68 \pm 10.76$ ,  $53.60 \pm 10.99$ , and  $54.62 \pm 12.48$  years, respectively, in all three cases younger than the average DR hospitalization age ( $P < 0.001$ ) (Table 4). Since 2001, the number of patients with complications has increased with the number of hospitalizations, accounting for 1.61%-6.74%, 0.60%-1.50%, and 0.51%-1.50% of all DR patients, respectively (Fig. g).

### 3.7. Hospitalization cost

The hospitalization cost of DR patients mainly includes surgery cost, medicine cost and other costs (such as inspection cost, nursing cost, etc.). The proportion of surgery cost and drug cost has remained stable for more than ten years, representing about 10% and 40% of the total cost, respectively. The total hospitalization costs have steadily increased, and the difference among different years is statistically significant ( $p < 0.001$ ). The average cost in 2014 is 2.2 times greater than that in 2001 (Fig. 1f, 1h). Compared with the per capita annual income of urban and rural residents in China, however, the average hospitalization cost of DR patients decreased from 163.99% of rural per capita annual income in 2001 to 113.81% in 2014, and from 48.19% of urban per capita annual income to 41.39% [9].

## Discussion

The annual incidence of DR ranges from 2.2% to 12.7%, and the progression rate varies from 3.4% to 12.3% in different regions [10]. With the diffusion of unhealthy living habits and the increase of life expectancy, the patient population of DR is constantly expanding. Data of 53,587 inpatients were included in this study, accounting for 14.00% of concurrent ophthalmic inpatients, indicating that the diagnosis and treatment of DR is one of the main components of ophthalmic clinical work. Moreover, DR is also one of the most important complications of diabetes. It has been reported in the literature that 30% of diabetic patients have concurrent DR, and 5% to 10% of diabetic patients have visual impairment. The proportion recorded in this study (7.65%) suggests that the emphasis on DR is still insufficient [11]. The incidence of DR has little to do with season and climate, indicating that it is a disease worthy of our constant vigilance and attention. In addition, the fact that inpatient growth was greater than that of the epidemiological data may be related to the improvement of family economic conditions and of health care in China since the beginning of the 21st century.

In the study, nearly 70% of DR patients were hospitalized only once. Excluding the situation of some patients receiving medical treatment in other places, the effectiveness and necessity of hospitalization can still be illustrated. After 2001, the substantial progress in the medical strength of Chinese hospitals played a very important role in fighting DR. Another change in the past decade was that hospitals have generally begun to emphasize maximum bed rotation rate and utilization of medical resources, which is also reflected in this study. Since 2001, the number of days in hospital and days before surgery have been continuously and significantly reduced, and in 2014 they correspond to half what they were in 2001. On the one hand, this allows more patients to benefit from medical resources; on the other hand, it may partly result in a decline of medical effectiveness.

Another reason why DR needs to concern us is that it is most common in working people aged 40-60, the age of value creation. As a result, society suffers economic losses and places a heavy burden on families, and the increase in hospital costs has been less kind to the poor. Moreover, DR patients almost inevitably progress in the direction of visual impairment, increasing the pressure on families to care for them. Studies have shown that about 39% of young diabetic patients could have DR within ten years [12]. In this database, young DR patients account for 20% of the total, suggesting that the attention to DR should not

be reserved to middle-aged and elderly people. Whether they can control the progress of DR in the following decades will greatly affect their lives.

In a clinical setting, retinal experts can surgically intervene in the progression of DR, and the new method developed in the past decade is to inject drugs directly into the vitreous cavity. The results suggest that intravitreal drug injection is on the rise year by year, because it allows the drug to act directly on the relevant tissues with minimal systemic exposure. Intravitreal injections have a lower risk of complications (such as retinal detachment and severe infection), but they often need to be repeated monthly because of their short duration. Currently, anti-vascular endothelial growth factors (anti-VEGF) and hormones (triamcinolone, dexamethasone) are widely used, and the application of anti-VEGF drugs in eliminating diabetic macular edema (DME) and reducing bleeding before and after vitrectomy is increasingly recognized by clinical ophthalmologists [13-14]. It is noteworthy that most intraocular injections are performed in the outpatient department, and leave no hospitalization records. Therefore, these data may not be sufficient to reflect the actual situation of its application in China. Vitrectomy involves surgical removal of the vitreous gel, the main indication being the removal of vitreous hematocoele and the repair of traction retinal detachment. The surgery is very complicated and it usually takes a long time to restore vision [15]. In recent years, vitrectomy has become increasingly popular in China, but surgical skill levels are uneven, which may be one of the reasons why some patients undergo the operation multiple times. The data show that the use of all types of surgery is on the rise, including combined surgery with cataract, which is considered to be related to the maturity of the diagnosis and treatment scheme, and the economic benefits brought to hospitals and doctors by the operation.

Studies have shown that hospitalization costs are closely related to age, gender and complication type [16]. The proportion of complications such as vitreous hemorrhage, RD and NVG has not decreased, indicating that the progress of DR in the past decade was not well controlled. In clinical practice, many patients with diabetes or DR are accidentally discovered after a long illness, due to lack of awareness and the conditions of routine physical examinations. Even if they are known to have diabetes or DR, a considerable number of patients still cannot follow the doctor's advice to do regular follow-ups until they have obvious visual impairment or eye pain. In China, there is still a long way to go to strengthen the health education of diabetes patients, popularize knowledge about DR prevention and treatment, and conduct regular eye examinations. The main risk factor for DR are not limited to persistent hyperglycemia, but also hypertension, dyslipidemia and pregnancy play a role [5,6]. Studies have shown that diabetic patients without evidence of DR are recommended to have their eyes checked every two years. Patients with long-lasting diabetes, poor control of blood glucose and lipids, or high-risk hypertension require an annual eye exam. Blindness caused by DR can be prevented through appropriate screening and treatment [7].

According to the data, the hospitalization cost of DR increased year by year, but when annual per capita incomes from 2001 to 2014 are taken into account, this might actually represent a downward trend in the burden of DR [9,17]. However, in 2014, the most recent year for which research statistics are available, the hospitalization cost of DR was still higher than the per capita annual income in rural areas, which proves

that it still had a great impact on the low-income groups. To reduce the burden, doctors should reduce irregular operations, drug abuse and unnecessary examinations; hospitals should strengthen their control on the patient hospitalization process, simplify procedures and maximize the use of medical resources. Economic evaluation is becoming increasingly important.

With the popularity of the Internet of Things (IoT) and cloud computing, the trend of hospital informatization has been further accelerated. The reliability of electronic medical record data has been gradually confirmed. As an objective, accurate and high-quality data source, the IMRHP has played an increasingly important role in hospital decision-making, cost management, diagnosis, and treatment. The major and unique advantages of this study consist in the use of a well-structured standardized system, the adoption of medical big data information management and analysis technology, and the tracking of clinical electronic databases of the hospitals included in the information center for more than 10 years. By virtue of its wide range (94 grade IIIA hospitals in China), large sample size (65,759 person-times, 71,686 eyes) and reliable data (consistent electronic medical record system), more convincing answers can be extracted from the clinical data of DR inpatients.

Data analysis based on the IMRHP has its limitations. First, it is impossible to obtain more specific clinical data in addition to those included in the system-set options. Second, there is the possibility of inaccurate filling of diagnosis and surgical coding, which may affect the results. Third, researchers cannot infer causal relationships because of the nature of observational studies.

## Conclusions

In summary, this study analyzed the clinical characteristics and hospitalization cost structure of DR through a retrospective analysis of the IMRHP, providing rational advice and scientific data support for diagnosis and treatment. Since the beginning of the 21st century, the number of patients with DR has increased dramatically, thus exerting great pressure on the medical system. Although the concept of health and rational thinking leading to seek medical treatment have become more and more popular in China, some DR patients still face the challenges of late treatment, suggesting that the community-based and hospital-based DR diagnosis and treatment system still has a long way to go.

## Abbreviations

DR	diabetic retinopathy
IMRHP	inpatient medical record home page
ICD-9	International Classification of Diseases
RD	retinal detachment
NVG	neovascular glaucoma
EMRs	electronic medical records
anti-VEGF	anti-vascular endothelial growth factors
DME	diabetic macular edema
IoT	Internet of Things

## Declarations

Ethics approval and consent to participate: The study was submitted to and approved by the Medical ethics committee of Chinese PLA General Hospital.

Competing interests: The authors declare that they have no competing interests.

Ethics approval and consent to participate

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Authors' contributions: RPL, YZ, and MNZ defined the research theme. ZZ designed methods. RPL and WYL interpreted the results. YNS and JY co-worked on associated data collection and their interpretation. All authors read and approved the final manuscript.

Availability of data and materials section : All data generated or analysed during this study are included in this published article and its supplementary information files.

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## Tables

Table 1 Times and duration of hospitalization

Times of hospitalization	1	2	3	4	5	6	7	8	9	≥10	Totle
Number of patients	45685	5617	1422	473	173	93	38	32	15	39	53587
Mean hospitalization days	13	14	15	17	17	16	19	16	18	21	897191

Table 2 Age distribution of DR patients

Age	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	≥90	Totle
Number of male patients with DR	25	350	1906	6319	9543	8094	4901	1046	27	46	32257
Number of female patients with DR	37	392	776	4150	10183	10827	6262	797	49	29	33502
Number of patients with DR	62	742	2682	10469	19726	18921	11163	1843	76	75	65759
Number of patients with diabetes	751	3169	9343	33068	108435	199900	217139	203850	78618	5243	859516

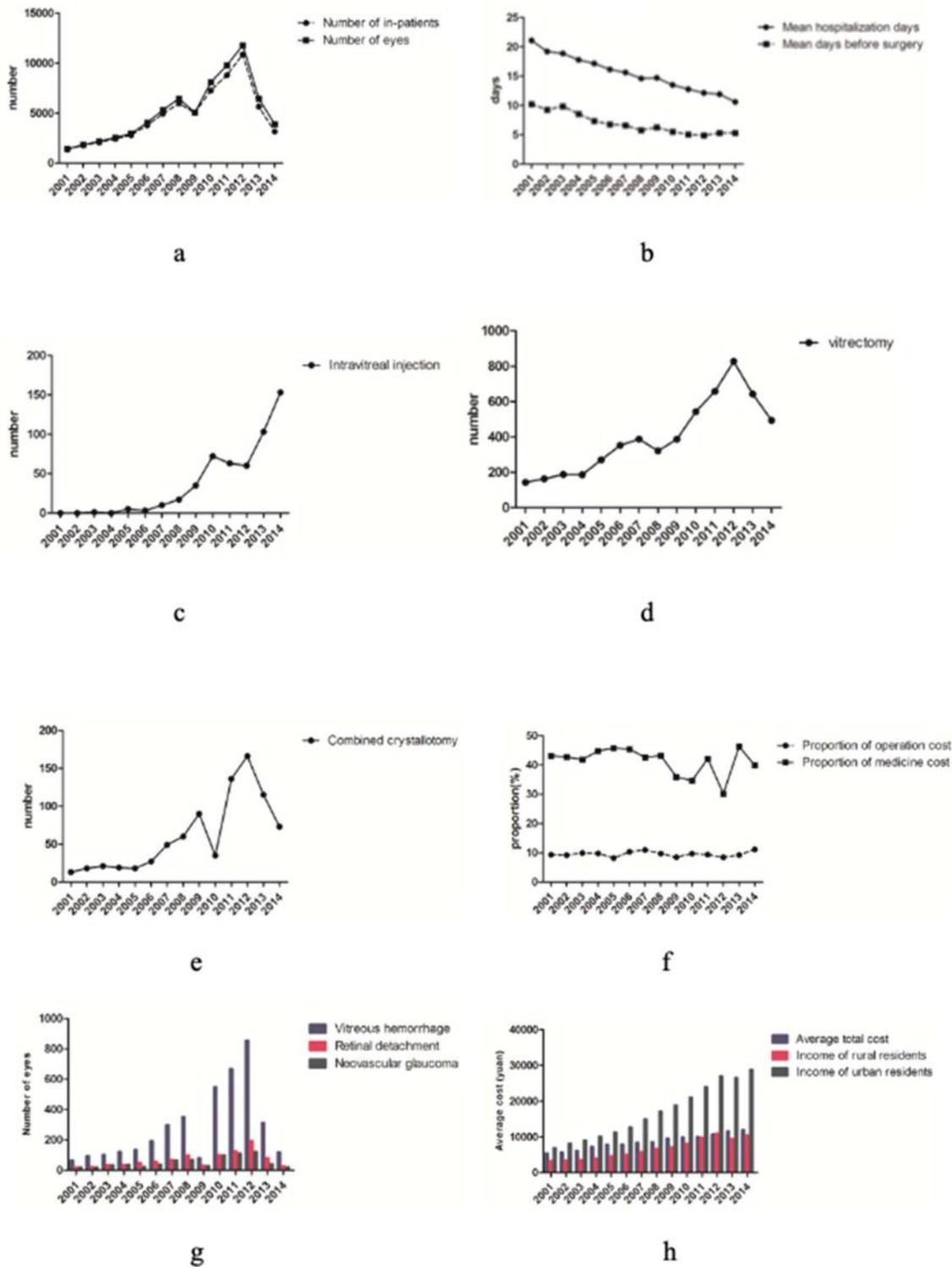
Table 3 The operation of DR

Operative types	Number of patients	Total number of operations	Maximum number of operations	Proportion of patients undergoing surgery
Intravitreal injection	448	522	4	0.84□
Vitreotomy	4668	5563	5	8.71□

Table 4 Complications of DR

Diseases	Number of patients	Number of eyes	Minimum age	Maximum age	Mean age	Mean hospitalization days	Average number of operations	Mean days before surgery
DR	65759	71686	12	108	58.88±11.85	14.19	0.30	5.96
DR with Vitreous hemorrhage	3377	3941	21	89	54.68±10.76	13.15	0.84	5.01
DR with Retinal detachment	778	938	20	94	53.60±10.99	13.04	0.83	4.903
DR with Angiogenic glaucoma	614	721	17	86	54.62±12.48	14.37	0.71	5.95

## Figures



**Figure 1**

Basic information about inpatients with diabetic retinopathy from 2001 to 2014 (a) number of inpatients and eyes (b) mean hospitalization days and days before surgery (c) number of intravitreal injections (d) number of vitrectomies (e) number of vitreoretinal surgeries (f) proportion of operation cost and drug cost in hospitalization expenses (g) frequency of three complications (h) average hospitalization expense compared with the income of rural and urban residents

## Supplementary Files

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

- [DRDATA.xls](#)