• Investigation •

Diagnosis related group grouping study of senile cataract patients based on E-CHAID algorithm

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Abstract

• AIM: To figure out the contributed factors of the hospitalization expenses of senile cataract patients (HECP) and build up an area-specified senile cataract diagnosis related group (DRG) of Shanghai thereby formulating the reference range of HECP and providing scientific basis for the fair use and supervision of the health care insurance fund.

• METHODS: The data was collected from the first page of the medical records of 22 097 hospitalized patients from tertiary hospitals in Shanghai from 2010 to 2012 whose major diagnosis were senile cataract. Firstly, we analyzed the influence factors of HECP using univariate and multivariate analysis. DRG grouping was conducted according to the exhaustive Chi-squared automatic interaction detector (E-CHAID) model, using HECP as target variable. Finally we evaluated the grouping results using non-parametric test such as Kruskal-Wallis *H* test, RIV, CV, *etc.*

• RESULTS: The 6 DRGs were established as well as criterion of HECP, using age, sex, type of surgery and whether complications/comorbidities occurred as the key variables of classification node of senile cataract cases.

• CONCLUSION: The grouping of senile cataract cases based on E-CHAID algorithm is reasonable. And the criterion of HECP based on DRG can provide a feasible way of management in the fair use and supervision of medical insurance fund.

• KEYWORDS: diagnosis related group; senile cataract; hospitalization expenses; E-CHAID algorithm
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INTRODUCTION

At present, the reform of the pharmaceutical and health care system has come to a pivotal stage. And the reform of payment mode of medical insurance is the attention focus of all three sides. The result of exploration to a scientific and reasonable payment mode of medical insurance which is acceptable and satisfactory to all demander (patients), payer (medical insurance bureau) and medical service provider (hospitals), is critical to the successful implementation of medical insurance reform[1]. Diagnosis related group (DRG) is a method recognized internationally to formulate the reference range of medical expenses. It can reduce the difficulty and cost of management in medical insurance organization and facilitate macro-forecast and control of medical expense[2-5]. Senile cataract is the main cause of blindness in the aged in China. According to recent growing trend, the number of cataract patients in China is going to reach 5.0625 million in 2020. The disease causes severe public health problem, impacting patients and their families greatly, and bringing heavy financial burden to the whole society meanwhile[6-8].

The study of DRG and its application is still under exploration in China. This paper examined the factors that influence the hospitalization expenses of senile cataract patients in Shanghai from 2010 to 2012, and tried to establish the senile cataract DRG to obtain the medical expense standard in each group. The result can provide as reference in future implementation of DRG management and payment in senile cataract by medical decision-making departments.

MATERIALS AND METHODS

Data source Data was collected from the first pages of the medical records data base of hospitalized patients from tertiary hospitals in Shanghai from 2010 to 2012 whose major diagnosis were senile cataract (ICD-10, code H25). Our data is provided by the Bureau of Medical Administration,

National Health and Family Planning Commission of the P. R. China. The number of efficient cases in all 29 798 patients are 22 097, eliminating 7701 cases with omission, missing items, logic error or ended up uncured. The surgery code is ICD-9-CM-3, 13.1908, 13.5901, 13.7101, 13.7103, standing for cataract phacoemulsification, extracapsular cataract extraction, intraocular lens implantation with cataract extraction and phacoemulsification plus intraocular lens implantation respectively.

According to existing research[9], classification indicators fall into three groups: social economic factors such as sex, age, marital status and type of payment; clinical factors such as times of hospitalization, condition of admission, whether complications/comorbidities occurred (such as hypertension, anisometropia, diabetes, post-procedural disorder of eye and adnexa, unspecified, chronic ischemic heart diseases), type of surgery and condition after hospitalization; medical consumption, *i.e.* the total medical expense of the patients (Table 1).

Decision Tree E-CHAID Analysis Exhaustive Chi-squared automatic interaction detector (E-CHAID) was adopted to build the decision tree. This method was proposed by Biggs *et al*[10] in 1991, modified from Kass's CHAID algorithm in 1975. E-CHAID adopts the group-to-the-end strategy when choosing the optimal grouping factor, *i.e.* retain the preprocessing result of the input variables and use the groups as brunches of decision tree, while keep joining the input variable groups until two final group or super-category form when calculating the *P*-value of test statistics, then ensure all the degree of freedom of the input variables statistics are equal, compare *P*-value, and take the input variable with the smallest *P*-value as the current optimal grouping variable[11].

Parameter Setting We set 4 classification nodes for the infinite Chi-square automatic interaction testing. The terminating condition of decision tree is reaching the maximal 4 levels, when the sample size of parent node is less than 100, or when child node less than 50. The confidence coefficient of separation and combination is 95%, and P=0.05 in F-test.

Evaluation Index Our study uses reduction in variance (RIV) and coefficient of variation (CV) to evaluate the grouping result of each group. Note that bigger RIV indicates greater heterogeneity among groups and thus better grouping. While smaller CV indicate smaller variation inside the group and thus better grouping[12].

Statistical Analysis Median and interquartile range were adopted to conduct descriptive statistical analysis with the data. And Mann-Whitney *U* test, Kruskal-Wallis *H* test, multiple linear regression analysis, *etc.* were used to analyze the factors influencing hospitalization expense.

All data was built into a database in excel. Decision tree E-CHAID and statistical analysis were conducted with the software SPSS 18.0 (USA) at a significant level of P=0.1.

Table 1 Selected variables and their assignments

Variables	Assignments
Social economic factors	
Sex	M; F
Age	<50; 50-60; 60-70; 70-80; >80
Marital status	Married; unmarried
Type of payment	Medical insurance; self-paying; others
Clinical variable	
Times of hospitalization	Zero; one; two; three; more than three
Condition of admission	Very urgent; urgent; mild
Whether complications/ comorbidities occurred	No; yes
Surgery type	13.1908; 13.5901; 13.7101; 13.7103
Diagnosis after hospitalization	Cured; improved
Medical consumption	
Total expense	Total expense of each hospitalization

RESULTS

General Condition In 22 097 senile cataract patients, male accounts for 40.02% (8843), while female accounts for 59.98% (13 254). The major age group is 70-80, accounts for 43.37% (9583). Surgery type ICD-9-CM-3 is 13.7103. Phacoemulsification plus intraocular lens implantation account for 72.90% (16 110 cases). Taking into account the clinical variables, especially variable complications/comorbidities, in 5940 cases of patients with complications/comorbidities, hypertension accounts for 26.23% (1558), anisometropia accounts for 17.76% (1055), diabetes accounts for 15.79% (938), post-procedural disorder of eye and adnexa, unspecified accounts for 6.87% (408), chronic ischemic heart diseases accounts for 1.72% (102) (Table 2).

Analysis of the Factors Influencing Medical Expenses of Hospitalization

Univariate analysis Hospitalization expense were used as analyzed variable, and sex, marital status, age, type of payment, times of hospitalization, condition of admission, whether complications/comorbidities occurred, diagnosis after hospitalization and surgery type as grouping variables to conduct Mann-Whitney *U* test and Kruskal-Wallis *H* test. The result shows that all the factors were statistically significant.

Multivariable analysis Conduct Multiple Linear Regression analysis using hospitalization expenses as dependent variable and social variables (sex, marital status, age, type of payment), clinical variables (times of hospitalization, condition of admission, whether complications/comorbidities occurred, diagnosis after hospitalization and surgery type) as independent variables. The result shows eight variables (sex, marital status, age, type of payment, condition of admission, whether complications/comorbidities occurred, diagnosis after hospitalization and surgery type) of the nine independent variables were statistically significant. Among the factors influencing hospitalization expenses of senile cataract patients, whether complications/comorbidities occurred has the most

Table 2 Hospitalization expense of senile cataract patients with different characteristic

Classification variables	No. of cases	Median (CNY)	Mean (CNY)	Lower quartile (CNY)	Upper quartile (CNY)	*P*
Social variable						
Sex						0
Male	8843	6412	6470	6101	6864	
Female	13254	6382	6430	6091	6756	
Marital status						0
Married	20919	6712	6729	6347	7151	
Unmarried	1178	6380	6430	6082	6771	
Age						0
<50	265	6360	6432	6146	6894	
50-60	2005	6382	6431	6086	6806	
60-70	4885	6418	6480	6122	6857	
70-80	9583	6402	6455	6106	6791	
>80	5359	6356	6404	6043	6768	
Type of payment						0
Insurance	20866	6394	6447	6103	6792	
Self-paying	163	5894	5892	5792	6014	
Others	1068	6459	6492	6042	6996	
Clinical variable						
Times of hospitalization						0
0	3422	6269	6344	6035	6471	
1	16265	6431	6472	6145	6848	
2	1924	6391	6378	5888	6812	
3	300	6527	6513	6049	6901	
>3	186	6601	6658	6095	7085	
Condition of admission						0
Very urgent	54	6683	6777	6416	7253	
Urgent	3931	6415	6453	6262	6608	
Mild	18112	6375	6443	6034	6831	
Whether complications/comorbidities occurred						0
No	16157	6358	6379	6082	6710	
Yes	5940	6534	6628	6129	7060	
Diagnosis after hospitalization						0
Cured	22038	6393	6444	6094	6796	
Improved	59	6545	6933	6234	7290	
Surgery type						0
13.1908	784	6619	6651	6234	7018	
13.5901	409	5363	5454	4849	5913	
13.7101	4794	6215	6156	5755	6664	
13.7103	16110	6438	6547	6161	6839	

CNY: China Yuan.

significant influence according to the standardized coefficient (Table 3).

Diagnosis related group grouping scheme of senile cataract in Shanghai According to the analysis of hospitalization expenses-influencing factors mentioned above, combined with Delphi method and relevant literature[13], the following four variables were chosen as explanatory variables: surgery type, whether complications/comorbidities occurred, age and sex; and medical expenses was target variable. Decision tree E-CHAID model was used to group data into 10 DRG. The mean, median, standard deviation and coefficient of variation are showed in the following table. The first grouping node variable selected by E-CHAID is surgery type. The second is whether complications/comorbidities occurred. And the third, age and sex. As demonstrated in Table 4, the average expenses and median in DRG2, DRG3, DRG4, DRG5, DRG6, DRG8 and DRG9 are

Table 3 Result of multiple stepwise regression analysis of the factors influencing hospitalization expenses of senile cataract patients

Variables	Unstandardized coefficients	Standard error	Standardized coefficients	*t*	*P*
Constant term	8561.38	724.43		11.82	0.00
Sex	-35.31	10.20	-0.02	-3.46	0.00
Marital status	-342.81	21.00	-0.11	-16.33	0.00
Age	-12.57	5.16	-0.02	-2.44	0.02
Type of payment	13.20	4.14	0.02	3.19	0.00
Times of hospitalization	0.80	7.60	0.01	0.11	0.92
Condition of admission	-77.52	12.93	-0.04	-5.99	0.00
Whether complications/comorbidities occurred	263.55	11.54	0.16	22.84	0.00
Diagnosis after hospitalization	429.74	96.68	0.03	4.45	0.00
Surgery type	-120.16	52.02	-0.02	-2.31	0.02

Table 4 The DRG grouping scheme of senile cataract in Shanghai

Groups	Conditions	No. of cases	Average expenses (CNY)	Median (CNY)	Standard deviation	Coefficient of variation
DRG1	Surgery type 13.7101, without complications/ comorbidities	3618	6061	6193	836.01	0.14
DRG2	Surgery type 13.7101, with complications/ comorbidities, male	480	6538	6521	1036.18	0.16
DRG3	Surgery type 13.7101, with complications/ comorbidities, female	696	6387	6459	1000.71	0.16
DRG4	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age <50	96	6681	6462.5	730.40	0.11
DRG5	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age 51-70	3671	6545	6443	595.52	0.09
DRG6	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age 71-80	5417	6493	6417	591.97	0.09
DRG7	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age >80	3017	6450	6376	613.14	0.10
DRG8	Surgery type 13.7103 or 13.1908, with complications/comorbidities, male	1818	6733	6581.5	828.14	0.12
DRG9	Surgery type 13.7103 or 13.1908, with complications/comorbidities, female	2875	6661	6528	756.35	0.11
DRG10	Surgery type 13.5901	409	5454	5363	864.54	0.16

DRG: Diagnosis related group; CNY: China Yuan.

approximately equal respectively. Take the high incidence of senile cataract into consideration, too many groups may impair the clinical use in daily medical process. Therefore, our study divides the senile cataract cases in Shanghai into 6 groups, merging DRG2 with DRG3; DRG4, DRG5 with DRG6; and DRG8 with DRG9 (Table 5).

Evaluation of Diagnosis Related Group Grouping

Kruskal-Wallis *H* test Because the hospitalization expenses are not normally distributed, rank sum test Kruskal-Wallis *H* test is used for data analysis. By means of non-parametric test of hospitalization expenses of each group, the difference among the hospitalization expenses of the 6 DRG is demonstrated to be statistically significant with the rank sum test statistic equaling 1729.957, degree of freedom equaling 5, and $P<0.01$. This indicates that the grouping model is reasonable.

Reduction in variance value Calculate the RIV value based on formula: RIV=(quadratic sum of total deviation from average–summation of the quadratic sum of total deviation from average of *n* subsets)/quadratic sum of total deviation from average, and compare the variation among hospitalization expenses of each group with the total variation. RIV value turns out to be 9.96%. Hence the grouping modal is conceived to be effective.

Coefficient of variation value CV is designed for the evaluation of the homogeneity of medical resources consumption inside the group. The CV value of the 6 groups in our study is presented in Table 4. All coefficients of variation are less than 1, fluctuating between 0.09 and 0.16. This indicates a high homogeneity inside the group, thus a reasonable grouping.

The standard expenses of each diagnosis related group and analysis of excess After grouping the senile cataract cases as

Table 5 DRG grouping scheme of senile cataract in Shanghai after recombination

Group	Conditions	No. of cases	Average expenses (CNY)	Median (CNY)	Standard deviation	Coefficient of variation
DRG1	Surgery type 13.7101, without complications/ comorbidities	3618	6061	6193	836.01	0.14
DRG2	Surgery type 13.7101, with complications/ comorbidities	1176	6449	6497	1017.62	0.16
DRG3	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age <80	9184	6516	6430	595.72	0.09
DRG4	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age >80	3017	6450	6376	613.14	0.10
DRG5	Surgery type 13.7103 or 13.1908, with complications/comorbidities	4693	6689	6547	785.63	0.12
DRG6	Surgery type 13.5901	409	5454	5363	864.54	0.16

DRG: Diagnosis related group; CNY: China Yuan.

Table 6 Setting of the hospitalization expenses of each DRG

Group	Conditions	No. of cases	Standard expenses (CNY)	P_{75}	Interquartile range	Upper limit of expenses	No. of cases exceeding the upper limit
DRG1	Surgery type 13.7101, without complications/comorbidities	3618	6193	6493	738	7600	68 (1.9%)
DRG2	Surgery type 13.7101, with complications/ comorbidities	1176	6497	6999	1139	8707	22 (1.9%)
DRG3	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age <80	9184	6430	6777	597	7673	319 (3.5%)
DRG4	Surgery type 13.7103 or 13.1908, without complications/comorbidities, age >80	3017	6376	6716	595	7609	119 (3.9%)
DRG5	Surgery type 13.7103 or 13.1908, with complications/comorbidities	4693	6547	7083	926	8471	157 (3.3%)
DRG6	Surgery type 13.5901	409	5363	5912	1063	7507	12 (2.9%)

DRG: Diagnosis related group; CNY: China Yuan.

mentioned, use median method to obtain the reference value of hospitalization charging standard in hospitals[14-15]. Despite the little variation of hospitalization expenses inside group, extreme value of expenses often occur in practice due to individual variation. As a result, the standard expenses of each group is not applicable to all cases. Referring to the method used by Gao *et al*[16] in the analysis of hospitalization expenses of digestive system disease, our study adopts 75% expenses of each group plus 1.5 times interquartile range (P_{75}+1.5Q) as the upper limit of the expenses control[17]. And 697 cases appear to exceed the limit, which account for 3.15% of the total cases (Table 6). The exceeding expenses add up to 5 847 523 China Yuan (CNY), accounting for 4.1% of the total expenses in our study.

DISCUSSION

The Importance of the Development of Senile Cataract Diagnosis Related Group According to the practice of DRG in other countries, DRG is a relatively effective method of medical expenses management and quality evaluation, which gives consideration to the interest of all sides including government, hospital and patients, and helps to reach a balance between quality and expenses of medical care[18]. Senile cataract is a common disease in ophthalmology. The diagnosis and treatment of different patients are similar, while the hospitalization expense varies significantly. The medical insurance system of Shanghai brought a new policy into force in 2004 in which senile cataract adopts single disease payment system. The lack of consideration of the variation of medical resource consumption resulted from the difference of patients' condition and treatment, may contribute to the overload of expenses at senile cataract patients' own, or unreasonable expenditure of government[19]. Through the analysis of all senile cataract cases in tertiary hospitals in Shanghai in 2012-2014, we build DRG and formulate an expenses standard of senile cataract based on the reality in Shanghai, which provide health administrative departments with reference to the establishment of payment method based on DRG applicable to China and reduction of medical expenditure meanwhile.

Selection of Grouping Node Variable Based on the analysis of factors influencing hospitalization expenses of senile cataract patients combined with the specificity of senile cataract and opinion from specialists, 4 factors are chosen as the grouping node of E-CHAID including surgery type, age, sex and whether complications/comorbidities occurred. In addition, another key problem in building tree model in E-CHAID is the number of classification node and when to stop the growth of the tree. Too less nodes result in a poor distinction of patients and a wide variation of expenses inside group. While too many nodes generate a huge tree which is

unpractical for subsequent use and may lead to overfitting of the model[20].

The following 4 are frequently used surgery type of senile cataract: cataract phacoemulsification, extracapsular cataract extraction, intraocular lens implantation with cataract extraction and phacoemulsification plus intraocular lens implantation. Different surgery types are of different costs of operation and correlating medical consumables. Moreover, the hospitalization expenses increases with age. As getting older, the worsening of physical state and resistance to disease as well as a slower recuperation, contribute to higher expenses collectively. Furthermore, whether complications/comorbidities occurred is of the most influence among the contributed factors of hospitalization expenses of senile cataract. The extra care required by patients with complications/comorbidities leads to the relatively higher expenses compared to those without complications/comorbidities.

Formulation of Hospitalization Expenses Standard

Because the data is not normally distributed, median method is used for the standard expenses. Median method uses the median value of the expenses of each group as the standard expenses, and 75% of the expenses in each DRG plus 1.5Q as the upper limit. These reference values offer basis for the establishment of payment compensation standard of senile cataract hospitalization expenses in practice. And hospitals can define the optimal limit of medical resource consumption of correlated disease and effectively control the expenses within the payment standard of certain DRG to avoid waste of medical resources according to the upper threshold of expenses in each DRG.

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REFERENCES

1 Wan HW. The inspiration to the disease payment method in China from DRG payment system abroad. *Medical and Philosophy* 2012;33(11):45-47.

2 Goldfield N. The evolution of diagnosis-related groups (DRG): from its beginnings in case-mix and resource use theory, to its implementation for payment and now for its current utilization for quality within and outside the hospital. *Qual Manag Health Care* 2010;19(1):3-16.

3 Jian W, Lu M, Chan KY, Poon AN, Han W, Hu M, Yip W. Payment reform pilot in Beijing Hospitals reduced expenditures and out-of-pocket payments per admission. *Health Aff (Millwood)* 2015;34(10): 1745-1752.

4 Kim TH, Park EC, Jang SI, Jang SY, Lee SA, Choi JW. Effects of diagnosis-related group payment system on appendectomy outcomes. *J Surg Res* 2016;206(2):347-354.

5 Polyzos N, Karanikas H, Thireos E, Kastanioti C, Kontodimopoulos N. Reforming reimbursement of public hospitals in Greece during the economic crisis: implementation of a DRG system. *Health Policy* 2013; 109(1):14-22.

6 Zhu M, Yu J, Zhang J, Yan Q, Liu Y. Evaluating vision-related quality of life in preoperative age-related cataract patients and analyzing its influencing factors in China: a cross-sectional study. *BMC Ophthalmol* 2015;15:160.

7 Xiao BX, Yi JL, Limburg H, Zhang GS, Mesurier RL, Muller A, Congdon N, Iezzi B. The prevalence of blindness, visual impairment and cataract surgery in Tuoketuo and Shangdu Counties, Inner Mongolia, China. *Open J Ophthalmol* 2015;5(01):23-30.

8 Zheng YF, Huang WY, Xiao BX, Qu B, Peng WY, Liu B, Jin L, Lamoureux E, Liu YZ. Preferences for participation in shared decision-making among cataract patients in urban southern China: a cross-sectional study. *Lancet* 2016;388(1):S56.

9 Zeng YB, He A JW, Lin P, Sun ZH, Fang Y. Developing case-mix standards with the Diagnosis-related Groups for payment reforms and hospital management in China: a case study in Xiamen city. *Int J Healthcare* 2016;2(1):102-110.

10 Biggs D, De Ville B, Suen E. A method of choosing multiway partitions for classification and decision trees. *J Appl Stat* 1991;18(1):49-62.

11 McCarty JA, Hastak M. Segmentation approaches in data-mining: A comparison of RFM, CHAID, and logistic regression. *J Bus Res* 2007; 60(6):656-662.

12 Palmer G, Reid B. Evaluation of the performance of diagnosis-related groups and similar casemix systems: methodological issues. *Health Serv Manage Res* 2001;14(2):71-81.

13 Seddon J, Fong D, West SK, Valmadrid CT. Epidemiology of risk factors for age-related cataract. *Surv Ophthalmol* 1995;39(4):323-334.

14 Quentin W, Rätto H, Peltola M, Busse R, Häkkinen U, EuroDRG group. Acute myocardial infarction and diagnosis-related groups: patient classification and hospital reimbursement in 11 European countries. *Eur Heart J* 2013;34(26):1972-1981.

15 Fofi C, Pecci G, Galliani M, Comunian MC, Muda AO, Pierucci A, Cinotti GA. IgA nephropathy: multivariate statistical analysis aimed at predicting outcome. *J Nephrol* 2001;14(4):280-285.

16 Gao ZH, Wan CH, Cai L, Xu CZ, Zhang XQ. The study on building standards of hospital cost to inpatients with digestive system diseases based on DRG. *Chin J Health Stati* 2006;23(4):323-325.

17 Schreyögg J, Stargardt T, Tiemann O, Busse R. Methods to determine reimbursement rates for diagnosis related groups (DRG): a comparison of nine European countries. *Health Care Manag Sci* 2006;9(3):215-223.

18 Han XM, Liu ZY, Zhao T. Analysis of hospitalization expenses of ovarian cancer based on DRG. *Chin J Health Stati* 2016;33(2):298-300.

19 Wu XY, Liu L, Zhen YX, Yu CR. Study of DRG grouping and expenses of acute myocardial infarction patients based on MS-DRG. *China Medical Record* 2014;15(8):47-50.

20 Zeng YB, Lin P, FangY. DRG grouping study of virus hepatitis patients based on CHAID. *Chin J Health Stati* 2015;32(3):514-517.