**Influence of Beijing Medical Reform Policy on Hospitalization Expenses-Taking patients treated with percutaneous coronary stent implantation as an example Based on IoMT**

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**Abstract**

With the popularization of the Internet and the promotion of mobile 5G networks, the combination of traditional industries and the Internet is a normal development trend. Under the background of "Internet +", some new concepts have also been derived. It is undeniable that informatization is also an important starting point in the development of medical and health care, and it is also a new technical means to guide the order of medical treatment .The Internet is changing the concept, mode, technology and method of medical service. "Internet + Internet of Things + light medical treatment" will become the health industry and medical industry The new opportunity is to undertake the new national medical reform policy and adapt to the new trend of new needs. **Objective:** To mainly evaluate the impact of the medical reform policies implemented in Beijing since 2014 on hospitalization costs and hospital benefits. Methods: Taking percutaneous coronary stent implantation (PCI) as an example, analyze the DRGs data of discharged patients from all second-level and above hospitals in Beijing from 2014 to the first half of 2021, and the difference between the cost difference between the DRG settlement and the project-paid patients of PCI discharged patients in a tertiary general hospital in Beijing. Before 2017, there will be a 15% increase in the price of medicines, and a 5% increase in the price of high-value consumables before 2019, this is used to calculate the cost of each year after excluding medicines and consumables. As an evaluation index of the benefit of medical institutions, using SPSS 26.0 statistical software to use t-test on different groups of data during the same period, in order to evaluate the impact of medical reform policies on hospitalization costs and hospital benefits. **Results:** The comprehensive reform of the separation of medicines in Beijing implemented in 2017 and the comprehensive reform of medical consumption linkage implemented in 2019 have little effect on the hospitalization costs of patients treated with percutaneous coronary stent implantation and average hospitalization days of patients.The purchase of stent consumables and tapes implemented and DRG payment in 2021 have a statistically significant decrease in the average cost of consumables per case and the total cost of PCI patients. Each round of medical reform has an increase in the benefits of medical institutions, but it is not statistically significant. **Conclusion:** The benefits of medical institutions have gradually improved, hospitalization costs have decreased significantly, and the reduced costs of medicines and consumables have been shifted to other costs such as diagnosis and treatment fees, and income has been shifted. Beijing's comprehensive medical reform has achieved remarkable results.

**Keywords:** Beijing medical reform policy; hospitalization costs; hospital benefits; CHS-DRG payment; IoMT

**Introduction**

In May 2012, Beijing issued the Beijing Public Hospital Reform Pilot Program, which identified five municipal public hospitals, including Friendship Hospital and Chaoyang Hospital, to implement the exploration of medical reform of "two separation" and "three mechanisms". The Notice of the Beijing Municipal People's Government on Issuing the Implementation Plan of the Comprehensive Reform of Separation of Medicine (No.11 [2017] of the Beijing Municipal People's Government) was officially released on April 8, 2017. The main contents are the cancellation of drug addition, registration fee and diagnosis fee, the establishment of medical service fee, the standardized adjustment of the prices of 435 medical services, the comprehensive reform of separation of medicine, the addition of medical service fee to the cancellation of drug addition, and the increase in the main items such as bed fee, nursing fee and general treatment fee, as well as the reduction in the prices of large-scale CT and MRI examinations. On June 15, 2019, the Implementation Plan of Beijing Comprehensive Reform of Medical Consumption linkage (Beijing Zhengban made [2018] No.50) was issued, with the main contents of abolishing the 5% or 10% increase policy for medical consumables in medical institutions and increasing the prices of items reflecting the labor value of medical staff in traditional Chinese medicine, pathology, psychiatry, rehabilitation, surgery and others. Notice of the Beijing Municipal Medical Security Bureau on Issues Concerning the Adjustment of the Reimbursement Standard for Coronary Stent and the Group Payment for Carrying out CHS-DRG Coronary Stent Implantation (J.H.I.F. [2020] No.38) was issued on January 1, 2021: CHS-DRG fixed payment was implemented for medical insurance patients undergoing percutaneous coronary stent implantation (PCI) treatment. At present, most of the articles are studying the effect of Beijing's health reform policy in 2017, but there are few studies on the effect of health reform policies in 2019 and 2021.

This study analyzed the cost components of percutaneous coronary stent implantation by DRG grouping of discharged patients in all grade II or above medical institutions in Beijing in each year, and analyzed the changes in hospitalization expenses, average hospitalization days, and hospital benefits of PCI patients from the big data level, combined with the DRG cost settlement information of discharged patients in a grade III general hospital in Beijing in the first half of 2021. This paper discusses the impact of CHS-DRG payment on hospital costs and hospital benefits from a case-by-case basis, and comprehensively evaluates the impacts of various medical reform measures on hospital costs, hospital benefits, and the average length of stay, to provide ideas for further deepening the medical reform.

1. **Objective and Method**

**1.1 Objective**

The DRGs data of all discharged patients who underwent PCI in all medical institutions above Class II in Beijing during each year from 2014 to the first half of 2021 and the information on the first page of PCI patients' discharge medical records and the settlement information of health insurance CHS-DRG in a class III general hospital in Beijing in the first half of 2021 were taken as the research object.

**1.2 Statistical Method**

Through the Beijing inpatient medical service performance evaluation platform, according to the Beijing BJ-DRGs classifier, PCI patients were divided into seven disease groups, including "FM11 percutaneous coronary drug-eluting stent implantation with AMI/HF/SHOCK", "FM13 percutaneous coronary drug-eluting stent implantation with complications and complications", "FM15 percutaneous coronary drug-eluting stent implantation, Without Complications and Complications ","FM17 percutaneous coronary drug-eluting stent implantation, death or referral within 5 days of hospitalization ","FM21 percutaneous coronary non-drug-eluting stent implantation, with AMI/HF/SHOCK ","FM23 percutaneous coronary non-drug-eluting stent implantation, with Complications and Complications ","FM25 percutaneous coronary non-drug-eluting stent implantation, without Complications and Complications ",and all expenses of PCI disease groups in each year were calculated according to the weighted average value. At the same time, the information on the first page of a patient's medical record as well as the settlement information of medical insurance patients' expenses grouped into the same group as the discharged cases from a tertiary general hospital in Beijing in the first half of 2021 were retrieved and entered into EXCEL to establish a database. BJ-DRGs divided the case expenses of each group into six categories, i.e., medical expenses, nursing expenses, management expenses, medical technology expenses, consumables expenses and drug expenses. The drugs had a 15% price increase before 2017, and the high-value consumables had a 5% price increase before 2019. Based on this, the income after excluding the cost of drug consumables from the cases in each year was calculated, which was used as the evaluation index of the benefit of medical institutions. SPSS 26.0 statistical software was used to t-test the data of different groups in the same period. The average hospitalization expenses, the average consumables expenses, the average hospitalization day, and the hospital benefit were compared, and the effects of different medical reform measures were analyzed.

**2. Results**

**2.1 Situation of PCI discharged patients in Beijing area**

From 2014 to the first half of 2021, the average age and mortality of PCI patients in Beijing showed little change in each year, and the average hospitalization days showed a downward trend (except for the impact of COVID-19 epidemic in 2020). The specific data are shown in Table 1.

**Table 1 Number of cases analyzed, mean age, mortality, mean hospital days by year**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| age | Number of cases analyzed | Number of deaths | Mortality% | Mean Hospital Days | average age |
| 2014 | 11039 | 94 | 0.85 | 8.88 | 59.61 |
| 2015 | 45053 | 81 | 0.18 | 6.94 | 60.61 |
| the year of 2016 | 48600 | 47 | 0.10 | 6.69 | 60.86 |
| the year 2017 | 50378 | 43 | 0.09 | 6.58 | 61.02 |
| the year of 2018 | 57088 | forty-two | 0.07 | 6.43 | 61.42 |
| 2019 | 62719 | forty-two | 0.07 | 5.94 | 61.54 |
| the year of 2020 | 44722 | 73 | 0.16 | 6.37 | 61.47 |
| First half of 2021 | 27687 | 28 | 0.10 | 5.69 | 61.55 |

**2.2 Hospitalization expenses and components of PCI discharged patients in Beijing area**

From 2014 to 2020, the average total expenses fluctuated within a narrow range, with no significant change. The cost differences before and after the separation of medicine reform in 2017 were compared. The average hospitalization expenses in 2018 after medical reform increased by RMB1,821, or 2.79%, from the average hospitalization expenses of RMB65,186 in the previous three years (2014–2016) after medical reform. After the implementation of the linkage reform of medical consumption in 2019, the average case cost in 2020 increased by 1,755 yuan, or 2.62%, compared with the average case cost of hospitalization in 2018 before the reform. It indicated that the reform measures of canceling the increase of drugs and consumables did not reduce the hospitalization expenses. The average hospitalization expenses of discharged patients in the first half of 2021 decreased by 25,889 yuan, or 37.65%, as compared with that in 2020. The average hospitalization expenses in the first half of 2021 were lower than those in each year from 2014 to 2020, with P=0.000< 0.001, showing a significant difference, suggesting that the health reform policy implemented in 2021 had a significant effect on the reduction of the average hospitalization expenses. The increase in hospitalization expenses for drugs and consumables was cancelled in 2020 and 2021. The change in policy is the centralized purchase of stent consumables with volume. The average hospitalization expenses were reduced by 25889 yuan, and the average consumables expenses were reduced by 25816 yuan/case, indicating that the decrease in hospitalization expenses was mainly due to the reduction in the purchase price of stent materials with centralized volume.

From 2014 to 2016, the average drug cost fluctuated within a narrow range, and there was no significant change. It began to decline in 2017, and the average drug cost was 3,856 yuan in 2018, 22.88% lower than the average of 5,000 yuan in the three years before the separate reform. It indicated that the separation of medicine reform in 2017 effectively reduced the medicine cost, but P=0.067> 0.05 had no statistical significance.

The average consumables cost fluctuated within a narrow range from 2014 to 2020. In 2019, the comprehensive reform of medical consumption linkage was implemented, and the 5% or 10% increase in consumables cost was canceled. However, the average consumables cost in 2020 decreased by RMB1,502 yuan, or 3.02%, compared with that in 2018. However, compared with 2014 and 2015, the increase was RMB 1,430 (3.05%) and RMB 1,637 (3.51%) respectively. The average case consumables cost in the first half of 2021 was significantly lower than that in each year from 2014 to 2020, with P =0.000, less than 0.001, showing significant difference. The support limit price and volume purchase policy implemented in 2021 has a significant effect on the reduction of consumables cost per case.

After excluding the cost of drugs and consumables, the income in 2018 increased by 423 yuan, or 2.76%, compared with the average value of 15,353 yuan in the three years from 2014 to 2016 before the separate medicine reform. The benefits of the separate medicine reform to hospitals were slightly increased. In 2020 and the first half of 2021, compared with 2018, 790 yuan and 1612 yuan were increased, by 5.01% and 10.22%, respectively. It indicated that the price adjustment measures of improving surgery, interventional therapy and other items reflecting the labor value of medical staff in the medical consumption reform implemented in 2019 were improving the hospital efficiency. The average hospitalization expenses and composition in each year are shown in Table 2.

**Table 2 Average Hospitalization Expenses and Components by Year**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| year | Average Hospitalization Expenses  (yuan) | Average drug cost per case  (yuan) | Average consumables cost  (yuan) | After excluding drugs, supplies cost income (yuan) |
| 2014 | 66054 | 6021 | 46812 | 16236 |
| 2015 | 63460 | 4827 | 46605 | 14876 |
| the year of 2016 | 66589 | 4927 | 49045 | 15595 |
| the year 2017 | 67690 | 4239 | 50571 |  |
| the year of 2018 | 67007 | 3856 | 49744 | 15776 |
| 2019 | 65750 | 3600 | 47068 |  |
| the year of 2020 | 68762 | 3954 | 48242 | 16566 |
| First half of 2021 | 42873 | 3059 | 22426 | 17388 |

Note: The drug price increase and consumables increase will be canceled between 2017 and 2019, so the income after excluding the cost of drugs and consumables cannot be calculated.

**2.3 Cost differences of different payment methods for PCI patients in a tertiary general hospital in Beijing in the first half of 2021**

In the first half of 2021, there were 344 discharged patients with PCI in a tertiary general hospital in Beijing. The average hospitalization cost was 42307 yuan, which was 566 yuan lower than the average value of the same period in Beijing. The average cost of drugs was 5888 yuan, and the average cost of consumables was 17007 yuan. After excluding the cost of drugs and consumables, the average case cost was 19,412 yuan, which was 2,024 yuan higher than the average of the same period in Beijing. The average hospital stay was 8.77 days.

The differences between the DRG-based payment group and the project-based payment group were compared. The average hospitalization expenses and the average consumables expenses of the DRG-based payment group were lower than the project-based payment group (P <0.05), which indicated that the DRG-based payment had a significant effect on reducing the costs. See Table 3 for comparative data of PCI patient expenses in a tertiary general hospital in Beijing in the first half of 2021.

**Table 3 Comparison of Expenses of PCI Discharged Patients in the First Half of 2021 in a Class III General Hospital in Beijing**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| group | Total case  Cost (yuan) | Average drug  Cost (yuan) | Average consumables  Cost (yuan) | Average medical treatment  Cost (yuan) | Mean Hospital Days  Number (days) |
| Pay-per-DRG group (n=221) | 40932.74  ±10703.45 | 6047.56  ±2745.58 | 15708.45  ±8138.16 | 19176.73  ±4651.42 | 8.53±2.79 |
| Pay-per-project group (n=123) | 44775.46  ±19809.81 | 5602.24  ±2859.43 | 19340.09  ±16091.90 | 19833.13  ±5588.39 | 9.20±4.26 |
| *p* | 0.02 | 0.162 | 0.006 | 0.245 | 0.078 |

The quota standard of DRGs for patients with FM19 percutaneous coronary stent implantation in Beijing area is 59,483 yuan. Among the 221 settled cases paid by DRG in sample hospitals, 10 cases showed deficit, with the largest showing deficit of 22,540 yuan. 95.48% cases showed surplus, the most surplus 38815 yuan; The mean value was 18641.60 10688.98 and the median was 20834. At present, the medical insurance fund pays the obvious surplus in full, indicating that paying according to DRG is beneficial to improving the economic benefits of the hospital. Although the quota standard of medical insurance is higher than the actual average hospitalization expenses, compared with the average hospitalization expenses in 2020, the average hospitalization expenses were reduced by 9,279 yuan, or 13.49%, indicating that the medical insurance fund also benefited. Compared with the hospitalization expenses before the reform, the hospitalization expenses of patients were significantly reduced, and patients received substantial benefits, which was consistent with the research results by Hao et al. [1]. The combination reform for percutaneous coronary stent implantation group in 2021 achieved a win-win situation of doctors, patients and insurance.

**3 Conclusion and Discussion**

**3.1 The impact of Beijing comprehensive health reform policy on hospitalization expenses.**

Some scholars believe that the government will cancel the increase in the price of drugs and consumables on the basis of increasing the financial subsidies to hospitals and the addition of medical service fees, which will play a certain role in reducing the medical expenses, but it is difficult to fundamentally reduce the medical expenses [2]. Similar results have been obtained in this study. The new medical reform measures including canceling the price increase of drugs and consumables, adding medical service fees, increasing the project prices reflecting the technical content of medical staff, such as nursing fees, rehabilitation treatment fees, pathological examination fees, and operation fees, and carrying out the joint efforts of multiple departments such as centralized drug procurement and Beijing-Tianjin-Hebei drug volume procurement have not significantly changed the hospitalization expenses of the PCI treatment group. However, the implementation of the limit price of stent consumables and the volume procurement measures have significant effects on reducing the hospitalization expenses.

**3.2 Consumables price is the main factor affecting the hospitalization expenses**

From the data of inpatient cost structure in Beijing since 2014, we can find that consumables has always been the main cost of inpatient. After the cancellation of drug price increase in the 2017 separate medicine reform, the proportion of consumables cost became more prominent. The average consumables cost of all hospitalized patients included in Beijing BJ-DRG subgroup in 2020 was 8,651 yuan, representing an increase of 2,942 yuan over the average medicine cost. Therefore, consumables cost has a greater impact on hospitalization costs. The significant decrease in the consumables cost of PCI patients in 2021 was mainly due to the decrease in the price of stents by more than 90%. Only by reducing the price of drugs and consumables from the source can we better control the hospitalization expenses and effectively solve the problem of "expensive doctor visit". For the regular use of high value consumables, can be used according to the collection or market data in accordance with the law of the market to develop payment standards; For new high-value consumables to be listed in the future, due to high degree of innovation and high price, we can learn from the experience of medical insurance drug negotiation access, timely carry out medical insurance access price negotiation, reasonably formulate medical insurance payment standards, and establish a dynamic adjustment mechanism [3]. It not only meets the needs of different patients, but also encourages innovation while taking into account the ability to pay for health insurance funds.

**3.3 Suggestion for more flexible DRG payment method**

In any payment mode, the relationship between medical insurance and patient is a game. Most of the studies [4–7] have shown that under the DRG payment model, the hospitalization expenses are reduced by shortening the average hospitalization days, optimizing business processes and improving work efficiency, but there are some risks, such as in the case of low cost control, individual departments in the hospital give priority to patients who pay for diseases in order to increase their income, and refuse the patients who pay by ordinary method, which makes the fairness of medical services not guaranteed. At the same time, in order to obtain the compensation according to the disease category quota, and further reduce the hospitalization expenses, some clinical doctors intentionally decompose or shift the responsibility to the critically ill patients to reduce certain clinical service items which are costly but necessary [8], thus reducing the quality of medical service and damaging the interests of patients. In the DRGs, the lower the cost paid by the hospital, the higher the compensation will be. The cost of the most advanced technology is generally higher than the current technology, or doctors are reluctant to use more advanced and better medical technology to treat patients, which is not conducive to the progress of medical technology and the development of disciplines. How to ensure the enthusiasm of medical institutions and promote the development and progress of medical technology without damaging the interests of patients [9]?

Therefore, whether a more flexible payment method can be implemented [10–13]: When determining the payment quota criteria for diseases, the average or median cost of local diseases is referred, and the grouping axis is adjusted according to the updates of medical technology, changes in disease spectrum, and other factors. Combined with the changes in medical costs, CPI levels and other factors, scientific calculation and adjustment of payment standards, and every year or every six months to adjust a .. When the medical expenses of patients were lower than a certain proportion of the quota standard, a certain proportion of the difference was given to reward medical institutions, and the payment pressure of the health insurance fund was reduced. When the hospitalization expenses of patients exceed a certain proportion of the quota standard, the medical institutions can get a certain proportion of cost subsidies, thus not only sharing the risks of medical institutions, but also taking into account the moral hazard and efficiency.

**3.4 Suggestion for continuously promote the price reform**

Although Beijing health care reform has carried out many rounds of price adjustment of various projects [14–15] and the income structure has been optimized, there are still many project service prices lower than the service costs of medical projects, and some even went backwards. It is suggested that a dynamic price adjustment mechanism based on changes in cost and income structure be established based on adequate measurement of project costs [16] to further rationalize the prices of medical service projects, effectively improve the self-compensation ability of medical institutions, and ensure the high-quality development of public hospitals.

**Data sharing agreement**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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**References**

1. Hao Jin. Fan Zixuan. Bai Yuanyuan et al. Investigation and analysis of patients' subjective feelings on the effectiveness of medical reform in the context of improving medical service. [J]. chinese journal of hospital administration, 2021,37(6):455-459.
2. Jiang Jianhua. Cancel the drug addition policy on the impact of medical expenses [J]. Medicine and Philosophy (Humanities and Social Medicine Edition), 2010 (5): 44-46.
3. Ding Jinxi, Huang Xinfeng, Li Wei et al. Research on overseas medical insurance access system of high-value medical consumables and its enlightenment to China [J]. Shanghai Medicine, 2021 (1): 65-69.
4. SUN Peng-nan, Li Lu. DRG payment reform on the impact of hospital economic management and countermeasures [J]. chinese health economics, 2022,41(2):80-82.
5. Liang Shaoqing, Zhang Chennuo. The impact of DRG payment mode reform on hospital management [J]. China Health Standards Management, 2021,12(22):37-41.
6. Zhu Jiaying, Gao Jilong, Ren Jinwen, et al. Analysis of the function of DRG payment in the high-quality development of public hospitals [J]. Health Economic Research, 2021,38(12):57-61.
7. Zhu Bifan, Xu Jiajie, Sang Peimin, et al. DRG payment on the impact of the health service system analysis-based on OECD empirical data [J]. Health and economic research, 2021,38(5):49-54.
8. Dai Jun, Huang Fengming, Wang Lei et al. Analysis of the impact of different payment methods on doctor behavior in public medical institutions [J]. Modern Hospital, 2021 (1): 85-94.
9. Liu Yage. China's medical services and insurance payment negotiations [D]. Beijing University of Chinese Medicine, 2011.
10. Wu Lin, Chen Yongfa. Health insurance payment incentives to integrate the logic of medical services and implementation path [J]. Health and economic research, 2022,39(1):31-35,39.
11. Wu Lin, Li Mengying. Deviation between health insurance payment incentives and doctors' multi-task execution-a new explanation framework and policy implications [J]. China Health Policy Research, 2022,15(1):37-42.
12. Li Fen, Jin Chunlin, Zhu Liping, et al. Value-oriented health insurance payment system implementation path [J]. Health and economic research, 2021,38(1):10-13.
13. Wang Yiting, Feng Ruihua. Health care payment reform to promote the concept of value-based medical realization framework [J]. chinese health economics, 2022,41(2):21-23.
14. Xiao Jiuqing, Li Yi, Kong Guoshu, et al. A study on the influence of medical reform in Beijing on the hospitalization expenses of medical and surgical patients in a hospital [J]. chinese journal of hospital administration, 2021,37(3):257-260.
15. Zhang Xiao, Sang Zhicheng, Wang Xiaoyan. Beijing comprehensive reform of medical consumption linkage on the impact of medical services in traditional Chinese medicine [J]. modern medicine journal of china, 2022,24(2):97-99.
16. DAI Zhi-min, Cao Li-qing, Xu Tan. The construction of dynamic adjustment mechanism of medical service price in public hospitals [J]. Chinese Hospital Management, 2017 (9): 1-4.