A Study on Implementation of Inpatient Treatment by DRG-Based Reimbursement Model in China

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ABSTRACT

Purpose: This study aimed to evaluate the influence of DRG-based hospital payment system approach on implementation of inpatient treatment.

Methods: This study was largely based on retrospective analysis of DRG-based hospital payment data from third class hospital for the period of October 2021 to February 2022 including determination of diagnosis groups with most significant balance of payment loss and corresponding departments, development of pathways to DRG-based inpatient treatment, pre-checking of prescriptions, in process education of clinical pharmacists and case follow up, comments and penalty measures. The rational drug use, drug income proportion and DRG-related medical services capability assessment (manageable number of DRGs, CMI, average hospital stay, time consumption index and resource consumption index) of departments with loss were compared before and after intervention.

Results: Data analysis revealed that BR23 (cerebral ischemic stroke with accompanying diseases or complications) balance of payments loss was most significant with higher average drug income proportion than such in groups of balance of payments surplus. The Neurology Department BR23 demonstrated significant balance of payment deficit. Therefore, the ischemic stroke drug clinical treatment pathway was successfully developed and after intervention, prescription errors counted 14.14, therefore demonstrated 6.89% decrease and at the same time medicines consumption rate was 27.17% with 9.43% decrease. The number of manageable number of DRGs increased by 3, CMI increased by 0.14, average length of stay decreased by 0.8 days, time consumption index and resource consumption index decreased by 0.11 and 0.18 respectively.

Conclusion: DRG-based hospital payment management of inpatient treatment provided theoretical support for DRG code-based reimbursement cost control and scientific cost control and has improved quality management of hospital service.

Keywords: DRG; Clinical drug treatment pathway; Cost control; Ischemic stroke

HIGHLIGHTS

- This work provides an insight into the study of new introduction of DRG-based hospital payment into hospital management system.

- Through the extracted data, it sets a unique analysis on how DRG reimbursement approach positively effects hospital economics.

- The described approach and complex of taken measures demonstrated significant decrease of number of prescription errors.

- The new conception of drug application clinical pathway is important for hospital resource management planning.

INTRODUCTION

Diagnosis related groups (DRG) are one of the important tools used in medical insurance reimbursement system and quality and efficiency evaluation of provided medical services as well as in a hospital management optimization.

DRG is a part of prospective per-case payment system, which supposes to classify patients into diagnosis groups for further treatment management based on the principal diagnoses, types of treatment and the treatment procedures. DRG grouping mainly includes three fundamental steps. First, DRG grouping utilizes anatomical and physiological classification criteria to divide all possible principle diagnoses into diagnosis areas and to form major diagnostic categories (MDC). Second, DRG groups are divided according to the primary diagnosis and medical treatment under each MDC. Third, classification of cases in DRGs is based on the following variables, such as patient age, length of stay, disease complications and so on, which have significant effect on medical expenditures and hospital resources allocation.

Clinical pathway is an important basis for DRG-based hospital payment systems. It regulates all case related diagnostic procedures and treatment approach during the inpatient disease treatment and homogenizes resource consumption. Therefore, it is necessary to introduce clinical regulations of treatment into hospital operations based on disease types to promote inpatient rational medicine use and to avoid situation when patient could be overtreated (received not necessary services) or undertreated (denied of optimal services). The drug application clinical pathway (hereinafter referred as "drug clinical treatment pathway" or "drug clinical pathway") is an introduction of standardized and homogeneous drug treatment plan for the drug treatment of patients during hospitalization based on correct diagnosis, intervention type, etc. The clinical pathway and DRG's concept of "homogenization of inpatient treatment procedure and resource consumption" both have synergies, that provides reference and support for DRG code-based reimbursement cost control. Therefore, based on recorded cases, pharmacists and doctors developed drug clinical treatment pathway for disease treatment, which included prescription pre-checking system validation, in-process intervention, post evaluation of each case and real-time feedback to optimize management measures for the inpatient medicine use. Such kind of long-term management mechanism can be introduced widely beyond single case processing up to therapeutic area in order to promote the hospital management system development with optimization of DRG-based payment for care [1-3].

MATERIAL AND METHODS

Data Source

The data was provided by Shaanxi Medical Security Bureau for the term between October 2021 to March 2022 and originated from the DRG payment database of a third class hospital in Shaanxi Province. Multiplied cases and single episode cases were excluded after processing and evaluation of the data.

Study Methods

Analysis of groups of balance of payments deficit: Through the statistical analysis of the hospital data (October 2021), the diagnosis related groups with the most significant balance of payment loss and total number of cases during the above mentioned period of time of three months were determined.

Drug clinical treatment pathway development: After analysis of the DRGs, which balance of payments loss was most significant among the above mentioned groups, the drug clinical treatment pathway was further developed to improve care giving to patients. Drug clinical pathway is a document outlining a standardized, evidence based multidisciplinary management plan identifying the appropriate sequence of clinical interventions for designated drugs, which content mainly included drug name and following characteristics: hospital locally manufactured drugs or centralized purchased drugs, indications, contraindications, usage and dosage, treatment course and policies related to medical insurance payment. The design of drug clinical pathway always takes into account drug instructions, local and foreign country clinical practice guidelines, systematic reviews, Meta-analysis, randomized controlled trials (RCT), "The National Basic Medical Insurance, Work Injury Insurance and Maternity Insurance Drug Catalogue (2021)" and related policies and regulations of the state, province and city levels.

Analysis of common problems related to the DRGs with loss in balance of payments of hospital by comparison with previously designed clinical pathway: According to analysis of the original DRG payment data provided by the Shaanxi Provincial Medical Security Bureau and existed clinical pathway, the irrational drug use in several diagnosis related groups was discovered.

Pre-checking of prescriptions: According to the drug clinical treatment pathway operating procedure, corresponding prescription review approach was established through the prescription pre-checking system. And this approach mainly utilizes consideration of indication, form of administration and dose of administration, contraindication/caution, repeated use of medication, drug interaction, drug incompatibility, prescribing medicines for special populations to prevent obvious medication errors, clearly unreasonable medication use, as well as to notify about medication use not covered by insurance and to prioritize use of centralized purchasing drugs in the inpatient care.

Case intervention: Clinical pharmacists actively promoted CHS-DRG payment policy and conducted corresponding training to introduce advantages of priority use of national essential medicines and centralized purchased drugs and new clinical med-

icine application guidelines. Clinical pharmacists are in charge of examination and processing of current medical records, as well as responsible for optimization of clinical protocols including drug use for discovered cases where DRG payments do not comply with payment standards. Therefore, the scope of clinical pharmacist responsibilities includes review, analysis and improvement of the clinical plan. In turn, the problems doctors face at steps of prescription process are summarized and forwarded to pharmacist to further optimize the review process.

Case intervention follow up: Our approach supposed monthly random check of the doctor's prescriptions in the e-prescribing system and providing comments regarding rational drug use in accordance with relevant drug clinical pathway. As a result, the irrational drug use cases have been reported to the related departments and corresponding measures such as written warning or fines have been taken.

Feedback management and e-prescribing system optimization: Analysis of errors during prescription checking with following optimization of prescription pre-checking system was taken as a fundamental approach in order to improve the hospital efficiency. Furthermore, the data of DRG payments was analyzed again. Assessment of those diagnosis related groups required improve of treatment control and their impact on patient care was performed once again.

Statistical Analysis

SPSS 22.0 statistical software was used for data processing, data analysis was done by T-Test, expressed as mean ± standard deviation, and $P < 0.05$ indicated a statistically significant difference.

RESULTS

Analysis of Hospital DRG Reimbursement Payments

BR23 (cerebral ischemic stroke with accompanying diseases or complications) had the most significant balance of payments loss and the higher average drug income proportion than such in groups of balance of payments surplus.

Analysis of hospital DRG reimbursement payments of 10 groups with significant loss of balance on October 2021 revealed that the BR23 group had the most significant balance of payment loss in terms of total amount as well as had the biggest number of reported cases. The most significant loss was discovered in the Neurology Department for BR23. The BR21 group took the fifth place in our "anti-rating" of balance of payment loss in hospital accounting, and, more remarkably, BR23 and BR21 both were corresponding to inpatients with cerebral ischemia (**Figure 1**).
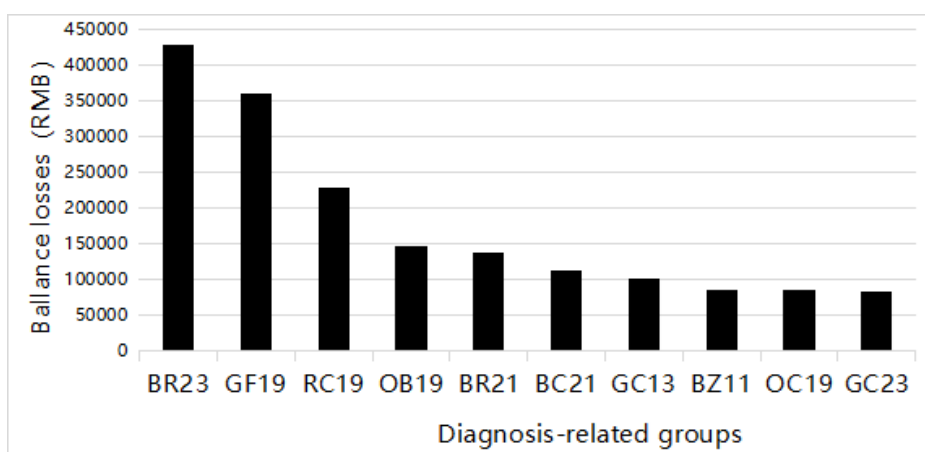

Figure 1: 10 DRGs with most significant balance of payments loss before intervention. Notes: BR23 states for cerebral ischemic stroke with accompanying diseases or complications; GF19-surgery of anal canal, anus and perianal area; RC19-radiotherapy of malignant proliferative tumors; OB19-post cesarean section care; BR21-cerebral ischemia with severe accompanying diseases or complications; BC21-Ventricular shunt implantation and revision surgery with severe accompanying diseases or complications; GC13-other surgical operations of esophagus, stomach and duodenum with severe accompanying diseases or complications; BZ11-nervous system other diseases with severe accompanying diseases or complications; OC19-operative vaginal delivery; GC23-other surgical operations on small intestine and large intestine (including rectum) with accompanying diseases or complications.

In order to discover the reasons of this account loss of the BR23, we further used Mann Whitney U test to statistically analyze the cost structure of BR23, included surplus and loss of account balance related to different patient group treatment. We dis-

covered that the drug income proportion in the surplus group (median proportion 27.08%) was significantly lower than that in the deficit group (median proportion 36.99%) with statistically significant difference ($z=-4.336$, $P<0.0001$) (**Table 1**).

Table 1: BR23 account loss and surplus cost structure comparison.

Parameter	Case number	Median Proportion (%)	z, P
Drug Income	Surplus (72, 40.4%)	27.08	-4.336, <0.001
	Deficit (106, 59.6%)	36.99	
Drug Usage	Surplus (72, 40.4%)	0	-1.306, 0.192
	Deficit (106, 59.6%)	0.245	
Examination/Tests	Surplus (72, 40.4%)	57.87	-4.084, <0.001
	Deficit (106, 59.6%)	49.77	

| Treatment Expenses | Surplus (72, 40.4%) | 6.02 | -1.236, 0.216 |
| | Deficit (106, 59.6%) | 5.47 | |

Notes: DRG payment standard - actual payment amount of the hospital ≥ 0; account deficit: DRG payment standard - actual payment amount of the hospital<0; The study based on data Skewed Distribution. Mann Whitney U test was used. P<0.05 indicates a significant difference, and P<0.001 indicates an extreme significant difference.

Development of drug clinical treatment pathway for ischemic stroke group: According to China's Stroke Prevention and Control Guidelines (2021), Guidelines for Diagnosis and Treatment of Ischemic Stroke (2021) and medication instructions, etc., under the current hospital project drug clinical treatment pathway for ischemic stroke was developed through summarizing and classification of most widely used for this disease treatment medications, which were finally grouped into three categories as "recommended, optional and not recommended" supplemented with evidence based medicine references. Further, According to the "Implementation Opinions on Establishing a National Essential Drug System" formulated by Nine Ministries and Commissions and National Health Commission released "Notice on further improving the clinical equipment and use of selected drugs in the centralized procurement of drugs organized by the state" and other relevant regulations, essential drugs and drugs under centralized procurement protocol marked as ischemic stroke drug clinical treatment pathway medications were recommended for priority use during the inpatient treatment [4-7] (**Figure 2**).
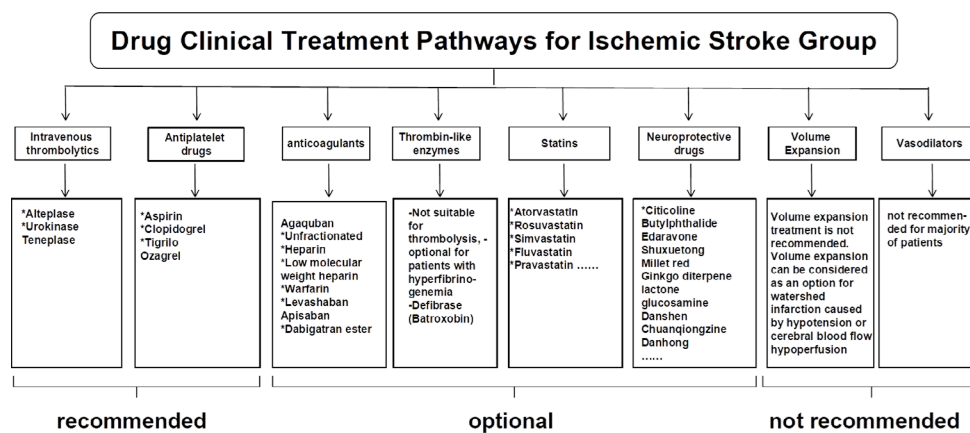
Figure 2: Drug Clinical Treatment Pathways for Ischemic Stroke Group. Notes: Refers to the classification and categories of drugs used for ischemic stroke treatment, where A, B and C represent recommended, optional and not recommended drugs as options for treatment, respectively; The asterisk "*" in front of the drug name indicates that drug belongs to essential drugs category, "*" mark carried drugs are centralized purchased drugs.

Given that, the new more detailed drug clinical treatment pathway has been developed for the four categories of medicines with more complicated situation around their use in practice, such as intravenous thrombolytics, antiplatelet drugs, anticoagulants, drugs improving neurological deficits and it has included indications, contraindications, pharmacological effects, etc. The usage, dosage and treatment course were described with attention to details to guarantee the successful implementation of clinical practice (**Figures 3-6**).

Figure 3: Intravenous Thrombolysis Notes: Reflects the route of intravenous thrombolytics drug clinical treatment pathway.

Antiplatelet Therapy

If intravenous thrombolysis is not suitable for patients, or there is indications for intravascular thrombectomy. There are no contraindications for antiplatelet therapy

Mild stroke patients do not receive intravenous thrombolytics

For physician supervising thrombolytic therapy
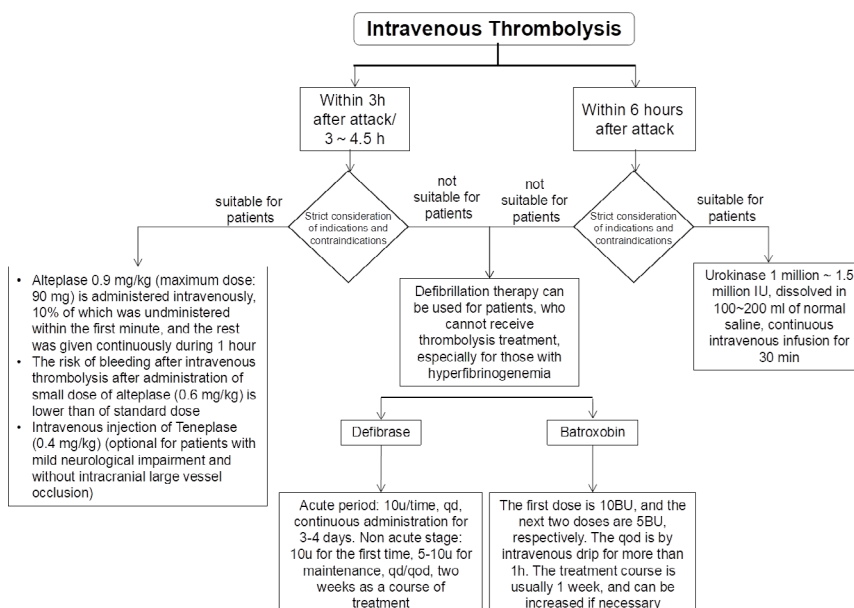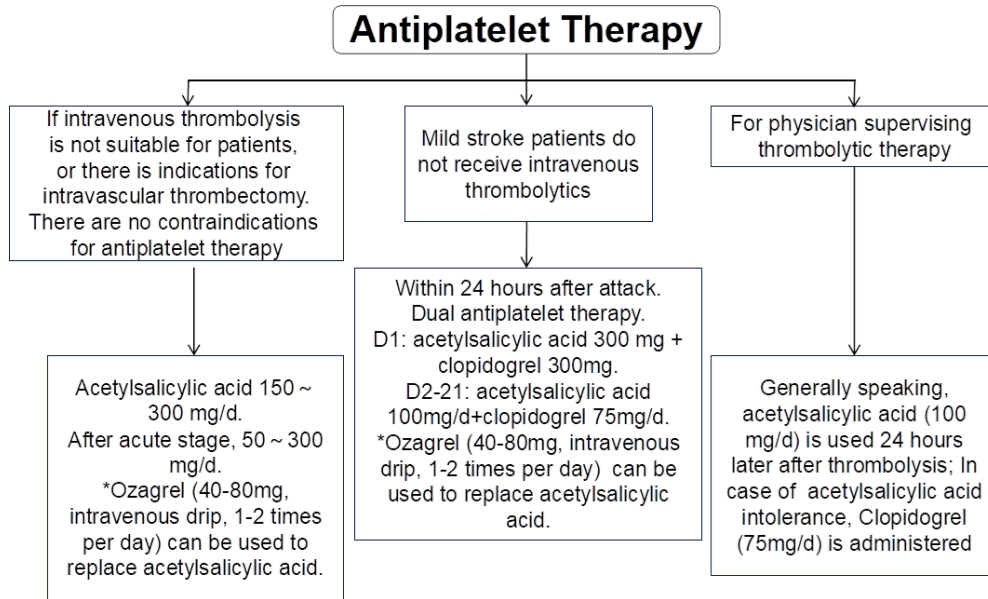
Acetylsalicylic acid 150 ~ 300 mg/d. After acute stage, 50 ~ 300 mg/d. *Ozagrel (40-80mg, intravenous drip, 1-2 times per day) can be used to replace acetylsalicylic acid.

Within 24 hours after attack. Dual antiplatelet therapy. D1: acetylsalicylic acid 300 mg + clopidogrel 300mg. D2-21: acetylsalicylic acid 100mg/d+clopidogrel 75mg/d. *Ozagrel (40-80mg, intravenous drip, 1-2 times per day) can be used to replace acetylsalicylic acid.

Generally speaking, acetylsalicylic acid (100 mg/d) is used 24 hours later after thrombolysis; In case of acetylsalicylic acid intolerance, Clopidogrel (75mg/d) is administered

Figure 4: Antiplatelet Therapy. Notes: Shows the antiplatelet medication drug clinical treatment pathway.

Neuroprotection

Determination whether it is accute stage or recovery period

Acute stage

Recovery period

Acute stage or recovery period

Scavenging free radicals, Improving cerebral microcirculation

Antiplatelet drugs

Improving cerebral microcirculation and metabolism

Antiplatelet drugs

Activating Blood and Dredging Collaterals

Antioxidant, antiplatelet & vasodilator therapy,

Edaravone Butylphthalide

Shuxuetong

*Citicoline

Troxerutin; Danhong; Salvia miltiorrhiza and ligustrazine; Vinpocetine

Ginkgo diterpene lactone glucosamine

Gu Hong

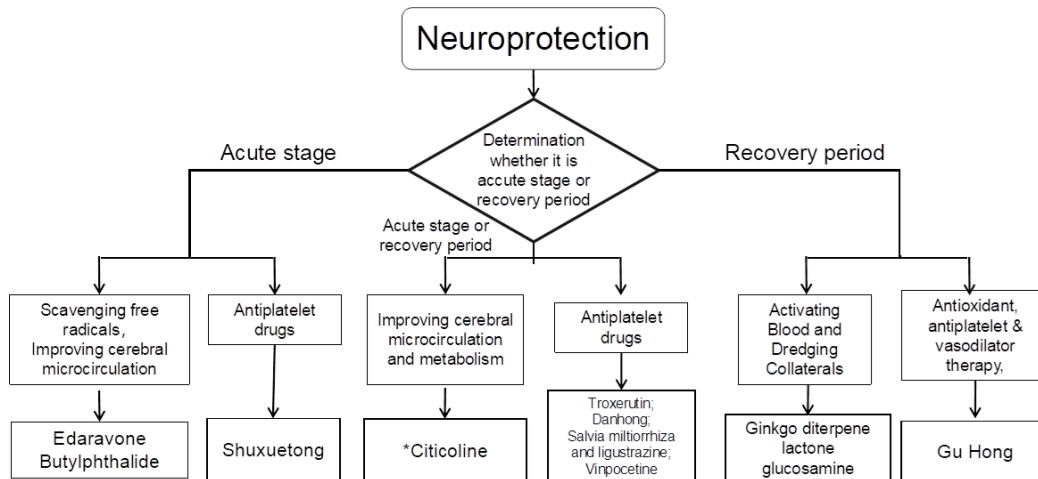**Figure 5:** Neuroprotection Notes: Displays the anticoagulants drug clinical treatment pathway.

Anticoagulant therapy

Not recommended for majority of patients; Only at erlier stage if there is no other choice for alternative treatment

Implantation of mechanical heart valves and other special circumstances require comprehensive evaluation (focus size, blood pressure control, control of liver and kidney function) and careful selection of medication

The efficacy of anticoagulants for ischemic stroke therapy in patients with ipsilateral internal carotid artery stenosis remains to be confirmed

If anticoagulant therapy is still required after thrombolysis, the anticoagulants must be administered 24 hours after withdrawal of thrombolytics

Argatroban

Heparin

LMWH

Warfarin

Rivaroxaban

Apixaban

Dabigatran

first 2 days, 60mg by continuous intravenous infusions over 24h. Next 5 days, 10 mg by intravenous drip over 3h

Subcutaneous injection: 5000~10,000 u for the first time, 8000~10,000 u for q8h or 15,000~20,000 u for q12h; The total amount is about 30000~40000 u every 24 hours. Intravenous injection: 5000~10000 u for the first time, or 100 u/kg according to the weight q4h. Intravenous infusion: 20000~40000 u/d, 5000 units can be administered intravenously as the initial dose before infusion.

0.4-0.6 ml, bid, subcutaneous injection, the course of treatment is defined as 10 days

Avoid loading dose, 3-4 mg per day is administered orally for 1-3 days, continue administration of 2.5 to 5 mg per day after 3 days (INR2-3)

Oral administration of 20mg qd (15mg qd for lower weight and elderly patients)

5mg orally bid (FDA recommendations)

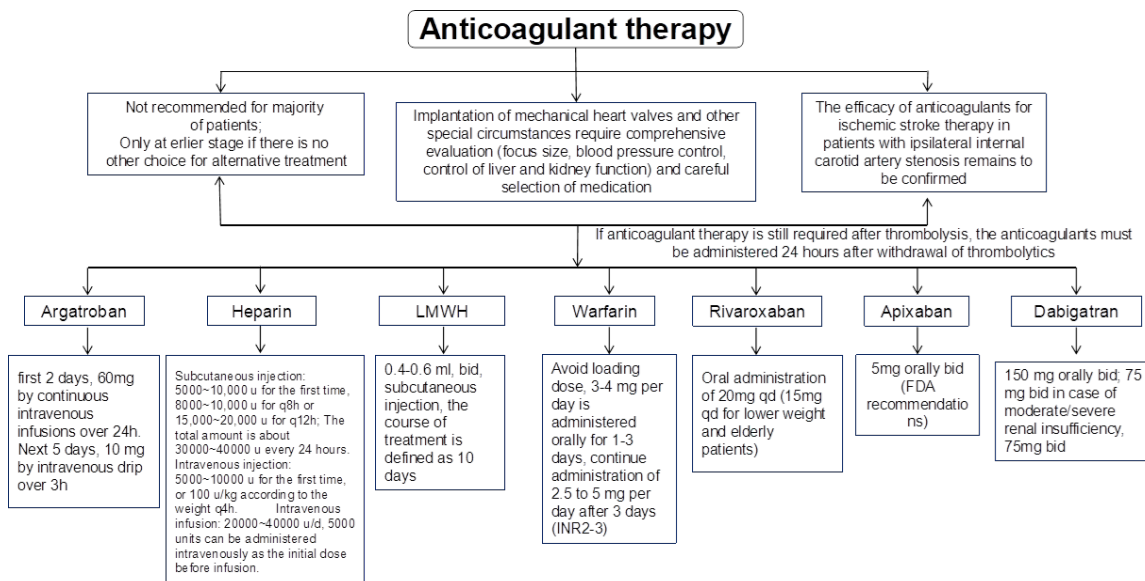150 mg orally bid; 75 mg bid in case of moderate/severe renal insufficiency, 75mg bid

Figure 6: Anticoagulant Therapy Notes: Describes drug clinical treatment pathway for neurological deficit improvement therapy. Abbreviations: (LMWH) low Molecular Weight Heparin.

The indications of antiplatelet drug Ozagrel according to manufacturer instruction included acute thrombotic cerebral infarction and motor disorders associated with cerebral infarction and although strictly speaking it was not recommended for the medication treatment of ischemic stroke according to the guidelines, but, however, Ozagrel has been included in the national medical insurance catalogue in 2021, so this medication has been widely used in our hospital and was discovered to frequently appear in common medication errors. Therefore, we incorporated Ozagrel into clinical treatment pathway, too (**Figure 4**). Regarding drugs for improvement of neurological deficits, the drug clinical treatment pathway has listed the pharmacological effects of each medication and made it convenient for doctors and pharmacists to check whether choice of medicine is correct before and after prescribing. Regarding the drugs with similar pharmacological effects, it is stated that the choice is made in accordance with each case conditions. For instance, Citicoline is the first line drug, which was recommended as the first choice drug for treatment. Edaravone and Butylphthalide have undergone clinical studies and demonstrated sufficient clinical evidence and therefore were also recommended for

the treatment of acute ischemic stroke as stated in guidelines. Shuxuetong, Troxerutin, Danhong and Ginkgo Biloba diterpene lactone glucosamine are currently included in The National Medical Insurance Catalogue, while Salvia Miltiorrhiza Ligustrazine, Vinpocetine, Deproteinized Calf Serum Injection and Gu Hong are national key monitored drugs, which have been excluded from The National Medical Insurance Catalogue. Additionally, it should be taken into account, that Edaravone, Butylphthalide and Shuxuetong are designated for acute disease treatment only, while Dan Hong and Ginkgo Diterpene lactone glucosamine are used during cerebral infarction recovery period [8-14] (**Figure 6**).

Referred to the 2021 year edition of The National Medical Insurance catalogue, we have summarized 12 drugs covered by insurance and limited number of certain conditions among all drugs for the treatment of ischemic stroke [9] (**Table 2**), therefore clinicians may choose the most appropriate drug treatment plan according to the patient medical insurance coverage. At the same time, clinical pharmacists also rely on this information to make right comments on doctor prescriptions.

Table 2: List of drugs with insurance coverage limits for the ischemic stroke treatment.

Drug Name	Medical Insurance Coverage Limits
Ozagrel Injection	Ozagrel injection treatment reimbursement is limited to new acute thrombotic cerebral infarction cases, and the payment cannot exceed 14 days
Agatraban	Indication covered by insurance policy is limited to acute cerebral infarction with signs of motor paralysis, and this medication should be used within 48 hours after the attack.
Citicoline (injectable form)	Insurance does not cover other cases except patients with acute craniocerebral trauma and brain surgery with disorders of consciousness, and the payment cannot exceed 14 days
Edaravone Dexborneol concentrate for injections*	Limited to new patients with acute ischemic stroke who started to use it within 48 hours after attack, and the payment cannot exceed 14 days
Butylphthalide soft gel capsule*	Limitation does not includes new patients with acute ischemic stroke who started to use this medication within 72 hours of onset, and the payment cannot exceed 20 days
Butylphthalide Sodium Chloride Injection*	Indication covered by insurance policy is limited to patients with acute ischemic stroke who started to use this medication within 48 hours after attack, and the payment cannot exceed 14 days
Shuxuetong Injection	Insurance covers only critically ill patients admitted to second level hospital or above level medical institutions with clear evidence of acute ischemic cerebrovascular disease
Troxerutin (injection)	Insurance coverage is limited to new ischemic cerebral infarction patients, and the payment cannot exceed 14 days
Dan Hong Injection*	Indications limited to those mentioned in the instruction
Ginkgo diterpene lactone glucosamine injection*	Insurance payment covers only patients in convalescent stage of cerebral infarction admitted to second level hospital or above level medical institutions, and the maximum payment coverage for a single hospitalization is limited to 14 days

Notes: Table 2 is related to the "National Basic Medical Insurance, Work Injury Insurance and Maternity Insurance Drug Catalogue (2021)", and medicines marked with * are medicines included in National Reimbursment Drug List "Manufacturer-Negotiated List during the agreement period".

BR23 ischemic stroke medication use and balance of payments deficit analysis results: With reference to principles of drug clinical treatment pathway for ischemic stroke treatment, clinical pharmacists analyzed whether medical use of drugs for the ischemic stroke treatment is correct or not. The results revealed, that repeat medication, inappropriate use (not according to the indications) and exceeding the recommended period of time drug use and overdose cases were common errors in doctor prescriptions for the BR23, where the unreasonable medication use rates were 5.63%, 1.8% and 0.82%, respectively. The type of drugs mainly related to the problem of repeat medication was medicines for improving neurological deficits.

Patients were prescribed to take various cerebral protective drugs and antiplatelet drugs at the same period of time. Such treatment plan could increase unwanted drug interaction rate and as a result, the risk of adverse reactions, for instance, risk for bleeding. Furthermore, repeat use of medication was also discovered during analysis of prescriptions for Aspirin and Ozagrel combination. Both are thromboxane synthase (TXA2) inhibitors, and in fact, it is tricky to combine them for dual antiplatelet therapy. Instead, the adenosine diphosphate (ADP) receptor inhibitor Clopidogrel is recommended for combination with one of these drugs. Inappropriate medications not according to the indication were mainly found in the prescriptions for recovery,

while unreasonable drug prescribing were typically discovered in prescriptions of drugs used during the acute phase of cerebral infarction. The use exceeding the recommended period of time frequently occurred when critical care drugs were used for a longer period of time than it should be [15].

Optimization of prescription pre-checking system: According to drug clinical treatment pathway, we have established review rules for prescription pre-checking system algorithm. 168 review rules have been revised, included 8 aspects of regulations on medication, such as drug indications, contraindications, route of administration and dosage, drug interactions, repeat medication, drug incompatibility, special patient populations care and medical insurance related provisions.

Evaluation of drug rational use and economic benefits in the Neurology Department (BR23) after follow up intervention: The results demonstrated that error rates in Neurology Department (BR23) doctor prescriptions before and after intervention were 21.03% and 14.14%, respectively. Obviously, after 5 months followed the intervention, it was decreased by 6.89%. Among all parameters, wrong indication and repeat administration decreased significantly by 2.69% and 1.27%, respectively. Other medical prescription errors also decreased at different rate as depicted in **Figure 7**.
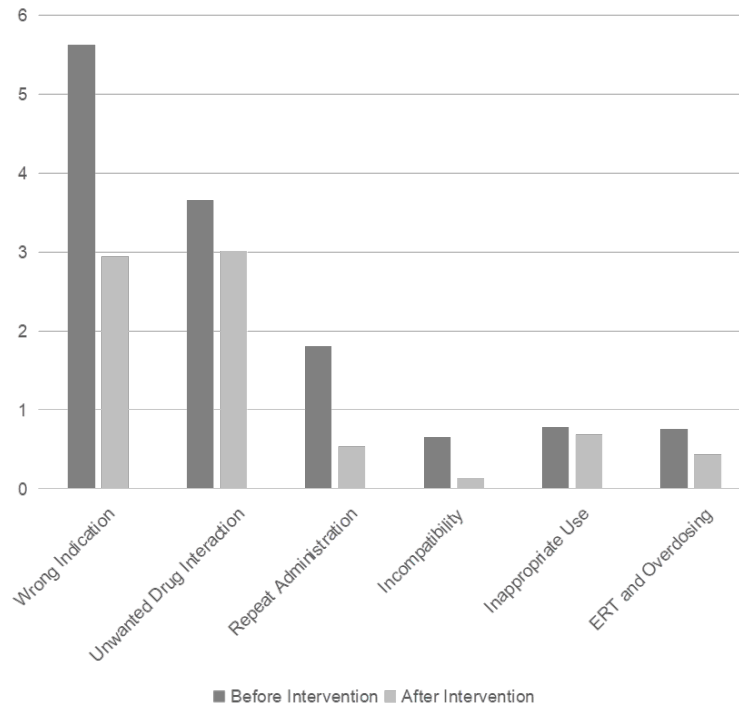

Figure 7: Prescription Errors before and after Intervention Notes: Displays the time points before and after intervention for the period of October 2021 to February 2022. Prescription errors contained wrong indication and risk of exceeding the insurance coverage limitations.

The results of the economic evaluation of Neurology Department BR23 prescriptions of drugs showed that the average drug cost per treatment course decreased from 6793.39 Yuan before intervention to 4953.02 Yuan after intervention. Drug income proportion before and after intervention was 37.14% and 27.17%, respectively, with 9.43% decrease. Generally speaking, patients have received higher quality medical services, while the cost of medications during hospitalization has been significantly reduced. The rational drug use in our hospital has been continuously improved and, at the same time, consumption of medical resources has been reduced, therefore we can conclude that the goal of DRGs as a scientific tool for treatment cost control has been successfully achieved.

Evaluation of the neurology department ability to provide adequate quality medical services with DRGs: Ischemic stroke remains primary cause of patient hospitalization in the Department of Neurology. After drug clinical treatment pathway had been developed and introduced to drug management process, Department of Neurology drug rational use and medication safety were significantly improved, as well as the DRG-related care giving operations in this department were optimized with further positive outcomes for patients (**Table 3**).

Table 3: Evaluation of Neurology Department capabilities in scope of DRG-based care.

Criteria	Before Intervention	After intervention
DRG groups	48	51
Case Mix Index(CMI)	1.27	1.41
Average Hospital Stay (days)	9.2	8.4
Time Consumption Index	1	0.89
Resource Consumption Index	1	0.82
Notes: Presented data reflects results before and after intervention, October 2021 and February 2022, respectively.		

If we take a look into DRG classification system changes, the number of manageable DRGs increased by 3, as a result, number of diseases that can be treated in Neurology Department has been raised, too. The scope of work was further expanded, and we observed that case mix index (CMI) has been increased from 1.27 to 1.41 and the disease treatment difficulty index has also been increased, therefore indicated that ability of neurologists to successfully manage more severely ill patients with higher treatment difficulty index was improved, that in turn corresponded to the requirements to diagnosis and treatment services in III A level hospital. Together with this, the average hospital stay after intervention was 8.4 days or 0.8 days less compared to the data before intervention. Time consumption index in turn decreased by 0.11. Taking together, this data demonstrates improvement of the effectiveness in the treatment of diseases in the Neurology Department. As a result, the bed turnover rate and number of patients received treatment at the same period of time increased, too. However, the hospital stay of 8.4 days still remained longer than the typical for Chinese III A level hospital average stay meaning. The conclusion is treatment efficacy still requires further improvement. If we speak regarding the resource consumption index, which was decreased by 0.18, we can conclude, that the initial goal of the cost control optimization was achieved

Promotion and application of management model based on DRG classified disease group approach for other therapeutic areas: Previously, at the period of time from December 2020 to April 2021, we introduced a drug clinical treatment pathway for gastro-esophageal reflux disease encoded as GW19 (esophagitis, gastroenteritis). Within five months, the unreasonable rate of PPI use decreased from 29.66% to 16.62% of that after intervention (totally, by 13.04%) [16].

After December 2020, we have also examined empiric treatment of inpatient urinary tract infections encoded as LU13. We found that there were many cases of irrational use of fosfomycin oral administration forms in the clinical care practice. Although this is essential medicine, any irrational use of drugs could not be ignored, so we have developed clinical treatment pathway for empirical treatment of urinary tract infections, too, that resulted in the restriction on applications of related antimicrobial drugs, correction of dosages and treatment course. After such measures as review of prescriptions, intervention and clinical pharmacist follow up procedure training, the situation with irrational use of fosfomycin oral administration forms has been significantly corrected. In terms of numbers, the unreasonable medication use rate of fosfomycin was reduced by 55.8%, inappropriate indications and unreasonably long course of medication occasion were decreased by 51.5% and 9.7%, respectively [17,18].

DISCUSSION

Successful application of DRG code based reimbursement cost control for inpatient medication use requires improvement of rational drug use, decreasing percentage of the off-label use, avoiding of repeat medication, incompatible mix of several drugs, exceeding the recommended dose and standard duration of treatment and decreasing rate of unnecessary medication. By the other hand, we should consider medication use based on principals of health economics. Centralized purchasing of drugs

as a strategic line plays a central role in rationalization of pharmaceutical expenditures.

The development of clinical drug treatment pathway is considered to be a scientific approach to the drug cost control and medical expenses control. The design and development of drug treatment pathway requires comprehensive consideration of such critically important elements of hospital care as hospital economics and rational medication use for each disease local hospital treatment procedure and integration of drug treatment pathway concept and procedure into clinical practice to benefit from new regulations. The development of clinical drug treatment pathway is dynamic process. It requires periodical updates and optimization based on new evidence based medical information, the changes of pharmaceutical management and medical insurance policies in country, provincial and city levels.

Prescription pre-checking system is positioned at the upstream stage of closed-loop management and plays a key role in reducing unreasonable medication use from medical resource consumption point of view and allows discovering the problem from the beginning. Warning system of exceeding the limit of medical insurance is a targeted reminder function for preferential use of centralized purchased drugs together with medication risk warning system for potentially inappropriate medication use for elderly group of patients both are independent and innovative audit projects introduced in the clinical practice in our hospital. These tools can guarantee the control on prescribing medication in terms of safety, effectiveness and hospital economics.

CONCLUSION

Thereafter revealed the problems related to the hospital operations and focused on BR23 group in the Department of Neurology characterized by most significant account loss, we have analyzed the possible reasons for this and found that excessive use of medication was the major cause of balance of payments deficits. The medication use was reviewed, and we discovered wrong indications in prescriptions, unreasonable repeat medication and exceeded allowable period of treatment. Therefore, pharmacists in close cooperation with physicians developed a new clinical drug treatment pathway for the ischemic stroke (BR23) to standardize medication use. From October 2021 to February 2022, we optimized DRGs payments for care based on clinical drug treatment pathway we had developed for the treatment of inpatients with ischemic stroke. Due to the application of prescription pre-checking system for review of prescriptions, implementation of in-process clinical pharmacist training, optimization of procedures, monitoring of medication use, implementation of doctor's post prescribing comments and punishment measures, both rational drug use and the economics of care in Neurology Department were significantly improved compared with those before the intervention. In addition, the same approach has also been successfully applied for GW19 gastro-esophageal reflux disease and LU13 urinary system infection, resulted in the great improvement of rational drug use for treatment of patients. As a final conclusion, the DRG-based hospital payment management approach and introduction of drug clinical treatment pathway provide a theoretical basis for DRG code-based inpatient treatment reimbursement cost con-

trol and scientific cost control and at the same time improve hospital care services.

ETHICS AND CONSENT STATEMENT

The study conforms to the principles outlined in the Declaration of Helsinki. Ethical clearance was obtained from the Medical Ethics Committee of Shaanxi Province People's Hospital. Informed consent was not required to be obtained from all subjects, because subject's privacy and personal identity information were protected and not disclosed, as well as exemption from inform consent has not adversely affected the rights and health of the subjects. Medical Ethics Committee of Shaanxi Province People's Hospital decided that this is ethically acceptable. Authors used medical records data obtained from previous clinical diagnosis and treatment. This data provided to authors by Shaanxi Medical Security Bureau is for scientific use only, limited and strictly confidential and contains no disclosure of the personal identity or information making possible to identify the subjects.

CONFLICT OF INTEREST

The author reports no conflicts of interest in this work.

REFERENCES

1. National Medical Insurance Bureau (2019) National pilot technical specifications and grouping scheme for the trial of disease-related groups (DRG) payment.

2. Shan W, Xingyu Y, Qin J (2017) Research on C-DRG clinical grouping methods. J China Health Eco 36(6): 3.

3. Fanbo J, Changkai Z, Bing H (2019) Exploration and practice of clinical pathway of drug therapy in our hospital. J Hosp Manag China 39(2):4.

4. National Health Commission (2021) Guidelines for stroke prevention and treatment in China (2021 edition).

5. Chinese Medical Association (2021) Guidelines for diagnosis and treatment of ischemic stroke at the basic level. Chinese J Gen Pract 09:927-946

6. Ministry of Human Resources and Social Security (2009) Implementation of opinions on establishing the national essential drug system.

7. The National Health Commission (2019) Good Practice in the clinical allocation and use of selected drugs in the centralized procurement of drugs organized by the state.

8. Linyi (2014) Ozagrel for Injections. Linyi: Shandong Luoxin Pharmaceutical Group.

9. National Medical Insurance Bureau (2021) List of drugs for national basic medical insurance, work-related injury insurance and maternity insurance.

10. YANG J, LIU M, ZHOU J (2011) Edaravone for Acute Intracerebral haemorrhage. The Cochrane Datab Systemat Rev.

11. Zhang X, Wang A, Zhang JY, Jia B, Huo X, et al. (2021) Efficacy and safety of butylphthalide for patients who had acute ischaemic stroke receiving intravenous thrombolysis or endovascular treatment (BAST trial): study protocol for a randomised placebo-controlled trial. BMJ Open 11(5): e045559.

12. Zhao JY, Wang XL, Wang XF, Yuan RR, Zhang YK (2022) Meta-analysis and GRADE evaluation of Shuxuetong Injection in treatment of stroke in progressive. EuropePMC 47(3): 807-818.

13. Gao J, Shao X, Guan Y, Mei J (2021) Effect of danhong injection on neurological recovery and adverse events in patients with acute ischemic stroke: A protocol for a randomized, double-blind, placebo-controlled clinical study. Medicine 100(46): e27683.

14. Gang LY (2017) Ginkgo Diterpene Lactone Glucosamine for Injections. Lianyungang: Jiangsu Kanion Pharmaceutical co ltd.

15. Zhang J, Jiang M, Zhao H, Han L, Jin Y, et al. (2021) Synthesis of paeonol-ozagrel conjugate: Structure characterization and *in vivo* anti-ischemic stroke potential. Front Pharmacol 11:608221.

16. National Health Commission (2020) National health commission guidelines for clinical application of proton pump inhibitors.

17. Renal Disease and Blood Purification Special Committee of Chinese Women Physicians Association. (2017) Expert consensus on diagnosis and treatment of female urinary tract infection in China.

18. Vaggers S, Puri P, Wagenlehner F, Somani BK (2021) A content analysis of mobile phone applications for the diagnosis, treatment, and prevention of urinary tract infections, and their compliance with european association of urology guidelines on urological infections. Eur Urol Focus 7(1):198-204.