Review

Comparison of diagnosis-related groups (DRG)-based hospital payment system design and implementation strategies in different countries: The case of ischemic stroke

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SUMMARY   Diagnosis-related groups (DRG) based hospital payment systems are gradually becoming the main mechanism for reimbursement of acute inpatient care. We reviewed the existing literature to ascertain the global use of DRG-based hospital payment systems, compared the similarities and differences of original DRG versions in ten countries, and used ischemic stroke as an example to ascertain the design and implementation strategies for various DRG systems. The current challenges with and direction for the development of DRG-based hospital payment systems are also analyzed. We found that the DRG systems vary greatly in countries in terms of their purpose, grouping, coding, and payment mechanisms although based on the same classification concept and that they have tended to develop differently in countries with different income classifications. In high-income countries, DRG-based hospital payment systems have gradually begun to weaken as a mainstream payment method, while in middle-income countries DRG-based hospital payment systems have attracted increasing attention and increased use. The example of ischemic stroke provides suggestions for mutual promotion of DRG-based hospital payment systems and disease management. How to determine the level of DRG payment incentives and improve system flexibility, balance payment goals and disease management goals, and integrate development with other payment methods are areas for future research on DRG-based hospital payment systems.

Keywords   diagnosis-related groups, payment system, hospitals, stroke

1. Introduction

Global health expenditures are increasing. Predictions indicate that spending will increase from $7.9 trillion in 2017 to $11.0 trillion in 2030 (*1*). Hospital expenses account for one of the largest shares of total healthcare expenses in all countries (*2*). Countries are seeking innovations in the methods of paying for hospital care to better allocate healthcare resources, improve hospital efficiency, and control the growth of healthcare costs. In 1983, a diagnosis-related groups (DRG)-based hospital payment system was first introduced as a new prospective case-based reimbursement system for medical care in the United States (U.S.). Since then, a range of DRG-based hospital payment systems have been widely used in inpatient care worldwide in an effort to reduce healthcare costs, such as in Europe and rapidly developing countries in Asia and sub-Saharan Africa

(*3*). DRG-based hospital payment systems are gradually becoming the main mechanism for reimbursement of acute inpatient care.

DRG-based hospital payment systems are a form of activity-based funding used to classify hospital care according to the care provided. The basic idea of a DRG-based hospital payment system is that all patients treated by a hospital are classified into a limited number of DRGs, which are supposed to be clinically meaningful and relatively homogenous in their patterns of resource consumption (*4*). Each DRG is associated with a specific cost weight or tariff, and hospitals using a DRG-based hospital payment system either receive a DRG-based case payment or a DRG-based budget allocation. Classifying patients into groups with similar levels of resource use would standardize the case-mix of patients and allow valid comparisons of hospital efficiency and output-based payment. Studies have shown that DRG-

based hospital payment systems largely increased transparency, efficiency, and the quality of hospitals in many countries (*5*).

DRG-based hospital payment systems integrate a wide range of patient information that helps to describe and understand the patient, resulting in care that optimizes patients' needs and goals (*6*). Studies have revealed differences in the ability of DRG-based hospital payment systems to explain variance in the costs and length of stay (LoS) across countries (*7*). A comparison of patient characteristics in classification systems by DRG in different countries can improve the performance of DRG classification and patient control strategies can benefit. With changes in people's lifestyles and global aging, stroke has become the second highest cause of death globally and a leading cause of disability (*8*). According to the Global Burden of Disease estimates, there were around 12.2 million incident cases of stroke, 143 million disability-adjusted life-years lost, and 6.6 million deaths globally in 2019 (*9*). The disease burden of stroke varies widely geographically and economically, with almost 90% of all deaths and disability from stroke occurring in lower-income and middle-income countries, particularly in sub-Saharan Africa and Asia (*10*). Ischemic stroke is the most common type of stroke, causing severe disability to the patient and placing a heavy burden on families and counties. Novel strategies for the prevention and management of stroke are needed in countries around the world. In this article, ischemic stroke is used as an example to summarize the design of existing DRG-based hospital payment systems and experience with their implementation to provide a reference for policymakers in countries concerned about DRG-based payment systems and to provide suggestions for stroke management strategies.

2. Search strategy

We conducted a search of the literature published from January 1983 to December 2023. We started by searching for English-language publications indexed in PubMed with "diagnosis-related groups", "DRG", "diagnosis related group", or "case-mix" in the title, keywords, or abstract. We also searched Google for the same keywords to identify grey literature, books, government reports, *etc*. Following the literature search, identified publications were reviewed and a list of countries with DRG-based payment systems was created. Certain countries that use DRG just for patient classification and not for hospital payments were excluded from the list. Once a list of countries was created, we performed a second literature search with no language restrictions in PubMed and Google that focused on countries on the list, using the name of each country combined with the same keywords mentioned above. In this way we further validated the list of countries while obtaining detailed information on each country's system design and implementation strategy.

As we further explored the development of DRG-based hospital payment systems in countries with different income classifications, we used the World Bank's country income classification of 2022 (*11*).

Ischemic stroke was identified as cases with a principal diagnosis coded for cerebral infarction (I63) using the International Classification of Diseases (ICD), 10th edition. Classification variables and grouping algorithms for ischemic stroke cases were retrieved from the newest national DRG systems (*12-15*) and detailed comparisons were made to ascertain similarities and differences in DRG system design across countries.

3. Overview of the global use of DRG-based hospital payment systems

Internationally, a total of 49 countries have introduced DRG-based hospital payment systems as of 2023, in addition to 13 countries that are piloting or exploring the use of DRG-base hospital payment systems. Based on the annual incremental development rate of countries using DRG-base hospital payment systems, the period from 1983 to 2023 can be divided into three stages: birth, slow development (0.9 new countries per year), and rapid development (2.2 new countries per year) (Figure 1A). The U.S. was the world's first country to use a DRG-based hospital payment system in 1983. DRG-based hospital payment systems then entered a phase of slow development in the 20 years from 1984 to 2003, predominantly in European countries. In the two decades since 2004, the use of DRG-based payment systems has entered a phase of rapid development, and the systems are tending to spread globally. DRG-based payment systems have gradually become the principal means of reimbursing hospitals for acute inpatient care in most high-income countries (*5*). Across the Asian and Pacific region, increasing attention is now being paid to the use of DRG-based hospital payment systems as the basis for hospital funding arrangements (*16*). There are already 15 middle-income countries that have introduced DRG-based hospital payment systems, such as China, Malaysia and Thailand, and 12 middle-income countries are piloting or exploring the use of DRG-based payment, such as Vietnam and the Philippines (Figure 1).

4. Comparison of national versions of DRG-based hospital payment systems

There were two ways for countries to introduce DRG-based hospital payment systems, importing one of the already-existing DRG systems from abroad or developing a new DRG system (*17*). The former option requires a well-developed health administration and information system. The latter requires strong team support to meet the context of a particular country's needs. In this paper, we selected countries that have developed unique DRG-based hospital payment systems, including countries that
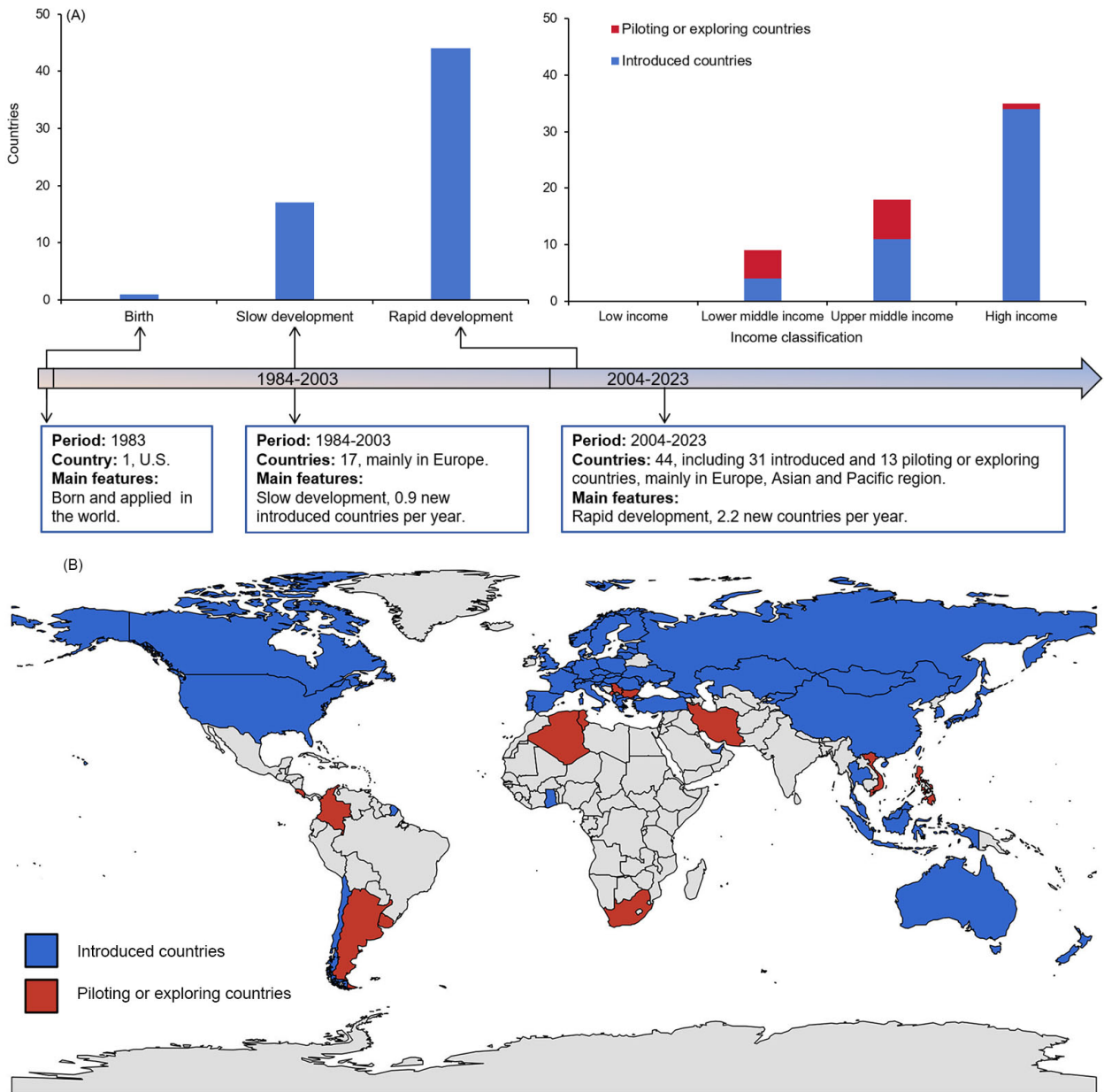
Figure 1. Global use of DRG-based hospital payment systems. (A) The three stages of development of DRG-based hospital payment systems and their distribution in countries with different income classifications. **(B)** Geographic distribution of countries using DRG-based hospital payment systems. *Abbreviation*: U.S., United States.

pioneered DRG-based hospital payment systems (the U.S. and Australia), countries that have long used DRG-based hospital payment systems (England, Sweden, Germany, the Netherlands, Japan, and Thailand), and countries where DRG-based payment systems were recently introduced (the Republic of Korea and China). The similarities and differences of DRG-based hospital payment systems in these countries were compared (Table 1). Learning from different countries' approaches and experiences is important for the development, use, and evolution of DRG-based hospital payment systems around the world.

4.1. Number of groups

The number of groups in DRG-based hospital payment systems mainly ranged from about 600 to over 2,000. Almost all countries, with the exception of the Netherlands, started with a relatively small number of groups when the DRG-based hospital payment system was initially introduced. As the payment system gradually matured, the number of DRG groups tended to increase. In the Republic of Korea, more than 90% of hospitals are private *(18)*, and due to strong opposition from private hospitals payment has long been mandated for only 78 groups in the Korea-DRG (K-DRG) (out of 1,880 groups) covering seven conditions involving relatively simple surgery (*e.g.* cataract surgery and appendectomy), while other care is still paid for on a

Table 1. Comparison of different versions of DRG-based hospital payment systems

Country (Year introduced)	Patient classification system	Diagnosis/ procedure codes	No. of groups in 2023	No. of groups initially	Frequency of revision	Previous payment system	Original purposes	Classification variables*	Payment characteristics	Ref.
U.S. (1983)	MS-DRG	ICD-10-CM ICD-10-PCS	766	470	Annual	FFS	Improving efficiency and controlling medical costs	Age, sex, and discharge status of the patient 5 Severity levels	The per-discharge payment amount is based on the average national resource use for treating patients under similar circumstances, not including fees for physicians and some education & research.	(13,22, 24,25)
Sweden (1992)	NordDRG	ICD-10-SE KVÅ	1463	722	Annual	Global budget	Aiding transparency and management of hospital care	Age, discharge status and LoS 3 severity levels	Sweden has compiled national weights for DRG payments, but each region has a high degree of local autonomy and the usage of DRG payments varies greatly across regions.	(24,26, 27)
Australia (1993)	AR-DRG	ICD-10-AM ACHI	789	527	Irregular	Historic budgets	Improved efficiency, equity of resource allocation and healthcare quality	Age, sex, mode of separation, LoS, birth weight, duration of ventilation, and mental health status 5 severity levels	Payment systems focus on measuring disease complexity and impact on resource consumption, allowing for precise grouping.	(17,28)
England (2003)	HRG	ICD-10 OPCS-4	2900	610	Annual	Global budget	Patient classification, and increasing the transparency of hospital care	Age, sex, LoS, discharge status, and neoplasms/malignancies 6 severity levels	Tariffs include all operating expenses, staff costs and capital costs, but excludes the costs of education and research. Uses many different exclusion mechanisms and has a number of additional payments.	(5,29, 30)
Germany (2003)	G-DRG	ICD-10-GM OPS	1235	664	Annual	Global budget	Reducing health care costs, increasing transparency, and encouraging health system efficiency	Age, sex, birth weight, LoS, duration of ventilation, reason for discharge, and type of admission Unlimited severity levels	Payment includes all costs except costs for investing in/maintaining infrastructure and education & research. Uses many different exclusion mechanisms and has a number of additional payments.	(22, 30-32)
Japan (2003)	DPC	ICD-10-CM Japanese original codes	2334 (out of 4726)	1860 (out of 2552)	Biennial	FFS	Standardization, transparency, and accountability of hospital care	Age, sex, birth weight, type of care provided, and ancillary treatment 2 Severity levels	Payments are set on a per diem basis. Surgeries, endoscopies, rehabilitation therapy, devices and drugs given on the day of surgery are not included in the DPC payment, but paid on an FFS basis.	(14,17, 33)
Netherlands (2005)	DTC	ICD-10 Health care activity codes	5593	Over 30000	Irregular	Global budget	Facilitating negotiations between purchasers and providers	Medical specialty, type of care, demand for care, diagnosis, treatment axis	Payments could include outpatient care and post-discharge follow-up care and entail a separate fee for medical specialists. Several groups possible per hospital stay.	(5,15, 20,22)
China (2011)	CHS-DRG	ICD-10 ICD-9-CM	618 (2020)	108 (out of 650)	Irregular	FFS	Reducing health care costs, and improving the quality of medical care	Age, birth weight, discharge status, LoS, medical costs, and duration of ventilation 3 Severity levels	In the process of promoting DRG-based hospital payment. Payment standards are based on hospitalization fee data from the past few years and differ among provinces. There were four local DRG versions in the beginning; the national version, CHS-DRG, was launched in 2019.	(12, 34-39)
Thailand (1998)	Thai-DRG	ICD-10-TM ICD-9-CM	1545	511	Irregular	FFS	Addressing low hospital admission rates and increasing public expenditures on hospitals	Age, sex, discharge status, birth weight, and neoplasms/malignancies 5 Severity levels	Applied to inpatient care at public hospitals and voluntary private hospitals and global budget limits are applied.	(17,19, 40)
Republic of Korea (2013)	K-DRG	ICD-10-CM	- (out of 2721)	78 (out of 1880)	Irregular	FFS	Solving problems stemming from overtreatment under the FFS system	Age and sex 4 Severity levels	Facing strong opposition from private hospitals, DRG only covers seven conditions and payment at public hospitals and voluntarily participating private hospitals. Otherwise, payments are on an FFS basis.	(17,19, 23,41)

*Except Principal diagnosis and procedure, which are commonly used in all 10 countries. *Abbreviations:* U.S., United States; DRG, diagnosis-related groups; MS, Medicare-severity; ICD, International Classification of Diseases; CM, clinical modification; PCS, Procedure Coding System; FFS, fee-for-service; SE, Swedish modification; KVÅ, Swedish national classification system for surgery and non-surgical procedures; LoS, length of stay; AR, Australia Refined; AM, Australian modification; ACHI, Australian Classification of Health Interventions; HRG, Healthcare Resource Group; OPCS-4, the Office of Population Censuses and Surveys Classification of Interventions and Procedures, version 4; G-DRG, German-DRG; GM, German Modification; OPS, Operation and Procedure Classification; DPC, diagnosis procedure combination; DTC, diagnosis treatment combinations; CHS, China Healthcare Security; TM, Thai Modification; K-DRG, Korean DRG.

fee-for-service (FFS) basis (*19*). In order to facilitate negotiations between healthcare purchasers and providers, the Netherlands initially created more than 30,000 groups of diagnosis treatment combinations (DTCs) reflecting clinical logic more than administrative logic (*20*). However, the number of groups has been drastically reduced to around 5,000 since 2012 due to the high level of complexity and weak operability of DTC. The Japanese Diagnosis Procedure Combination (DPC) is characterized by an emphasis on classifying patients from a clinical perspective, with a total of 4,726 groups in 2023, but payment was provided for only 2,334.

4.2. Coding of diagnosis and procedures

The coding of diagnosis and procedures is important for a DRG-based payment system since this information forms the basis of the definition of patient groups. As shown in Table 1, all 10 countries use the ICD-10 for diagnosis. Significant differences exist since countries usually use the ICD-10 with country-specific modifications, such as the U.S. clinical modification, German modification, or Thailand modification. The classification system for procedures varies greatly in countries, such as the U.S. ICD-10 Procedure Coding System (ICD-10-PCS) or the Australian Classification of Health Interventions (ACHI). Almost every country has developed its own procedure coding system tailored to its needs. Consequently, these systems are very heterogeneous. Germany has converted the ACHI into the Operation and Procedure Classification (OPS) (*21*). In Sweden, the classification of surgery and non-surgical procedures is called KVÅ. The surgical procedures in KVÅ are generally the same as the procedures in the Nordic Medico-Statistical Committee Classification of Surgical Procedures (NCSP), but the medical procedures are national in scope. When introducing a DRG version from another country, attention should be paid to the bias in different coding systems.

4.3. Classification variables

The variables used to define a group and to assign a case can be complex and vary between countries. The variables required usually include clinical variables, demographic and administrative variables, and resource-use variables (*19*). Principal diagnosis and procedures are commonly used in all 10 countries because they provide the basis for the costing or pricing of treatment and resource use. Age, sex, and discharge status are commonly considered as demographic and administrative variables. Resource-use variables indicating the level of severity or complexity of the diagnosis/procedure are used in almost all 10 countries except the Netherlands. The division into severity levels within the classification is usually limited, with up to six levels in the England-Healthcare Resource Group (HRG). In the German DRG

(G-DRG) system, the number of severity levels is not, in principle, limited, and up to nine levels are now used (*22*). Other variables such as LoS and the duration of ventilation are used in some countries to classify cases into economically and medically homogenous DRGs (Table 1).

4.4. Original purposes and payment characteristics

There are some differences in the purpose of adopting a DRG-based hospital payment system in various countries. European countries that introduced DRG payment are mainly oriented towards increasing the transparency and efficiency of hospitals (*5*). Japan's DPC/per diem payment system was intended to deliver quality health care and to efficiently construct a clinical database by standardizing information platforms, thereby improving the transparency of hospital care (*17*). South Korea introduced the K-DRG to solve problems stemming from overtreatment under the FFS system (*23*). Although the original purposes vary in countries, there are four main purposes of DRG-based hospital payment systems: to contain costs, increase the efficiency of inpatient care, improve the transparency of hospital care, and to improve the quality of care (Table 1). In South Korea, the K-DRG version 4.4 that was revised in 2021 has 2,721 officially identified DRGs, but only seven disease categories are covered while other care remains on an FFS basis. In the ten countries, only the Netherlands may have several DRGs per hospital stay, and payments are set on a per diem basis only in Japan. The basic characteristics of patient classification systems in the ten countries are summarized in Table 1.

5. DRG-based hospital payment for ischemic stroke

There can be large differences between countries in how they group the same disease. Taking ischemic stroke as an example, different countries have different number of groupings, classification variables, and payment methods (Figure 2). The number of DRGs is similar in China and the U.S., where ischemic stroke patients are divided into about 10 groups, while they are divided into 20 in the Netherlands. In Japan, there are 1,584 groups for ischemic stroke, accounting for 33.5% of the total DPC groups.

A principal diagnosis of stroke is considered at an early stage in the grouping algorithm in almost all 10 countries' DRG systems, while China and the U.S. have a pre-main diagnostic category (pre-MDC) only based on surgical procedures without considering the principal diagnosis. The pre-MDC is generally used for cases that consume a lot of medical resources and that are difficult to classify into other groups. In the U.S. and Netherlands, patients treated with thrombolysis are assigned into specific groups. The presence of relevant complications or comorbidities (CC) influences the
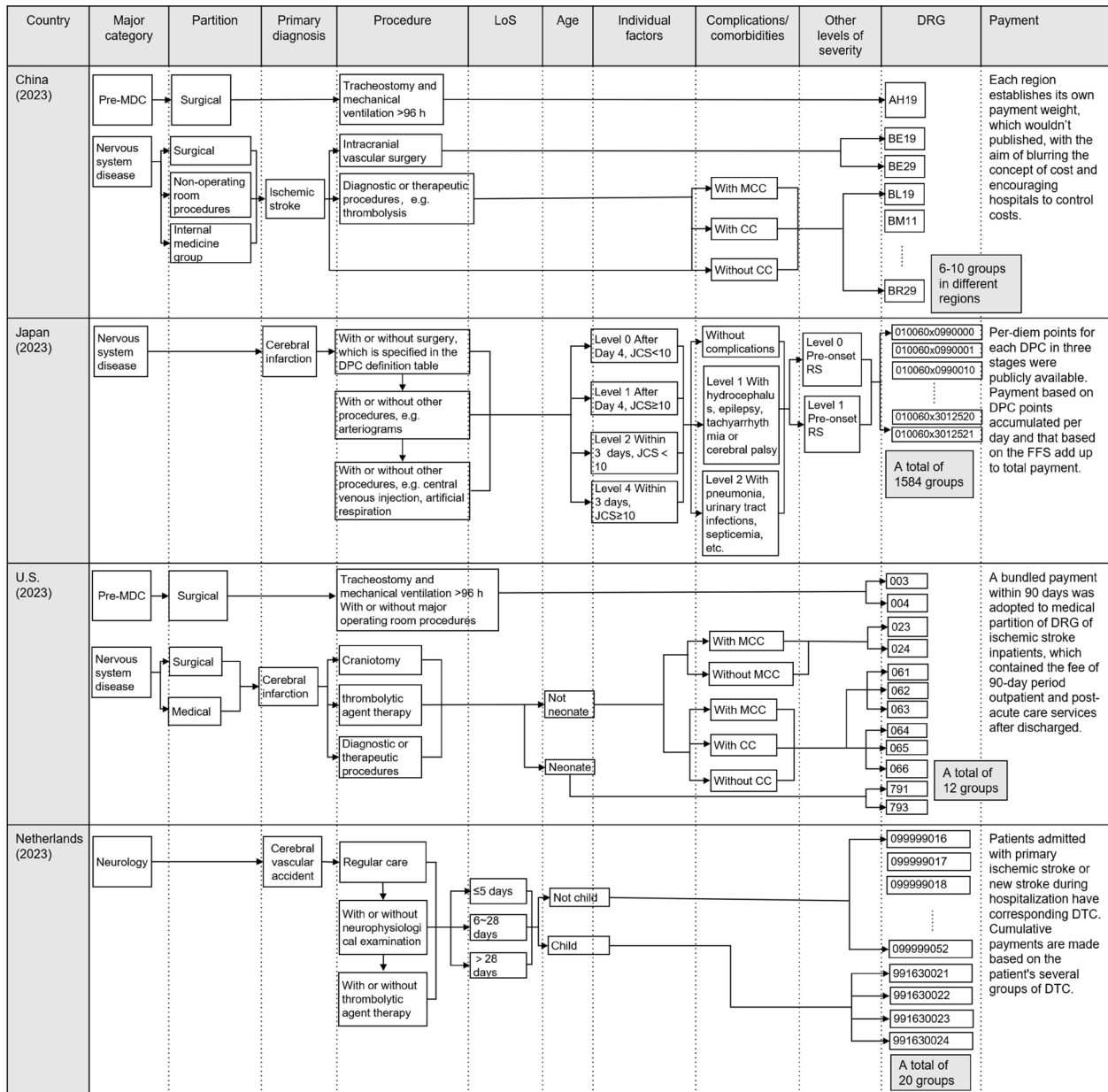
Figure 2. Graphic depiction of grouping variables and payment strategies for inpatients suffering from ischemic stroke under the DRG-based hospital payment system in China, Japan, the U.S. and the Netherlands. *Abbreviations*: LoS, length of stay; DRG, diagnosis-related groups; MDC, main diagnostic category; MCC, major complications or comorbidities; CC, complications or comorbidities; DPC, diagnosis procedure combination; JCS, Japan Coma Scale; RS, Rankin Scale; FFS, fee-for-service; U.S., United States; DTC, diagnosis treatment combinations.

classification of stroke patients in China and the U.S. In addition to diagnosis and procedure, classification variables in the Netherlands include LoS (5 days, 6–28 days, 28+ days) and patient age (child and nonchild). Japan's ischemic stroke grouping is very detailed. Various surgical procedures are grouped separately. Classification variables reflecting stroke severity are used only in Japan's DPC system such as Japan Coma Scale (JCS) scores reflecting patient consciousness and disability/dependence levels and Rankin Scale (RS) scores pre-onset. The DPC systems are finally divided into 1,584 groups after permutations and combinations, but the payment points for some groups are the same. The grouping of ischemic stroke in Japan is more

based on clinical logic to facilitate disease statistics and management.

6. Implementation strategies for DRG-based hospital payment in different countries

6.1. Payment for ischemic stroke cases

Directly analyzing and comparing payments for specific diseases is complicated because different countries set DRG-based payment rates at different levels and there are different additional payments. In ischemic stroke cases (Figure 2), patients in the same DRG have the same payment standards and are only assigned to one

DRG group per hospital stay and the payment does not involve outpatient and post-acute care in China. In order to encourage coordination and cooperation between hospitals and post-acute care facilities, the U.S. adopted a bundled payment (*42*). Payment for ischemic stroke care in the medical partition of Medicare-severity DRG (MS-DRG) is bundled within 90 days of discharge, which means outpatient and post-acute care will no longer be paid for in the 90-day period after discharge. Among the 10 countries, only the Netherlands allows several DRGs per hospital stay. Patients admitted with primary ischemic stroke or new ischemic stroke during hospitalization have a corresponding DTC, and cumulative payments are made based on the several groups under the DTC under which the patient falls. In addition to very detailed grouping of ischemic stroke, Japan's DPC payment system also focuses on the quality of ischemic stroke management. Early rehabilitation for ischemic stroke patients was among the 13 quality monitoring indicators for hospitals accepting DPC payment in Japan and additional medical fee incentives are provided to hospitals that meet the quality indicators (*17*).

6.2. The impact of COVID-19 on DRG-based hospital payment systems

Before the COVID-19 pandemic, many healthcare systems around the world were already struggling to contain spending and meet the increasing demand for healthcare needs due to aging populations and a rise in chronic disease. The COVID-19 pandemic further worsened these problems and presented unique challenges to health systems. During the COVID-19 pandemic, hospitals paid by DRG systems based on activity were at financial risk because of the sudden drop in hospital admissions (*43*). Some countries, such as France, have created new DRG codes to classify payment for patients with COVID-19, and more countries have adopted a higher payment tariff or new budgets other than DRG payments to encourage hospitals to prepare for and provide care for COVID-19 patients (*43*). Japan used the existing DPC to pay for COVID-19 inpatients, while the compensation points for COVID-19 patients were updated several times every year. These points were generally 1-6 times the points for the original grouping as a result of changes in the classification of COVID-19 under the Infectious Diseases Act (*44*). COVID-19 has caused Japan to reflect on the flexibility of the DPC payment system, and the country listed "establishing a healthcare system that can flexibly respond to emergency medical needs" as a challenge in its "Basic Policy on Economic and Fiscal Management and Reform 2021" (*45*). Germany paid for COVID-19 patients according to conventional DRG payment standards but directly compensated hospitals for COVID-19-related revenue losses, such as extra financial assistance for each empty bed (*46*). England returned to global budgets in response to the COVID-19 pandemic and announced a deviation from DRG in its "National Health Service Long Term Plan" in 2019 (*47*); as of 2022, the country was moving towards a payment system that consists of three components-a fixed payment, a variable component largely based on DRGs, and a quality-related component.

7. Discussion and prospects

7.1. Differences between DRG payment versions across countries

Over the past four decades, the gradual introduction of the DRG-based hospital payment system from the U.S. to countries around the world and its continuous updating in various countries have caused differences between countries in terms of the purpose, grouping, coding, and payment mechanisms of DRG systems, even if they were based on the same classification concept. The number of groups covered by DRG-based hospital payment systems ranged from about 78 in South Korea to 5,593 in the Netherlands and has tended to increase in almost all 10 countries. In order to ensure homogeneous groups of patients, DRG systems need to consider the most important determinants of resource consumption as classification variables. The classification variables can be complex and vary between countries. Common classification variables include principal diagnosis, procedures performed, patient characteristics, and the severity of the case (*48*). The purposes of adopting a DRG-based hospital payment system differed among countries. For example, England and South Korea introduced DRG-based payment to contain costs and increase efficiency, while Australia implemented DRG-based payment to improve the transparency of resource allocation. Although the original purposes vary in countries, there are four main purposes: containing costs, increasing the efficiency of inpatient care, improving the transparency of hospital care, and improving the quality of care. Countries that need to introduce or learn from other countries' DRG-based hospital payment systems must evaluate which elements of existing DRG versions to introduce, which elements to develop on their own, and how to combine different elements consistently based on their own circumstances.

7.2. The long-term and complex process of optimizing DRG-based payment systems

Most countries that use a DRG-based payment system update their systems regularly. The process of introducing DRG-based payment systems is always carried out in stages, with gradual changes in the types of diseases covered, hospitals covered, areas covered, and payment rates. Countries that have recently introduced a DRG-based hospital payment system generally have limited DRG coverage, such as China's DRG-based payment

system that is only used in some cities and piloting hospitals and South Korea's K-DRG that only covers a limited number of disease categories. Countries that have long used DRG-based payment systems have wide coverage, such as the Thai-DRG the covers all diseases, while some European countries like the Netherlands have even extended DRG systems from inpatient to outpatient care. Some countries such as England have established additional payments that deviate from the DRG-based payment system as the goals of the healthcare system have changed. DRG payment incentivizes hospitals to control costs and improve efficiency through economic leverage, so hospitals will respond strategically to the incentives of the DRG-based payment system to explore profit maximization, which may have unintended consequences. Continuously monitoring hospital activity and dynamically updating payment rates can adjust the incentives to achieve intended goals.

7.3. Mutual promotion of DRG-based payment systems and disease management

Several studies have identified stroke severity as an important determinant of resource utilization in the treatment of stroke patients (*49-51*). When hospitals admit proportionally more patients with more severe illnesses, they are underfunded when receiving only a uniform payment per patient because of the oversimplified grouping of DRGs. Stroke severity is not included as a classification variable in most of the DRG-based hospital payment systems (*52*). There are no ICD-10 codes for ischemic stroke of differing severity at this time, which maybe a major impediment to incorporating stroke severity into DRG systems. In its DPC, Japan has incorporated the JCS score indicating patient consciousness and disability/dependence levels and RS scores pre-onset in the grouping variables for ischemic stroke since 2010. Studies have shown that adding such scores increases the usability of administrative databases and can facilitate risk-adjusted in-hospital mortality assessments, thereby promoting reform of incentive systems or payment systems (*51,53*). Learning from disease classification variables in other countries can promote the optimization of groupings in a country's DRG-based payment system. At the same time, patient prevention and treatment strategies and standardized clinical management can also benefit from classified databases that include more information about patient disease diagnosis and treatment. Groupings under DRG-based payment systems need to balance the two elements of clinical similarity and homogeneity of resource consumption.

7.4. Challenges and prospects

No hospital payment system is likely to perfectly align with the interests of payers, patients, and providers. As the spectrum of diseases changes, the population ages, and the COVID-19 public health emergency persists, the priorities and goals of countries' healthcare systems are constantly changing, and so is the proportion of DRG-based payments out of total hospital payments. Studies have shown that in some high-income countries, policymakers are searching for new ways to shift their inpatient payment systems away from a focus on volume to value-based purchasing methods (*24*). How to improve the flexibility of the DRG payment system and optimally integrate it with other payment methods to form a diversified payment system is a challenge for the sustainable development of DRG-based hospital payment systems. Many countries are exploring mechanisms for reasonable coexistence of a DRG-based payment system and various other payment methods such as global budgets, add-on payments, and episode-based payments. At present, the DRG-based payment system mainly covers inpatients in most countries. There are difficulties in controlling medical costs overall and cost transfer is a risk. A number of countries in Europe have extended the scope of DRG payments beyond 24 hours after discharge (*22*). Based on a disease spectrum featuring chronic diseases with a high incidence and a long and complex course, how to integrate inpatient care with outpatient care, day services, rehabilitation services, or nursing in the DRG-based hospital payment system may be the future direction for development of healthcare payments.

8. Conclusion

Over the past four decades, DRG-based hospital payment systems have tended to spread globally. Diversification and localization are inevitable for the sustainable development of DRG-based hospital payment systems. With the rapid changes in today's global healthcare and healthcare needs, the development of DRG-based hospital payment systems is also facing huge challenges. How to determine the level of DRG payment incentives and improve system flexibility, balance payment goals and disease management goals, and integrate development with other payment methods are areas for future research on DRG-based hospital payment systems, and they will also determine the development of DRG-based hospital payment systems over the next four decades.

Conflict of Interest: The authors have no conflicts of interest to disclose.

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