Original Article

Assessing the Economic Implications of a Diagnosis-Related Groups Payment System in Iran's Health System Transformation Plan

Abstract

Background: The Health System Transformation Plan (HSTP) in Iran aimed to enhance universal health coverage through improved access and reduced out-of-pocket payments. However, rising healthcare expenditures have posed challenges. The Diagnosis-Related Groups (DRG) payment system has been implemented in developed countries to reduce costs, improve efficiency, and enhance service quality. This study estimates the potential cost savings in pharmaceutical and inpatient services within the HSTP framework, focusing on public hospitals affiliated with Isfahan University of Medical Sciences (MUI). **Methods:** This study was conducted in three stages. First, a cross-sectional study design was used to collect current inpatient and pharmaceutical costs from public hospitals affiliated with MUI before and after the health sector reform. Second, a meta-analysis was conducted to determine the effects of implementing the DRG payment system on the costs of inpatient and pharmaceutical services. Finally, the possible costs of medication and hospitalization in 2015 were estimated by applying the annual inflation rate. The predicted costs were calculated by multiplying the impact values of the DRG payment system on the estimated expenses in 2015. The potential cost savings were calculated by subtracting the current expenses from the predicted expenses based on the DRG payment system. **Results:** Based on the assumption ratio of changes following the implementation of the DRG payment system, the study estimated cost savings of $60,282,055 in both inpatient and pharmaceutical expenses. **Conclusions:** Implementing the DRG payment system could have resulted in significant cost savings, equivalent to 9.2% of the total health sector expenditures of MUI.

Keywords: *Cost savings, diagnosis-related groups, fee-for-service plans, health care reform, prospective payment system*

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Background

The second phase of health sector reform aiming the universal health coverage was implemented in Iran in 2014. It was nominated as the Health System Transformation Plan (HSTP). The main objectives of this plan were increasing the access of residents in medium and large cities to essential health services and reducing out-of-pocket payments. In addition, in this project, health service tariffs increased to motivate health service providers, especially medical professionals.[1]

The payment system through the HSTP was carried on the Fee-for-Service (FFS) system in specialized outpatient services and the case-mixed payment in inpatient services. Nowadays, Iran health system is facing an excessive rising in health expenditures. This has challenged the primary advantages of the HSTP, particularly financial protection for patients and the satisfaction of patients and health services providers.[2-4]

The reimbursement systems based on the FFS and/or case-mixed payment systems are two of the oldest types of reimbursement systems by which employers or insurance organizations reimburse providers' fees for services that were supplied for customers (or patients) in the past. In these types of retrospective payment systems, numerous challenges have been faced by either health service recipients or employers (public health organizations or insurance organizations). The most important challenges are the excessive raising of health costs (decreasing efficiency) and lack of financial risk protection for customers (disruption of health inequity).[4] According to previous study that was conducted in Isfahan, after

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the implementation of the transformation plan in the health system, compared to before, the costs incurred by the MUI and insurance organizations increased by 92%.[5] Today, in many developed countries, authorities have launched the Diagnosis-Related Groups (DRG) payment system to reimburse for health services in hospitals or expensive services (some expensive drugs), instead of the case-mixed and/or FFS payment systems.[6]

The DRG payment system was initially created by researchers at Yale University in the 1970s. At first, the purpose of the DRG planning was to evaluate the quality of hospital services and to measure hospital performance. However, since 1983, DRG has been used to allocate hospitals' budgets, as well as repay hospital bills in the United States of America.[7,8] After the United States, DRG quickly became popular among many other countries for two reasons: 1) reducing health costs and improving efficiency in hospital resources and 2) increasing transparency in the amount and manner of services provided by health centers and also improving their quality.[9]

The fundamental question is that if the HSTP had been implemented based on the DRG payment system, how many health expenses could have been prevented and saved? Unfortunately, there was no adequate evidence on this issue, particularly in developing countries.

The purpose of this study was to estimate the cost savings in pharmaceutics and inpatient services in public hospitals affiliated with Isfahan University of Medical Sciences (MUI) as a model university in Iran during the HSTP on the condition that, instead of the FFS and case-mixed payment systems, the DRG payment system had been implemented.

Methods

This research can be divided into three parts: 1) collecting current inpatient and pharmaceutical costs of MUI hospitals, 2) conducting a systematic review and meta-analysis to measure the effect of the DRG payment system, and 3) predicting inpatient and pharmaceutical expenses based on DRG and the annual inflation rate.

MUI hospitals data collecting

A cross-sectional study was conducted to collect data on the current expenses of inpatient and pharmaceutical services in all 37 public hospitals affiliated with MUI. Data for the years 2013 and 2015, 1 year before and 1 year after the implementation of the HSTP, were collected from the Budget Management Office of MUI using the census method.

Systematic review and meta-analysis

A systematic review and meta-analysis of published articles from hospitals worldwide were conducted to determine the effect size of a DRG-based payment system on inpatient and pharmaceutical expenses.

Articles search

The Cochrane Manual principles were followed,[10] and findings were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[11]

Six electronic databases (Web of Science, Medline/PubMed, Scopus, Google Scholar, Embase, Cochrane, and Magiran) were searched for all published studies up to September 2022 that examined the effects of implementing the DRG payment system on inpatient costs and medication costs in inpatient wards.

Search protocol

The search was conducted by combining two groups of related keywords. Keywords within each group were combined using the OR operator, and the two groups were combined using the AND operator. The first group consisted of keywords related to efficiency, impact, and cost control, while the second group described the DRG-based payment systems.

The Inclusion Criteria:

- English studies published up to September 2022, with research designs approved by the Effective Practice and Organization of Care Group (EPOC), including randomized clinical trials, nonrandomized clinical trials, before–after control studies, and time-series studies that reviewed or critiqued the effects of establishing a DRG payment system for hospital services
- Time-series studies with a precise start time of the intervention and at least two execution points before and after the implementation of the DRG-based payment system
- Studies examining changes in hospital and medication costs by comparing years before and after the implementation of the DRG payment system
- Studies comparing the effects of implementing a DRG payment system to a retrospective system

The Exclusion Criteria:

- Studies examining the effects of establishing a DRG payment system over a time other than before and after its implementation
- Studies comparing the effects of a DRG payment system with other prospective payment systems
- Studies solely comparing the effects of implementing a DRG payment system qualitatively
- Studies including costs other than hospitalization and medication costs in their statistical data
- Studies lacking evidence regarding the effects of implementing a DRG payment system
- Review studies, letters to the editor, and articles solely reviewing healthcare providers' points of view
- Studies solely focusing on DRG measurement or comparing different DRG categories, as well as articles examining the financial impact of DRG divisions

- Cohort studies without a clear starting point and endpoint
- Studies without a control group to compare the results of the DRG payment system implementation.

Articles select

Two researchers reviewed the titles of the extracted papers, excluding duplicate titles and selecting appropriate titles. The full texts of the selected studies were then evaluated by the two researchers, and relevant and appropriate studies were chosen. Any disagreements between the researchers regarding the eligibility of specific research were resolved through discussion with a third reviewer.

Data extraction

The findings from the selected studies were collected and recorded in a checklist, including the researcher's name, study year, study duration, country of research, sample size, types of hospital services, and data on changes in drug and inpatient services costs after the implementation of the DRG payment system. The effects of the DRG payment system on the number of medication and inpatient expenses were obtained based on the collected statistical data [Tables 1 and 2].

Data synthesis

The mean and standard deviation (SD) of study variables were used to compare intervention and control group (before and after) changes. Standard error (SE) was converted to SD by multiplying SE with the square root of the sample size of each group. The pooled effect size was calculated as the weighted mean difference (WMD) and 95% confidence interval (95% CI). Heterogeneity between studies was evaluated by Cochran's Q and I-square (I2) tests; I2 higher than 50% was considered substantial heterogeneity.[21] For estimating the pooled effect sizes

Table 1: Characteristics of included studies that examined the changes in the pharmaceutical and inpatient expenses following the implementation of the DRG-based payment system

Number	Study (author, year, Ref§)	Country	Type of Study	Study period (years)	Diagnosis/procedures	Study periods after DRGs** adoption (year (s))
1	Jian (2020)[12]	China	CBA*	2010-2012	Cerebral ischemia, lens surgery, vascular procedures, unilateral uterine adnexectomy	1
2	Lave (1988)[13]	USA	CBA	1984-1985	Psychiatric patients	1
3	Kwak (2014)[14]	Korea	CBA	2011-2012	Appendectomy, operations on the anus, and operations on the uterus and adnexa	1
4	Kwak (2018)[15]	China	CBA	2012-2014	Adenotonsillectomy and tonsillectomy	1
5	Yuan (2019)[16]	China	CBA	2008-2014	Acute myocardial infarction	3
6	Shin (2013)[17]	Korea	CBA	2012-2013	Obstetrics and Gynecology	1
7	Jung (2018)[18]	Korea	CBA	2012-2014	Cesarean section, Hysterectomy, Adnexectomy	2
8	Cao (2018)[19]	China	CBA	2009-2013	10 surgical procedures	2
9	Song (2000)[20]	Korea	CBA	NR	Uterine and Adnexa procedure	NR***

*CBA: controlled before-after; **DRG(s): Diagnosis-related groups; ***NR: not reported; §Ref: reference

Table 2: Summary of studies that examined the changes in the pharmaceutical and inpatient expenses following the implementation of the DRG-based payment system

Study (author, year, Ref§)	Number of patients	Changes in the inpatient expenditure (%)	*P*	Changes in Pharmaceutical expenses (%)	*P*
Jian (2020)[12]	*C: 124400 **I: 141263	-6.2	<0.001	NR¶	
Lave (1988)[13]	C: 93627 I: 66268	-14.1	<0.001	NR	
Kwak (2014)[14]	381 Hospitals	-4.67	<0.001	NR	
Kwak (2018)[15]	C: 688 I: 714	-6.8	<0.001	NR	
Yuan (2019)[16]	C: 727 I: 2168	+15.59	<0.0001	-13.01	<0.0001
Shin (2013)[17]	C+I: 202	-18.7	0.000	-41.97	0.000
Jung (2018)[18]	C: 88983 I: 72017	-4.55	<0.001	NR	
Cao (2018)[19]	C: 15524 I: 11941	-6.17	<0.001	NR	
Song (2000)[20]	C: 50 I: 33	not significantly difference		-17	<0.001

*C: control group (cost-based payment group); **I: intervention group (DRGs-based payment group); ¶NR: not reported; §Ref: reference

and their corresponding 95% CIs, a random effects model based on DerSimonian and Laird method was adopted; otherwise, we used the fixed effects approach.[22] To explore the source of heterogeneity, we did a subgroup analysis based on the duration of DRG conduction. Also, sensitivity analyses were conducted to evaluate the extent to which inferences might be affected by a particular study. Publication bias was also evaluated by the visual inspection of the funnel plot. Also, Egger's and Begg's regression tests were used for the formal evaluation of publication bias.[23] Statistical analyses were performed by using STATA version 11.2 (STATA Corp., College Station, TX, USA). *P* values less than 0.05 were considered statistically significant.

Estimating inpatient and pharmaceutical expenses

Iran is facing a high inflation rate, yearly. To adjust the effect of inflation on the costs of the health sector, instead of increasing the costs due to the implementation of the HSTP in Iranian's health system, we applied the annual inflation rate for 2 consecutive years after the implementation of the HSTP (for fiscal years 2014 and 2015) on 2013 MUI's hospital inpatient and pharmaceutical expenses based on the official statistics of the National Statistics Organization of Iran.[18]

The 2015 MUI's hospital inpatient and pharmaceutical *estimated* costs (without considering the effects of the HSTP) were measured only due to the increase in the percentage of inflation.

By carrying out a meta-analysis, the amount of measured impact of the DRG payment system was multiplied by the amount of 2015 MUI's public hospital inpatient and pharmaceutical *estimated* costs, in which the annual inflation was included. This way, we *predicted* costs of MUI's public hospital inpatient and pharmaceutical expenses in 2015 (provided that the model of the payment system based on DRG was applied).

The cost savings in either hospitalization or medications were measured by subtracting the *current* 2015 MUI's public hospital inpatient and pharmaceutical expenses collected from MUI's Budget Management Office from the *predicted* costs in MUI's public hospitals in 2015 by considering a DRG payment system implementation.

Ultimately, the total cost savings were estimated by adding the predicted costs for the pharmaceutical and inpatient services for the fiscal year of 2015.

Ethical Statement

This research was conducted based on the permission of the Research Ethics Committee of Shahid Sadoughi University of Medical Sciences with code IR.SSU.MEDICINE.REC.1399.184.

Results

Article search results

Among different countries, the DRG-based payment system had different scopes with varying levels of complexity. There were significant differences in the weight of the groups or the repayment rate. But all these studies included the predetermined criteria of our research for the DRG-based payment system.

Through searching in the six databases of Web of Science, Medline (PubMed), Scopus, Google Scholar, Embase, Cochrane, and Magiran, 7219 related articles were identified, out of which 2567 articles were deleted due to duplication. 4606 articles then were deleted after reviewing their titles and abstracts because of mismatching the inclusion and exclusion criteria. In total, 46 articles were added to the full-text review stage. Finally, nine articles were selected for final review.[12,14-20] Figure 1. shows the article selection process based on the PRISMA diagram.

Table 1 shows the characteristics of the selected studies. These nine studies are before and after control studies.[12,14-20] The publication date of the studies varied from 1988 to 2018. Those studies were conducted in the United States,[13] South Korea,[18,14,17,20] and China.[12,15,16,19]

The impact of the implementation of the payment system based on the DRG reported in nine articles extracted from the systematic review is reported in Table 2.

Based on the nine studies obtained, the cost data of the pharmaceutical and hospitalization section were separately meta-analyzed and the results are reported in Figures 2 and 3.

Meta-analysis of DRG's effect on pharmaceutical expenses

The meta-analysis that was conducted on the three existing studies to investigate the effect of DRG on drug costs indicated an average decrease of 21.04% (95% CI: 10.82 to 31.25 $P < 0.001$) in these costs [Figure 2].[16,17,20]

Considering the significance of the Chi-square test for heterogeneity and the i-squared index being higher than 50%, there was a considerable abnormality in the data, and therefore, the effect estimation was done with the random effect approach.

Due to the small number of studies, publication bias was not evaluated, but the sensitivity analysis performed showed that the combined results of three studies were not influenced by any of the studies alone; the estimation of the effect of DRG on drug expenditures was estimated, and the withdrawal of each of them from the meta-analysis does not change the meaning.

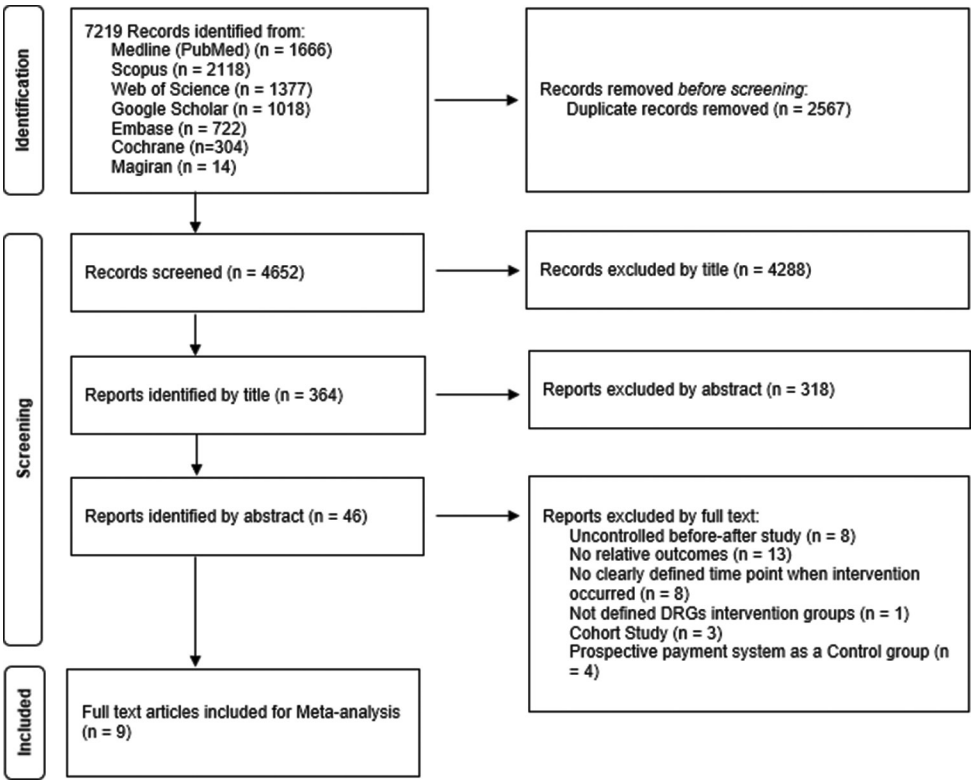

Figure 1: PRISMA study selection process flowchart

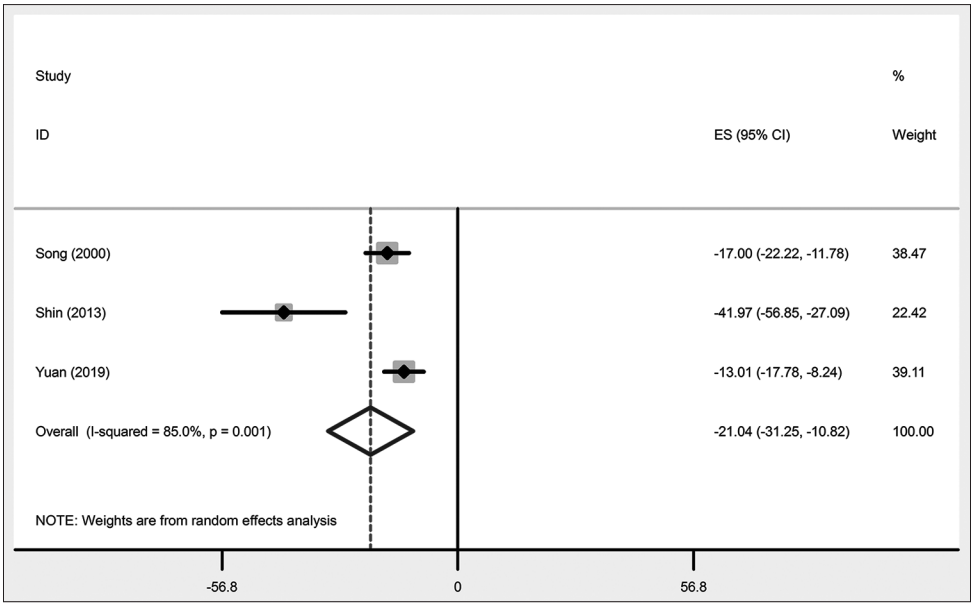

Figure 2: Meta-analysis of the effect of DRG-based payment system on hospital pharmaceutical section costs

Meta-analysis of DRG's effect on inpatient expenses

Considering the significance of the Chi-square test for heterogeneity and the i-squared index being higher than 50%, there was considerable heterogeneity in the data, and therefore, the effect was estimated using the random effect approach. Based on this, the meta-analysis conducted on eight existing studies to investigate the effect of DRG on hospitalization costs of patients indicates an average decrease of 5.63% (95% CI: 2.246 to 9.025 $P = 0.001$) in these costs [Figure 3].[12-19]

Evaluation of publication bias with a funnel plot and Begg and Egger statistical tests showed that publication bias is not statistically significant. However, the sensitivity analysis performed showed that the combined results of eight studies were not influenced by any of the studies alone, and the estimation of the DRG effect on inpatient

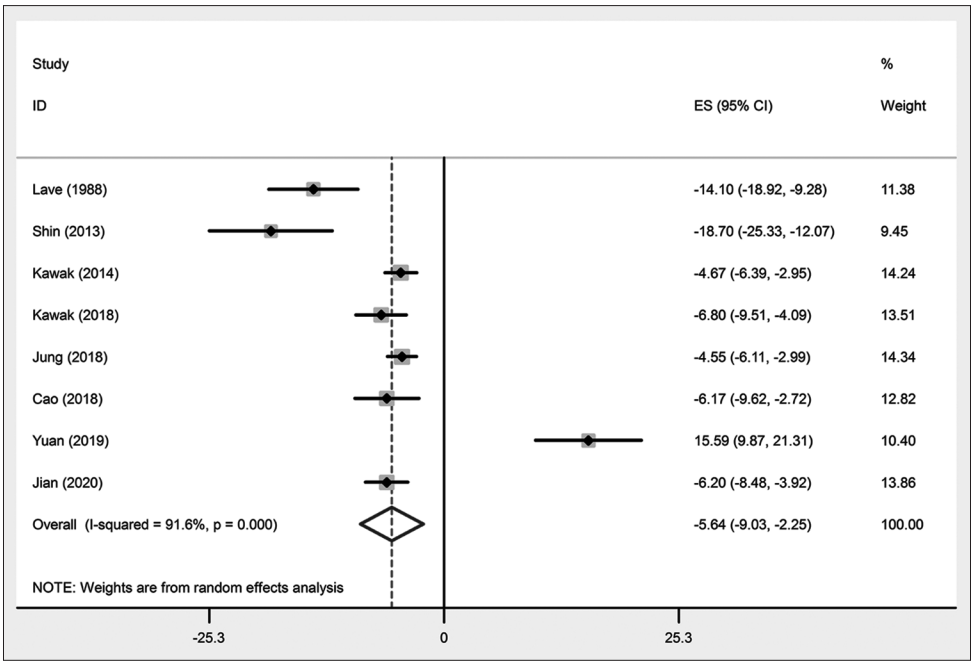

Figure 3: Meta-analysis of the effect of DRG-based payment system on hospital inpatient section costs

expenditures was not significantly changed by removing each of them from the meta-analysis.

MUI's predicted cost calculation

According to the website of the Central Bank of Iran, the exchange rate was $1, which was equal to 28,430 Rials in 2015.[24]

It should be taken into account that the inflation rates in the two fiscal years of 2014 and 2015 were 27.8% and 25.5%, respectively,[25] and the total inflation rate in this interval was 53.3%.

MUI's pharmaceutical predicted cost calculation

According to the cost documents in the Budget Management Department of MUI, the number of *current* costs for pharmaceutical services in 2013 and 2015 (1 year before and 1 year after implementing the HSTP) raised from $68,364,798 to $125,175,305. It showed a growth rate of 83%.

The effect of the implementation of the DRG payment system on pharmaceutical expenses according to meta-analysis is -21.04%.[17,20,16] The *predicted* pharmaceutical costs considering the annual inflation and implementation of the DRG payment system in 2015 could be approximated as $82,752,634.

Instead of the FFS payment system, if the DRG-based payment system had been launched simultaneously with HSTP in 2014, it could have saved $42,422,671 in pharmaceutical expenses of MUI's public hospitals 1 year later [Table 3].

MUI's inpatient predicted cost calculation

The average *current* cost per hospitalized patient in MUI's public hospitals in 2013 was $586, which after implementing the HSTP, raised to $812 in 2015.

According to the *current* expenses in 2013 and taking into account the effect of the DRG payment system and including annual inflation, the *predicted* costs per hospitalized patient in 2015 would be estimated $847.

By subtracting the *predicted* average cost per admission in 2015 (after applying the effect of the DRG payment system and taking into account the annual inflation) from the estimated average cost per hospitalized patient in 2015 only taking into account the biennial inflation after 2013 it was estimated that a $51 could have been saved per hospitalized patient.

A total of 350,184 patients were hospitalized in MUI's public hospitals in 2015. If the number of hospitalized patients in 2015 is multiplied by the *predicted* inpatient costs per hospitalized patient, a total of $17,859,384 could have been saved from the simultaneous implementation of the HSTP and the DRG payment system in inpatient services [Table 4].

Total cost savings if the DRG payment system is implemented

The total *presumptive* saving costs in the case of implementing the DRG payment system and implementing the HSTP simultaneously was calculated by summing the two abovementioned cost savings: The cost savings in the pharmaceutical services and the inpatient services would be $60,282,055 in MUI's public hospitals.

By comparing the amount of money that could have been saved with the approved budget of some other current expenses in MUI in 2015,[26] these findings highlight

remarkable information that can be seen in Table 5. For instance, if the DRG payment system had been implemented with HSTP simultaneously, 9.2% of the total expenditures imposed on the health sector of MUI could have been saved yearly.

Discussion

Based on our findings, instead of the FFS and case-mixed payment systems, if the DRG payment system had been implemented with HSTP simultaneously, 9.2% of the total expenditures imposed on the health sector of MUI could have been saved yearly. The DRG-based payment system is a painless cost control policy that involves health care providers rather than recipients of health services. The painless cost control policies have the least negative impact on citizens' access to essential health services.[2]

The DRG payment system controls health expenditures by utilizing resources efficiently. One of these ways is to reduce the length of stay (LOS) of the patient in the hospitals.[27] Reducing the LOS and consequently reducing inpatient costs are the positive results of the DRG reimbursement mechanism that were reported in many studies.[28-31]

Table 3: The estimation of the number of costs saved for pharmaceutical expenses if the DRG-based payment system had been implemented in MUI¶ in 2015

The variable	Number/Ratio
Pharmaceutical expenses in 2013	$68,364,798
Pharmaceutical expenses in 2015	$125,175,305
The amount of cost increase from 2013 to 2015 during the HSTP	83%
The sum of annual inflation rates from 2013 to 2015[25]	53.3%
The estimated cost in 2015, only taking into account the biennial inflation after 2013	$104,803,235
The effect of the implementation of the DRG* payment system on pharmaceutical expenses[16,17,20]	-21.04%
The estimation of the pharmaceutical costs in 2015 considering the annual inflation and implementation of the DRG payment system	$82,752,634
The number of savings in pharmaceutical costs if the DRG payment system had been applied in the HSTP**	$42,422,671

*DRG (s): Diagnosis-related groups; **HSTP: Health System Transformation Plan; ¶MUI: Isfahan University of Medical Sciences

Table 4: The estimation of the costs savings in inpatient services in public hospitals affiliated to MUI¶ if a DRG*-based payment system had been established during the HSTP in 2015**

The variable	Number/Ratio
Incurred expenses for hospitalization services in 2013	$181,129,298
Number of people admitted to public hospitals affiliated with MUI in 2013	308669
Average cost per hospitalized patient in 2013	$586
Incurred expenses for hospitalization services in 2015	$284,395,763
Number of people admitted to public hospitals affiliated with MUI in 2015	350184
Average cost per hospitalized patient in 2015	$812
The number of increased costs in 2015 compared to 2013 during the HSTP	$226
The sum of annual inflation rates from 2013 to 2015[25]	53.3%
The estimated average cost per hospitalized patient in 2015 only taking into account the biennial inflation after 2013	$898
The effect of implementing a DRG payment system on the inpatient cost per hospitalized patient[12-19]	-5.64%
The estimated costs per hospitalized patient in 2015 if the DRG payment system had been applied with the measured effect	$847
The mean difference cost (cost reduction) between a condition in which the DRG payment system had been implemented and the one with the actual number of incurred expenses per hospitalized patient in 2015	$51
The mean total number of cost-savings in case of applying the DRG payment system, for all cases of hospitalized patients in 2015	$17,859,384

*DRG (s): Diagnosis-related groups; **HSTP: Health System Transformation Plan; ¶MUI: Isfahan University of Medical Sciences

Table 5: The frequency of expenses that could have been saved if a DRG-based payment system had been implemented in comparison with the approved budget of some budget sections of the MUI in 2015[26]

The institution's budget	The number of approved budgets (dollars)	The number of estimated cost savings compared to any part of the approved budget (%)
The MUI's¶ budget for the education domain	59,655,570	101
The MUI's budget for the research domain	1,773,811	3398
The total amount of MUI's budget for outpatient and inpatients health services	658,150,612	9.2

¶MUI: Isfahan University of Medical Sciences

However, in a study in England and Scotland between 2003 and 2005, Farrar *et al*.[32] showed that the LOS of patients with pelvic fractures increased after the DRG. In addition, Vulgaropulos *et al*.[33] showed that the LOS of patients with inflammatory bowel diseases increased after the DRG. In another study, Sarıyer *et al*.[34] showed that different factors affect LOS. They showed that the LOS varies according to the pattern of diseases diagnosed, and the day of the week in which the patients were hospitalized.

Busse *et al*.[29] in their book reported that hospital admissions increased following the implementation of the DRG payment mechanism in Australia, Denmark, the United Kingdom, France, Germany, Norway, and Spain. In contrast, in the United States, Central Asia, and Eastern European countries, the hospital admission rate decreased after the implementation of DRG. Reducing LOS may lead to denying some essential health services to clients or to transferring the costs to other hospitals, and/or to an adverse selection phenomenon in which patients with less severe diseases are admitted, while those patients suffering more severe conditions are refused. However, using efficient databases related to patients' discharge and readmission and other control tools can reduce the transfer of disease risks or costs to patients or related hospitals.[35]

In the FFS payment system, the pharmaceutical costs in hospitals are not fully covered by insurance companies, and part of the pharmaceutical costs are paid out of pocket. However, in hospitals whose payment systems are based on the DRG, patients generally are not paid off out-of-pocket for receiving inpatient services considerably. Reimbursement of medicines prescribed in the hospitals via DRG is provided by hospitals themselves. Therefore, hospitals exclude medications that are brand names while having the least value in terms of cost-effectiveness and/or the quality-adjusted life-year (QALY). In addition, pharmaceutics is fully covered by insurance companies for particular diseases (such as cancers or diabetes mellitus, etc.) in outpatient services in Organization for Economic Co-operation and Development (OECD) countries. For other medications (other than antibiotics), the amount which would be paid by customers as copayment (through out-of-pocket or supplementary health insurance) is minor (from $41 up to $1486.8 per year in Australia, up to a maximum of 10% of prescription costs in Germany, copayment for up to 58 Swedish kronor (SEK) per prescription and up to 2460 SEK per year in Norway, up to 10% for cheap medicines and up to 20% for expensive medicines in Switzerland and copayment up to 12% in the United Kingdom).[36-40]

The evidence from countries with both high- and medium-gross domestic products suggests that implementing the DRG causes the transparency of hospital operations improvement, reimbursement standardization, appropriate care encouragement, and unnecessary care reduction, which improves efficiency. So, hospitals are encouraged to control expenses and reduce hospital LOS.[15] Most studies that evaluated the effectiveness of transferring expenses from hospitals to other health centers showed that this approach transferred expenditures from inpatient wards to outpatient wards, health houses, and/or nursing home visits. Consequently, it increased the motivation of doctors to deliver proper medical care promptly.

It was shown that following the implementation of the DRG-based payment system, hospitals would increase the number of readmissions at the same time to compensate for their income.[15] However, establishing a DRG-based payment system has generally led to control the hospital expenses and pharmaceutical expenses.[35-41] In addition, physicians may provide inadequate medical care and reject patients with complicated conditions because their treatment leads to more resource consumption.[42] In many cases, the implementation of a DRG-based payment system requires strong support for relevant policies and up-to-date hospital information systems, medical records and diagnostic coding, and clinical guidelines. However, its use is limited in real-world conditions.[43]

Conclusions

In contrast to the retrospective payment systems such as the FFS or the case-mixed system, the DRG-based payment system generally reduces the inpatients and pharmaceutics expenses in hospitals. Furthermore, if the HSTP had been implemented through a DRG payment system, it would have caused annual cost savings of about $60,282,055 in the pharmaceutical and hospitalization costs in the public hospitals affiliated with the Medical University annually. In other words, if the DRG payment system had been implemented with HSTP simultaneously, 9.2% of the total expenditures imposed on the health sector of MUI could have been saved yearly.

Limitations

Despite our comprehensive systematic review, the number of published articles clearly stating the amount of change in pharmaceutical costs following the implementation of the DRG-based payment system was limited. As a result, we had to analyze cost savings in pharmaceuticals based on only three articles, although we conducted a meta-analysis of the available data. Another limitation of our study was the limited range of inpatient criteria considered, specifically the diagnosis for hospitalization or the types of operations. Additionally, the data on expenses in MUI's public hospitals were collected globally, encompassing costs, procedures, and operations across all departments in a fiscal year. We were unable to separate each expense from one another in hospital services, such as procedures or operation costs. While we have presented the data through meta-analyses, it is important to exercise caution when applying the findings of this study in real-world situations.

It is recommended that future studies evaluate the effects of the DRG payment system in real-life scenarios, particularly in general and/or teaching hospitals.

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Statement

We wish to note that this manuscript was previously published as a preprint on the Research Square platform under DOI: 10.21203/rs.3.rs-1382774/v1. However, the preprint represents an earlier version of our work, and since its publication, both the methodology and dataset have undergone substantial revisions. The current version, as published in this journal, constitutes the final iteration of the manuscript, which has been thoroughly revised and approved by all authors. Accordingly, this published version should be regarded as the definitive and official version of our work.

Data availability statement

All data generated or analyzed are included in this published article. However, the additional data are available from the corresponding author, upon reasonable request.

Author's contribution

The conception or design of the work was done by Reza Khadivi, and Yousef Khadivi. Data collection was done by Yousef Khadivi. Data analysis and interpretation were done by Reza Khadivi, Fatemeh Saghafi, and Yousef Khadivi. Drafting the manuscript was done by Yousef Khadivi. Critical revision of the article was done by Mohsen Nabi-Meybodi, Fatemeh Saghafi, and Reza Khadivi. Final approval of the version to be submitted was done by Reza Khadivi. All authors read and approved the final version.

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Conflicts of interest

There are no conflicts of interest.

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