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DRG-Based Hospital Payment Systems and Technological Innovation in 12 European Countries

David Scheller-Kreinsen, MPP*, Wilm Quentin, MD, MSc, HPPF, Reinhard Busse, MD, MPH

Department for Health Care Management, Berlin University of Technology, Berlin, Germany

ABSTRACT

Objectives: To assess how diagnosis-related group-based (DRG-based) hospital payment systems in 12 European countries participating in the EuroDRG project pay and incorporate technological innovation. **Methods:** A standardized questionnaire was used to guide comprehensive DRG system descriptions. Researchers from each country reviewed relevant materials to complete the questionnaire and drafted standardized country reports. Two characteristics of DRG-based hospital payment systems were identified as particularly important: the existence of short-term payment instruments encouraging technological innovation in different countries, and the characteristics of long-term updating mechanisms that assure technological innovation is ultimately incorporated into DRG-based hospital payment systems. **Results:** Short-term payment instruments and long-term updating mechanisms differ greatly among the 12 European countries included in this study. Some countries operate generous short-term payment instruments that provide additional payments to hospitals for making

use of technological innovation (e.g., France). Other countries update their DRG-based hospital payment systems very frequently and use more recent data for updates. **Conclusions:** Generous short-term payment instruments to promote technological innovation should be applied carefully as they may imply rapidly increasing health-care expenditures. In general, they should be granted only if rigorous analyses have demonstrated their benefits. If the evidence remains uncertain, coverage with evidence development frameworks or frequent updates of the DRG-based hospital systems may provide policy alternatives. Once the data and evidence base is substantially improved, future research should empirically investigate how different policy arrangements affect the adoption and use of technological innovation and health-care expenditures.

Keywords: DRG, health care, inpatient, pricing, technological change

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Introduction

Technological innovation in health care is highly valued by patients, doctors, and politicians [1] because advances in medical technology have greatly improved the ability to prevent, diagnose, and treat a large number of diseases and conditions reducing mortality and increasing the quality of life [2–5]. At the same time, technological innovation – which may be defined as “a drug, device, procedure or organizational support system that is perceived as new by a proportion of key stakeholders in a health care organization” [6] – is a major driver of increasing health-care costs [7,8], and policies have been devised with the aim of balancing technological innovation and affordability [9].

The hospital payment system is one important factor influencing the adoption and use of technological innovation in health care [10–13], especially so because many new technologies are first used in the inpatient sector. Nevertheless, there have been concerns that diagnosis-related group-based (DRG-based) hospital payment systems, which are the principal means of hospital payment in the majority of the Organisation for Economic Co-operation and Development countries [14], may not provide the right set

of incentives to encourage the desired adoption and use of technological innovation [15–17].

The basic idea of DRG-based hospital payment systems 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 resource consumption patterns [18]. Each DRG is associated with a specific cost weight or tariff, which is usually calculated from information about average treatment costs of patients falling within a specific DRG in at least a sample of other hospitals in the past. Depending on the country, hospitals under DRG-based hospital payment systems either receive a DRG-based case payment or a DRG-based budget allocation. In both variants, however, hospitals are exposed to the financial risk of having costs above the payment rate and are rewarded for keeping costs below.

There is general consensus in the literature on two basic incentives of DRG-based hospital payment systems: hospitals are encouraged to reduce costs per admission, and/or to increase the number of admissions [19]. Concerning the effects of DRG-based hospital payment systems on technological innovations, most studies assume that they incentivize the adoption and use of those technological innovations, which lead to reduced costs per admis-

* Address correspondence to: David Scheller-Kreinsen, Research Fellow, Department for Health Care Management, Berlin University of Technology, Germany, Strasse des 17. Juni 135 (H80), D-10623 Berlin, Germany.

E-mail: David.Scheller-Kreinsen@tu-berlin.de.

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sion and do not negatively affect quality of care [20,21]. When technological innovations are associated with increased costs per admission, however, disincentives exist for hospitals to adopt and use them until the DRG-based payment system is updated to account for their additional costs [9]. Consequently, most countries with DRG-based hospital payment systems have developed mechanisms to account for technological innovation in health care [9,16,22,23] in order to avoid compromising patient access to quality-increasing but cost-increasing technological innovations [17,20,24].

Prior studies have reported that the specific characteristics of DRG-based payment systems influence the effect these systems have on technological innovation [13,24]. The specific characteristics of DRG-based hospital payment systems in different countries and their implications for innovative technologies, however, have rarely been explored, especially in the European context. Most studies on DRG-based hospital payment systems and technological innovation stem from the United States [25,26–31], and most international comparative work on the patterns and determinants of the diffusion of technological innovation does not account for the differences that exist between different DRG-based hospital payment systems [32–35].

This study aims to describe specific characteristics of DRG-based hospital payment systems in 12 European countries (Austria, England, Estonia, Finland, France, Germany, Ireland, The Netherlands, Poland, Portugal, Spain/Catalonia, and Sweden) and their implications for technological innovation. More specifically, the study identifies characteristics of DRG-based hospital payment systems that are relevant for the adoption and use of technological innovation; presents specific payment instruments that are used in the context of DRG-based hospital payment systems in order to encourage adoption and use of technological innovation; and describes updating mechanisms of DRG-based hospital payment systems, which assures that technological innovation is ultimately incorporated into these systems. Furthermore, the discussion section provides additional insights by reviewing the experience in three particular policy contexts (i.e., France, The Netherlands, and Finland).

Our results were generated in the framework of the EuroDRG project “Diagnosis-Related Groups in Europe: Towards Efficiency and Quality” (funded under the seventh framework programme of the European Commission; www.eurodrgeu), which compares DRG-based hospital payment systems in 12 European countries. The project scrutinizes the characteristics of DRG-based hospital payment systems and empirically investigates their capacity to reimburse hospitals fairly for selected episodes of care.

Methods

Sources of information

Building on the experience of the HealthBasket project [36], researchers from 12 European countries participating in the EuroDRG project (Austria, England, Estonia, Finland, France, Germany, Ireland, The Netherlands, Poland, Portugal, Spain/Catalonia, and Sweden) developed a standardized questionnaire to guide comprehensive DRG system descriptions for each country. One section of the questionnaire focused specifically on how each country's DRG-based hospital payment system deals with technological innovations.

After pilot testing applicability of the questionnaire in three countries (The Netherlands, Poland, and Spain/Catalonia) in early 2009, an updated version was agreed upon in mid-2009. Subsequently, EuroDRG project partners reviewed laws, regulations, scientific and grey literature, and drafted standardized country reports. Country reports were presented and discussed in a workshop of the EuroDRG project in early 2010, and extensively

reviewed and commented on by national experts. Revised versions of the country reports were finalized in mid-2010.

Each country report contains information on the following aspects of DRG systems and their use for hospital payment: an overview to the development and use of DRGs for hospital payment in the country; a description of methods and regularity for updating the DRG-based hospital payment system; a detailed assessment of how patients are classified by the DRG systems; an overview of cost accounting within hospitals; and a summary of reimbursement mechanisms and regulations concerning technological innovation. In the summary section authors were asked to describe the following points: a) formal steps required for the adoption and use of technological innovation in hospitals; b) instruments and mechanisms for funding and reimbursement; and c) national experience with regard to the incentives (or disincentives) resulting from the reimbursement arrangements.

Analysis

All country reports were reviewed by two researchers (D.S.K., W.Q.) to identify characteristics of DRG-based hospital payment systems that are relevant for adoption and use of technological innovation. Two characteristics were identified as particularly important. On the one hand, when cost-increasing technological innovation first enters the market, the short-term availability of additional payments to cover the additional costs was seen as an important incentive stimulating adoption and use of technological innovation by hospitals in a number of countries. Therefore, the distribution of different types of short-term payment instruments, which operate outside or at the margin of DRG-based hospital payment systems, was assessed among the 12 countries included in this study.

On the other hand, technological innovation has to be eventually incorporated into DRG-based hospital payment systems through long-term updating mechanisms. The ability of DRG-based hospital payment systems to respond to technological innovation through long-term updating mechanisms is determined by two factors: 1) the frequency of updates, and 2) the time lag between the collection of (meaningful) cost and medical data and using this information for hospital payment. Therefore, the long-term updating mechanisms were assessed among the 12 countries included in this study. Information was extracted from the country reports, summarized in overview tables, and verified by EuroDRG partners from each country.

Results

Overview

Figure 1 illustrates short-term payment instruments and long-term updating mechanisms used in DRG-based hospital payment systems in Europe. On the left-hand side, the figure has short-term payment instruments used by different countries to encourage the use of cost-increasing technological innovations at a time when the DRG-based hospital payment systems do not yet account for technological innovation. These instruments can be completely outside the system (extreme left) or can be associated to the DRG-based hospital payment system (in the middle). On the right-hand side, the figure presents long-term updating mechanisms to incorporate technological innovation formally into the systems, either by updating the DRG system (i.e., the patient classification system or PCS), or by adjusting the payment rate.

Short-term instruments

Types of short-term payment instruments

Table 1 lists the three main short-term payment instruments used by different countries aiming to incentivize hospitals to adopt and

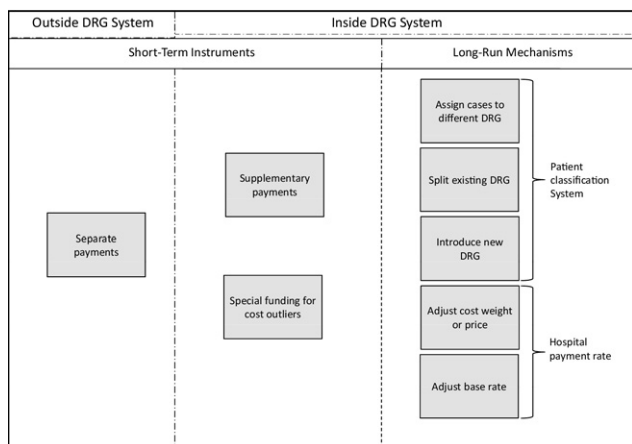


Fig. 1 – Short-term payment instruments and long-term updating mechanisms to encourage and incorporate technological innovation in DRG-based hospital payment systems. DRG, diagnosis-related group.

use technological innovation: separate payments; supplementary payments; and special funding for cost outliers. In addition, the table provides an overview to the main variants of each payment instrument.

Separate payments, which are the most important instrument operating outside the general DRG system, can take two forms: fee-for-service (FFS), negotiated nationally or locally – as for example in Germany [24] – or retrospective reimbursement of hospital reported total costs (e.g., used by some county councils in Sweden). Both payment instruments are usually used at a time when information about costs and effects of technological innovation is still relatively scarce. Separate payments do not necessarily require that procedure codes have been assigned. Consequently, they can be made available very rapidly and provide a high degree of flexibility with regard to the conditions under which payments are granted.

In contrast to separate payments, supplementary payments and cost-outlier funding are relevant for technological innovation but are also used in order to improve the general DRG system coherence by excluding certain high-cost technologies or high-cost patients and reimbursing them separately. Both instruments take a specific DRG payment rate as a starting point and justify additional payments in terms of substantial differences between incurred costs and standard payment rates.

Supplementary payments are paid on top of the “standard” DRG payment rate if specific technologies (including new and innovative ones) are applied. The amount to be paid on top of the standard rate can be negotiated or can take the form of retrospective reimbursement of reported costs (per case) above the standard rate of individual providers. In some countries costs are weighted across providers before payment is made. For example, the average costs per patient category are calculated and reimbursed (“payment of weighted costs”). The necessary administrative processes for establishing a relationship between a technological innovation and a DRG require some time, which may contribute to retarding the adoption by hospitals. In some cases, a procedure code needs to be assigned to a technological innovation before supplementary payments can take place, thus prolonging the process of providing reimbursement for technological innovation.

In countries where special funding for cost outliers is available, the way technologies (including new and innovative ones) influence homogeneity of resource use of cases within DRGs determines whether special funding is made available on top of standard payment rates. Cost-outlier funding builds on detailed

retrospective statistical analysis of cost data. Different variants of this instrument exist (see Table 1). In addition, many countries provide extra payments for length-of-stay (LOS) outliers for technological innovation. However, the relevance of these instruments is not clear because technological innovation can increase LOS when increasing survival of patients, but may also decrease LOS, e.g. when new, minimally invasive surgical procedures lead to faster patient recovery and discharge [37].

Distribution of short-term payment instruments in countries

Table 2 presents the distribution of the outlined short-term payment instruments in the 12 countries included in this study. Separate payments are the most frequently used payment instrument. Supplementary payments are also used in many countries. Surprisingly, cost-outlier funding for cost-increasing technological innovation is used only in Estonia, Finland, and some Swedish county councils. In many other countries, outliers are identified only via LOS because standardized cost data is not available on the patient level for all hospitals. Some countries (i.e., Austria and Portugal) do not make use of any short-term payment instruments.

Long-term updating mechanisms in European DRG-based hospital payment systems

Types of system updates and relationship to data

Updates of the PCS or the payment rate are not exclusively targeted at incorporating technological innovation into DRG-based hospital payment systems but are supposed to assure that the systems are always adapted to current practice patterns and treatment costs. Because data are required to make the updates, it is inevitable that DRG-based hospital payment systems exhibit a certain time-lag to current practice patterns and treatment costs.

When technological innovation increases (or decrease) treatment costs for a well-defined subset of patients falling into one or more DRGs, adjusting the DRG system (i.e., PCS) is the best way to incorporate technological innovation into the DRG-based hospital payment system. Several options such as reassigning patients to different DRGs splitting an existing DRG, and creating new DRGs can be introduced when adjustments are necessary (see Figure 1).

When technological innovation increases the costs of all services bundled in one DRG or of all hospital services, updates to the payment rate are the best approach to incorporate them

Table 1 – Instruments to encourage use of technological innovation and types of associated payments.

Instrument	Type of payment
<i>Outside DRG system</i>	
Separate payments	<ul style="list-style-type: none"> • Fee-for-service (based on weighted costs or negotiated payment) • Retrospective reimbursement of reported costs per case
<i>Inside DRG system</i>	
Supplementary payments	<ul style="list-style-type: none"> • Fee-for-service • Retrospective reimbursement of costs above standard rate • Payment of weighted costs
Special funding for cost outliers	<ul style="list-style-type: none"> • Retrospective reimbursement of costs above a statistically determined threshold • Fixed payments (based on weighted costs or negotiated payment) • Payment of weighted costs
DRG, diagnosis-related group.	

Table 2 – The distribution of short-term payment instruments in 12 European countries.

	Instruments used to provide extra payments for technological innovations		
	Separate payments	Supplementary payments	Cost-outlier funding
Austria	No	No	No
England	Yes (for up to 3 years)	Yes (for certain high-cost services)	No
Estonia	Yes (for certain high-cost services)	No	Yes
Finland	No	No	Yes
France	Yes	Yes	No
Germany	Yes	Yes (for certain high-cost services)	No
Ireland	Yes	No	No
The Netherlands	Yes (for certain high-cost drugs)	Yes (envisaged to start in 2011)	No
Poland	No	Yes (for certain high-cost services)	No
Portugal	No	No	No
Spain* (Catalonia)	Yes (for certain high-cost procedures)	No	No
Sweden	Depends on county council, all instruments are used		

* In Spain, hospital financing is decentralized. The presented information refers to Catalonia.

into the DRG-based hospital payment system. In order to increase payment for a specific DRG, its cost weight or payment rate can be recalculated. In order to increase funding for all hospital services, countries not operating a cost weight approach can inflate payment rates by the appropriate amount. Countries using a cost weight approach have two options. They can either adjust the base rate to account for proportionate increases of costs (e.g., a 5% increase of all hospital costs) or they can adjust the base rate and recalculate cost weights if technological innovations increase costs for all cases by a fixed amount.

Frequency and time-lag of system updates

Table 3 presents the frequency of updates and the time-lag to data used for updates in 12 countries across Europe. The PCS and the payment rate are updated annually in the majority of countries, but there are remarkable exceptions. In 2010, Estonia updated its DRG system for the first time since the introduction of NordDRGs to the country in 2003. Ireland currently uses Australian DRGs, which are updated every 4 years. Austria is an interesting outlier with regard to the adjustment of payment rates because DRG scores are not updated regularly, but are adjusted only for specific DRGs when deemed necessary by policymakers. The data used for updates varies consid-

Table 3 – Frequency of DRG system updates and time-lag to data used for updates in 12 European countries.

	DRG-based hospital payment system			
	Patient classification system		Payment rate	
	Frequency of updates	Time lag to data	Frequency of updates	Time lag to data
Austria	Annual	2–4 years	4–5 years (updated when necessary)	2–4 years
England	Annual	Minor revisions annually; irregular overhauls every 5–6 years	Annual	3 years (but adjusted for inflation)
Estonia	Irregular (first update after 7 years)	1–2 years	Annual or following update of FFS fees	1–2 years
Finland	Annual	1 year	Annual	0–1 year
France	Annual	1 year	Annual	2 years
Germany	Annual	2 years	Annual	2 years
Ireland	Every 4 years, linked to Australian updates of AR-DRGs*	Not applicable (imported AR-DRGs)	Annual - linked to Australian cost weight updates	1–2 years
The Netherlands	Irregular	Not standardized	Annual or when considered necessary	2 years, or based on negotiations
Poland	Irregular – planned twice per year	1 year	Annual update only of base rate	1 year
Portugal	Irregular	Not applicable (imported AP-DRGs)	Irregular	2–3 years
Spain (Catalonia)	Biennial	Not applicable (imported 3 year old CMS-DRGs)	Annual	2–3 years
Sweden	Annual	1–2 years	Annual	2 years

AR-DRGs, All patient (AP-)DRGs; CMS-DRGs, Centers for Medicare and Medicaid Services DRGs; DRGs, diagnosis-related groups; FFS, fee-for-service.

erably between countries. In Finland, data is used from the current year to update the DRG system for the next year and cost weights are recalculated as soon as data become available (during the same year). In most countries data for updating the PCS and adjusting cost weights or prices are 2 years old or more.

Discussion

This study has demonstrated that European DRG-based hospital payment systems are characterized by substantial differences in how they deal with technological innovation. Most, but not all, countries included in this study have complemented their DRG-based hospital payment systems with specific short-term payment instruments targeted at encouraging the adoption and use of technological innovations. Although all countries update their DRG-based hospital payment systems, the frequency of updates and the time lag to the data used for updates differ greatly.

The current study has important methodologic limitations. We did not empirically investigate the effect different characteristics of DRG-based hospital payment systems have on the adoption and use of technological innovations. Consequently, this study cannot deduct which characteristics of DRG-based hospital payment systems are better at encouraging adoption and use of technological innovations. Furthermore, because this study did not look at any specific technological innovations, it cannot draw conclusions about whether certain characteristics of DRG-based hospital payment systems are better at encouraging those cost-increasing technological innovations that are worth the additional expenditures. Nevertheless, in the next subsection, we qualitatively explore the disadvantages and advantages of different policy components for three country case studies (France, The Netherlands, and Finland). We found some of the likely effects of short-term payment instruments and long-term updating mechanisms on technological innovation, and highlight the results of possibly linking short-term payment instruments to the conditionality of continuing evaluation.

In addition, this study is also limited by the fact that it has focused on a small set of characteristics of DRG-based hospital payment systems even though other characteristics are likely to be important as well. For example, the ownership status of hospitals and whether or not hospitals are allowed to run deficits will modify the incentives related to DRG-based hospital payment systems. Furthermore, the strength of the incentives is determined by the percentage of total hospital revenue earned through DRG-based payments. If other sources of funding (e.g., budgets for capital investments, teaching, and research; or budget adjustments for structural characteristics) account for an important percentage of total hospital revenues (as in France, Germany, or Spain), the incentives for technological innovation related to these funding sources need to be considered. The availability of funding for capital investments can be important for adoption and use of technological innovation in large scale medical equipment. We include some information about the availability of additional funding for capital investments, which is provided in Appendix Table A1 found at: doi:10.1016/j.jval.2011.07.001, but a detailed discussion of the implications of all sources of revenue would go beyond the scope of this study.

Short-term payment instruments

Financial implications and experiences from France and The Netherlands

In general, short-term payment instruments provide strong incentives for hospitals to use technological innovations because they exempt the selected technologies from the incentives of DRG-based hospital payment [16]. Consequently, short-term payment instruments can be expected to be effective at encouraging adoption and use of the selected technologies, but they may also distort

clinical decision making and can lead to inefficiencies related to overprovision of these services and to increasing health-care expenditures.

In France access to technological innovation is a major public concern [38] and a generous set of short-term instruments has been developed. Separate payments are available from a national budget called MERRI (missions d'enseignement, de reference et d'innovation) and can cover costs related to the development of new therapies, drugs, or devices or to fund the use of specific innovative technologies on an experimental basis. In addition, supplementary payments are paid over and above regular DRG-based case payments for technological innovations if these have been declared part of a national list of supplementary payments by ministerial order or by the National Union of Health Insurance Funds [39].

To the authors knowledge no research has yet been conducted on the specific effect of these arrangements in promoting particular technological innovations. Some evidence is available about the development of expenditure over time: expenditures for separate payments and supplementary payments have been increasing rapidly. Total expenditures for supplementary payments increased by 37% between 2005 and 2007 and reached €2.4 billion (Euros) in 2008, accounting for roughly 6% of total hospital revenues [39] and for about 58% of pharmaceutical expenditures in university hospitals [40]. One reason for the strong increase in expenditures is that the criteria by which technological innovations are assessed prior to inclusion on the "liste en sus" are relatively vague and easy to manipulate. The criteria are: high costs; substantial effect on the homogeneity of the DRG system; and innovative character. The criterion of "costliness" is assessed based on information provided by manufacturers and technologies qualify for the "liste en sus" the more costly they appear to be. The criterion "innovativeness" is only vaguely defined and does not allow rule-based deduction of reimbursement decisions. In an attempt to control expenditures, volume targets for treatments on the "liste en sus" were defined at the level of individual hospitals in 2009, but their impact has been limited so far.

In summary, the French system seems to assure that access to technological innovations (particularly in cancer treatment) remains one of the most generous in Europe [38], but this comes at the cost of a considerable share of total hospital expenditures being spent on separate and supplementary payments [41]. Unfortunately, we are unable to determine whether current spending levels reflect strong country-specific priorities for encouraging technological innovation or whether they indicate overprovision of services for which the evidence base remains limited. It is clear, however, that robust evidence on cost-effectiveness of technological innovations is not a prerequisite for reimbursement from MERRI or through supplementary payments.

Of course, the evidence based on (long-term) effects of technological innovations can be limited at the time when decisions have to be made about the introduction of short-term payment instruments. If countries are concerned about ensuring access to technological innovations with expected significant quality improvements, but for which the evidence remains uncertain, it would be beneficial to use short-term payment instruments within a coverage with evidence development (CED) framework [42]. Under CED approaches, payments for technological innovations are provided only for a limited period of time and under the conditionality of continuing evaluation. The Netherlands provide an example for separate payments for innovative or orphan drugs within a CED approach [43]. Since 2006, hospitals can receive separate payments for innovative or orphan drugs under the condition that a plan exists for the assessment of cost-effectiveness of the drug in routine clinical practice. After 3 years, the data generated in the context of the assessment plan is used to inform decisions about providing further funding for the innovative (or orphan) drug.

Long-term updating mechanisms

The exception of Finland

In general, DRG-based hospital payment systems are thought to encourage the efficient use of resources by leaving treatment decisions to providers and making them residual claimants over any cost savings they implement [44,45]. Given that most DRG-based hospital payment systems are updated at regular intervals, the change of treatment patterns and costs resulting from the introduction of technological innovations should eventually be reflected by the DRG-based hospital payment system. Consequently, separate payments and supplementary payments can be discontinued, which increases the incentives for providers to make efficient use of resources.

Countries with frequent updates of their DRG system and payment rate, and those with a short time-lag between data collection and using the information for DRG-based hospital payment are in a better position for incorporating technological innovations into their systems. Nevertheless, incentives resulting from modification of the patient classification system need to be closely monitored. If a new DRG is introduced (e.g., for using a specific innovative medical device in a broadly defined group of patients) providers could be incentivized to overprovide the technological innovation [15].

As illustrated in Table 3, the DRG-based payment system in Finland is updated more frequently than in any other European country included in this study. Both the patient classification system and the cost weights are updated annually and the time-lag to the data informing these updates is only 6 months to 1 year. At the same time, Finland does not use separate payments or supplementary payments to encourage technological innovation. Finland, however, has a system of cost-outlier payment, which assures that cases with exceptionally high costs are reimbursed separately. In addition, the strong role of municipalities as both purchasers and providers of health care could play an important role in finding a balance between ensuring access to technological innovation and keeping expenditures under control [46]. Regrettably, there was no empirical evidence found about the combined effect of the Finnish approach to encouraging and incorporating technological innovation within its DRG-based hospital payment system. Nevertheless, it represents an interesting reference case and its relative merits in ensuring the integration of technological innovations into the DRG-based hospital payments system, and access and diffusion of technological innovations in the inpatient sector are interesting topics for further investigation.

Conclusions

A common challenge for policymakers when devising payment policies is to find the right balance between two conflicting goals [9]. On the one hand, there is a need to provide sufficient incentives for hospitals to make use of quality-increasing but cost-increasing technological innovations in order to ensure patient access. On the other hand, there is a need to keep expenditures for technological innovations under control. This study has shown that most, but not all, of the 12 included countries have complemented their DRG-based hospital payment systems with specific short-term payment instruments targeted at encouraging the adoption and use of technological innovations.

However, the discussion of experiences in France demonstrates that short-term payment instruments may lead to a strong increase in expenditures for the selected technologies. Furthermore, because short-term payment instruments are often introduced for technological innovations at a time when rigorous analyses of their (long-term) effects are not yet available, there is a risk that the additional payments inadvertently incentivize the use of cost-increasing technological innovations that do not necessarily

improve quality of care. Therefore, short-term payment instruments should be used very carefully, and granted only after careful assessments of the likely effects of the concerned technology on quality of care. In several European countries (e.g., France), the introduction of short-term payment instruments for technological innovations is currently more directly linked to the criteria of higher costs than to evidence on medical benefits. If countries want to provide additional payments for technological innovations for which the evidence remains uncertain, using short-term payments in the context of a CED approach similar to that used in The Netherlands appears to be beneficial.

The comparative assessment of long-term updating mechanisms for incorporating technological innovation into DRG-based hospital payment systems has shown considerable differences across countries. Some countries seem to be less concerned than others about keeping their DRG-based hospital payment system up-to-date. Furthermore, the example of Finland illustrates that it is possible to update both the PCS and the payment rate frequently and on the basis of very recent information, possibly even as a substitute for the extensive use of short-term payment instruments.

Short-term payment instruments and long-term updating mechanisms differ greatly among the 12 European countries included in this study. Future research should empirically investigate how these differences affect the adoption and use of technological innovation and health care expenditures. A precondition is that national data on expenditures and on the use of technological innovation in the framework of short-term payment instruments are made publicly available. Furthermore, future studies should scrutinize how specific technological innovations have diffused in countries since the introduction of DRG-based hospital payment systems in the early 2000s; and how these relate to the identified differences in characteristics of DRG-based hospital payment systems.

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Supplemental Materials

Supplemental material accompanying this article can be found in the online version as a hyperlink at doi: [10.1016/j.jval.2011.07.001](https://doi.org/10.1016/j.jval.2011.07.001), or, if a hard copy of article, at www.valueinhealthjournal.com/issues (select volume, issue, and article).

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