

## Chapter 2

# Cost-Containment Strategies for Population Health Management and How They Relate to Poly Chronic Conditions

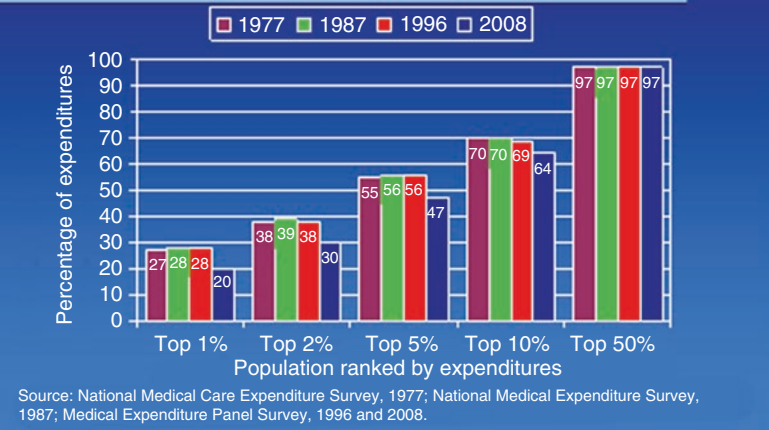
**Abstract** The effectiveness in population health management relies on employing multiple strategies in the improvement of the delivery system, particularly in the implementation of integrated care and continuity of care to avoid any drawbacks or ill side effects. Every nation has to refine outcome-based measurements and payment schemes to develop innovative and equitable rewards for key players or stakeholders in the health-care delivery system, to incentivize patients who are in tune to lifestyle changes (e.g., cessation of smoking, prevention and treatment of substance abuses, encouragement of patient participation in nutritional and dietary changes), and to facilitate patient engagement in the self-care practice of chronic disease management and prevention. This chapter offers an international perspective to examination of the prospective payment system, pay-for-performance evaluation, and value-based payment system.

**Keywords** Poly Chronic Conditions • Cost • Lifestyle • Management • Prospective payment system • Value-based payment

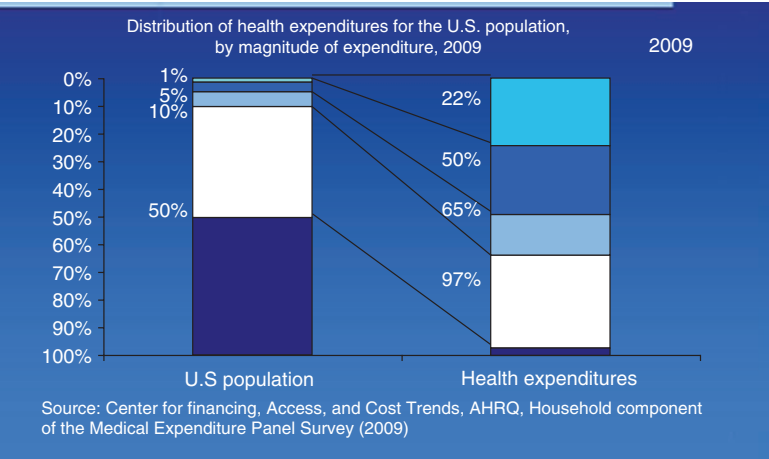
Health-care spending in the United States far exceeds expenditures in other developed nations, yet health outcomes in the United States are deemed worse than many other high-income nations (Squires and Anderson 2015). The prevalence of chronic conditions is rapidly increasing in the United States due to many factors, including an aging population and an increase in disease-specific risk factors such as obesity (Bodenheimer et al. 2009). The burden of chronic illness is not exclusively an American problem; many developed and underdeveloped nations alike are facing the same burden (World Health Organization 2005). Thus, there is a global need for effective strategies to contain health-care costs.

According to a recent panel survey of medical expenditures conducted by the Agency for Healthcare Research and Policy, Cohen and Meyers (2012) reported that the 1% of patients with chronic conditions accounted for 22% of the annual medical expenditures. The trends for medical expenditures are also shown in Figs. 2.1, 2.2.

In order to design and develop a comprehensive population health management (PHM) program, cost containment needs to take into account factors influencing



**Fig. 2.1** Trends in concentration of health-care expenditures and distributions



**Fig. 2.2** Health-care costs concentrated in sick few—sickest 10% account for 65% of expenses

health expenditures such as chronic conditions (particularly cancer, heart disease, diabetes, obesity, COPD, and mental disorder), inpatient care and unnecessary readmissions, medical errors, and overutilization of health services. This chapter will analyze three cost-containment strategies, the prospective payment system (diagnostic-related groups), pay-for-performance system, and value-based payment system, and will explain how they were implemented in different nations, as well as how they relate to poly chronic conditions.

## 2.1 Prospective Payment (Diagnosis-Related Group) System

Diagnosis-related group (DRG), a prospective payment system implemented in the United States in 1984, is a way to categorize hospitalization costs and determine how much to pay for a hospital stay. Because of this, DRG is a cost-containment strategy based on a fee-for-service system. Cost-containment strategies based on fee-for-service systems fall into three categories: price controls, volume controls, and expenditure controls (Rice 1996). The DRG system is a price-control strategy (McAlearney 2003). DRG-based payments theoretically deliver incentives to increase the number of complex cases treated and reduce the number of services per case (Busse et al. 2011).

### 2.1.1 DRGs in the United States

The DRG system was adopted first in the private insurance system in the United States (Cacace and Schmid 2009). In 1983, it was implemented by the US government within the Medicare program (Busse et al. 2011) to establish relationships between the diagnosis of a condition and the adequate funding necessary to treat that condition (Altman 2012; Wan 1995). DRG categories are structured in such a way that a numerical weight corresponds to the cost of the services provided to similar patients across the country. Thus, illnesses that require higher resources have higher DRG weights. Though the weight stays constant for all hospitals, the dollar amount can vary from facility to facility, based on numerous factors including being in a rural area or an area with high input prices, treating a disproportionate number of low-income patients, or operating a teaching program (Altman 2012).

The system was made to stop hospitals from unnecessarily hospitalizing patients or prolonging their stay without a reason. Thus, DRGs incentivized hospitals to provide care in a timely manner and ready the patient for discharge in the shortest amount of time possible, to avoid unnecessary utilization of services, and to serve more patients (Sturgeon 2009).

DRG categories have undergone modifications over the years, but the system remains a challenge in hospitals, since it requires trained professionals to deal with its complex coding and billing system (Sturgeon 2009).

DRGs take into account poly chronic conditions. For instance, there are different codes for complex pneumonia without any comorbidity, complex pneumonia with another chronic condition, and complex pneumonia with more than one other chronic condition, and each of these has a different reimbursement amount attached to it.

### ***2.1.2 Impact of DRGs in the United States***

The DRG system is said to have been successful in the United States in slowing down cost escalation of inpatient care, while maintaining quality and access (Ellis 2001). A 1988 analysis of the first 3 years of DRG implementation found that the system reduced inflation in aggregate costs (Guterman et al. 1988).

However, empirical evidence tells us that there was no increased efficiency in the United States. A 1988 study in New Jersey found no positive impact on hospital efficiency (Borden 1988). Another study that compared efficiency scores from 1984 to 1993 in 80 hospitals in Virginia also found no significant difference in technical efficiency due to the introduction of DRGs (Chern and Wan 2000).

### ***2.1.3 Adoption of DRGs Internationally***

The adoption of DRGs in the United States had rippling effects in Europe and Australia. After Medicare adopted DRGs as a basis for paying hospitals in the United States, DRG systems became the basis for hospital payment in most European countries and in many other countries around the world (Busse et al. 2011), though their objectives and consequences can be very different (Cacace and Schmid 2009). While the United States used DRGs to change the cost-based reimbursement from retrospective to prospective, most European countries linked payment to activity in systems with global budgets (Busse et al. 2011).

In Europe, the EuroDRG project was formed, which presently includes 12 countries: Austria, England, Estonia, Finland, France, Germany, Ireland, the Netherlands, Poland, Portugal, Spain, and Sweden (EuroDRG 2013). Portugal was the first country to begin running a DRG-based hospital payment system in 1988, for payments from occupational health insurance schemes in the late 1980s. Australia was the first to use DRGs to set budgets for its public hospitals in 1993 (Busse et al. 2011).

Many of these countries used DRGs initially for patient classification, though later also as a payment system, in conjunction with other payment components. England, for instance, had a 10-year adaptation period; DRGs were used for patient classification and increased transparency purposes and only after for payment purposes. Ireland, on the other hand, only had a 1-year adaptation period until DRGs started being used for budgetary allocation in 1993 (Busse et al. 2011). However, different systems varied in DRG weights and the monetary value associated with each weigh.

### ***2.1.4 Impact of DRGs Internationally***

In some nations, hospital efficiency has improved after the introduction of DRGs. However, as Busse et al. (2011) puts it, determining the cause is challenging due to confounding factors. In terms of costs, DRG-based payments were associated with

higher total costs in most cases (Forgione and D'Annunzio 1999; Anell 2005; Kastberg and Siverbo 2007; Moreno-Serra and Wagstaff 2010).

It is unclear how DRG systems affected patients with poly chronic conditions. The issue was raised in Australia, where their DRG system's performance toward patients with chronic conditions has been put into question (Griffiths and Hindle 1999).

## 2.2 Pay-for-Performance System

In the United States, health-care providers are typically paid for services through insurance payments or through payments made directly by patients. This fee-for-service system leads providers to focus on services that lead to high revenues, since it rewards the volume of services instead of the value or outcomes. However, creating another payment system that rewards quality without hurting providers, payers, or patients is challenging (Knickman and Kovner 2015).

A pay-for-performance (P4P) system, also called value-based payment or value-based purchasing, has become an umbrella term for an array of strategies that aim to improve the quality, efficiency, and overall value of health care. In this system, health-care providers are compensated for meeting specific performance measures and can be penalized for patients' poor outcomes or for being responsible for medical errors. Legislators and providers alike are turning to this model to control health costs and to increase the quality of care.

The move toward value-based payment is also driving the need for increased capabilities in PHM. According to the Health Intelligence Network (Healthcare Intelligence Network 2016), since providers who adopt P4P models have an economic interest in all aspects that impact their patients' health, they must develop new abilities and data-gathering skills and create community partnerships in order to understand and influence these factors.

P4P can be considered cost-effective if quality of care is improved at identical or lower costs. A study that evaluated the impact of different payment schemes (pay-for-coordination, pay-for-performance, and bundled payment) for integrated chronic care in different European countries found that P4P was the best at reducing health-care expenditure (Tsiachristas et al. 2012). However, a recent systematic review that evaluated 69 studies (58 of which were in outpatient settings) found that P4P programs are not consistently effective in improving health outcomes (Mendelson et al. 2017).

This section will examine pay-for-performance schemes in the United States and in other countries. Though some are similar, different countries' P4P programs differ. All the programs that were found incentivize clinical quality, though they vary in the scope of measure sets, payment size, and amount and aims.

### ***2.2.1 P4P In the United States***

In the United States, public and private payers alike have been creating incentives to reward providers for quality care, usually in addition to fee-for-service or other payment methods (Knickman and Kovner 2015). In 2007, there were an estimated 256 different P4P programs in the United States (Eijkenaar 2012).

In 2010, with the Patient Protection and Affordable Care Act, Congress legislated several Medicare programs meant to move in the value-based payment direction. Two different programs aimed at acute-care hospitals under the inpatient prospective payment system (IPPS) were implemented in October 2012. The Hospital Value-Based Purchasing Program rewards acute-care hospitals for quality of care that they provide to Medicare beneficiaries (US Department of Health and Human Services 2015). The Hospital Readmission Reduction Program consists of Medicare withholding payment from hospitals with high readmission rates (Centers for Medicare & Medicaid Services 2016b). These financial penalties are used to fund the Value-Based Purchasing Program (Centers for Medicare & Medicaid Services n.d.). This penalization program is why many IPPS hospitals have been steadily implementing techniques to reduce their unnecessary readmissions for individuals with chronic conditions and why cost-containment strategies aimed at chronic illnesses have been a highly discussed topic since the ACA.

Subsequently, two other programs aimed at physicians were implemented. The Physician Value Modifier Program rewards physicians with bonus payments when their performance attains specified measures of quality and cost. The adjustments are made on a per claim basis for items and services under the Medicare physician fee schedule (Centers for Medicare & Medicaid Services 2015). The Physician Quality Reporting System incentivizes physicians and group practices to report information to Medicare about the quality of their services (Centers for Medicare & Medicaid Services 2016a). In 2015, the program began applying a negative payment adjustment to physicians and practice groups who did not report data on the quality measures specified in the program (Centers for Medicare & Medicaid Services n.d.).

CMS is currently reviewing applications for programs that test whether access to services addressing health-related social needs has an impact on health costs, health outcomes, and quality of care for Medicare and Medicaid beneficiaries. This is due to a growing need for increased capabilities in PHM, which includes focusing on all areas that affect health (Healthcare Intelligence Network 2016).

Insurance companies have also implemented some other alternative payment systems, namely, bundled payments, reference pricing, and some forms of capitation (Knickman and Kovner 2015).

### ***2.2.2 P4P and Chronic Conditions in the United States***

In a systematic review of eight P4P schemes of PHM intended to improve delivery of chronic care (de Bruin et al. 2011), only two of the six in the United States had shown reports on quality, the Western New York Physician Incentive Project and the

Integrated Healthcare Association pay-for-performance program. None showed reports on costs. The Western New York Physician Incentive Project, which was implemented in 2001 in upstate New York, was designed to financially reward doctors for the quality of care delivered to patients with diabetes. Most participating physicians improved their average scores on most process and outcome indicators, including HbA1c control and LDL control (Beaulieu and Horrigan 2005). The other program, called Integrated Healthcare Association pay-for-performance, targeted 225 California managed care medical groups and independent practice associations. One study found that greater use of chronic care management processes (CMPs) was significantly associated with better clinical performance, namely, diabetes management and intermediate outcomes (Damberg et al. 2010).

A more recent systematic review attempted to examine the effects of different P4P programs in process of care and patient outcomes in outpatient and inpatient settings (Mendelson et al. 2017). They found that P4P may be associated with improved process-of-care outcomes in ambulatory settings but that there are no consistently positive associations between P4P and improved health outcomes in either setting. However, the review found that many of the studies that had found a positive effect on process-of-care outcomes had been conducted in the United Kingdom, where incentives are considerably larger than in the United States.

## 2.3 P4P in Countries Under the Beveridge Model

Many countries have a single-payer health system financed by the government through tax payments. These countries follow the Beveridge model. These include the United Kingdom, Spain, Portugal, most of Scandinavia, Hong Kong, New Zealand, and Cuba. Even though these systems tend to have low costs per capital, most of these countries have pay-for-performance strategies to control costs. This section will review P4P strategies in the UK and Portugal and how they relate to chronic conditions.

### 2.3.1 *The United Kingdom*

The United Kingdom has one of the largest pay-for-performance programs in the world, quality and outcomes framework (QOF). QOF was introduced in 2004, and it is focused on general practitioners. Even though it is a voluntary program, nearly all GP practices participate (Cashin 2011). Incentives are delivered on an annual basis in a point-based system. Practices can accumulate points based on their performance, up to a maximum of 1,000 points. QOF indicators and targets are updated every year, since the contract is renegotiated annually between the different parties (Cashin et al. 2012). As of 2015/2016, the flat rate per point was £160.15 (NHS Employers 2016b), which increased to £165.18 in 2016/2017 (NHS Employers 2016a). Payments are adjusted based on the size of the practice and the prevalence

of disease relative to national average values (Cashin et al. 2012). The points are divided among different domains (Cashin et al. 2012).

*P4P and Chronic Conditions in the United Kingdom* In 2016/2017, the QOF clinical domain is worth up to a maximum of 435 points, divided among 69 indicators across 20 chronic clinical areas. These include atrial fibrillation, secondary prevention of coronary heart disease, heart failure, hypertension, peripheral arterial disease, stroke and transient ischemic attack, diabetes mellitus, asthma, chronic obstructive pulmonary disease, dementia, depression, mental health (schizophrenia, bipolar affective disorder, and other psychoses), cancer, chronic kidney disease, epilepsy, learning disability, osteoporosis, rheumatoid arthritis, and palliative care (NHS Employers 2016a).

In 2012, a systematic review of 94 studies analyzed the impact of this P4P framework in different areas, including effectiveness, efficiency, equity, and patient experience (Gillam et al. 2012). There were modest improvements in the quality of care for the chronic conditions included in the framework, including mortality reductions. There were noted improvements in better recorded care, improved processes, and better intermediate outcomes for most disorders, notably diabetes.

As previously mentioned, a recent systematic review found low-strength evidence that P4P programs in outpatient settings may improve process-of-care outcomes. Positive results were documented in the United Kingdom under the QOF where incentives are much larger than any P4P programs in the United States (Mendelson et al. 2017).

However, one study found that a small number of practices reached high achievement levels by excluding large numbers of patients, though further research is needed to determine if they were excluded for valid clinical reasons or if only for compensation (Doran 2006).

Though in some indicators QOF seems to be cost-effective (Walker et al. 2010), the true impact on costs remains uncertain (Gillam et al. 2012).

### 2.3.2 Portugal

Portugal has had a pay-for-performance scheme since 1998/1999 for GPs, though the design was restructured in 2006 (Johnson and Stoskopf 2010) to include family health units (USFs). USFs are multidisciplinary teams formed voluntarily that are now paid partially through incentive mechanisms such as performance compensations and capitations with the goal of bringing GPs closer to patients (Barros et al. 2011). The incentives are based on the performance of teams and physicians alike (Johnson and Stoskopf 2010) and on the case mix of their patients (Barros et al. 2011). 2006 was also the first year that Portugal met its budget for health care (Johnson and Stoskopf 2010). From 2006 to 2013, there was a modest decrease in public health-care expenditures as a total value (Pordata 2016a), on a per capita basis (Pordata 2016c), and as a percentage of the GDP (Pordata 2016b).



*P4P and Chronic Conditions in Portugal* The Regional Health Administration budget for primary care has seen a relative increase in the capitation component. The capitation component is adjusted by demography and by disease burden index by regional prevalence of certain conditions, namely, hypertension, diabetes, stress, and arthritis. Poly chronic conditions are found to be a very common occurrence in Portuguese primary care users (Prazeres and Santiago 2015), and a study in Portugal found that increased poly chronic conditions are linked to worse health-related quality of life (Prazeres and Santiago 2016).

One study analyzed the performance of USFs and primary care centers (Fialho et al. 2011). The number of days that a patient had to wait for an appointment with a GP was 54% lower in USFs, waiting times for emergency/acute consultations were shorter on average, and the average time spent in the waiting room for a nursing appointment was considerably lower. Also, there was a 45% reduction in the average number of days required to wait for a GP appointment and a 36% reduction in the average time spent in the waiting room for medical consultations. In terms of expenses, there was a 5% average reduction of total costs.

## 2.4 P4P in Countries Under the Bismarck Model

Countries that have a multi-payer insurance model follow the Bismarck model, and these include France, Germany, the Netherlands, France, Belgium, Switzerland, Japan, and some of Latin America. This section will cover the Netherlands' and France's P4P programs.

### 2.4.1 The Netherlands

The Netherlands has mandatory health insurance. However, much like the United States, the Netherlands' health-care funding is fragmentary, which kept long-term, pay-for-performance programs from being established. However, in 2007 a bundled payment program was approved to increase the quality of care for chronic conditions. Initially an experimental program with a focus on type 2 diabetes, the program was approved for nationwide implementation in 2010 and was extended to chronic obstructive pulmonary disease and vascular risk management (Struijs and Baan 2011). Insurers pay a bundled payment to a "care group," a principal contracting entity, to cover diabetes care services. The care group comprises multiple providers, often exclusively GPs. The care group assumes both clinical and financial accountability for all patients assigned to its program. By 2010, there were about 100 care groups operating diabetes management programs.

*P4P and Chronic Conditions in the Netherlands* In the years since P4P was implemented, patient mortality rates and costs have reportedly dropped significantly,

though the specific numbers are yet to be published (Struijs 2015). Between 2007 and 2010, during the preliminary phase of the program, there were mild to moderate improvements in health-care delivery and several outcome indicators. Poly chronic conditions were reportedly not high on care groups' agendas during this experimental phase (Struijs et al. 2012), and it is unclear if that has changed.

### 2.4.2 France

In France in 2009, a P4P pilot program for primary care physicians was introduced named Contract for Improving Individual Practice (CAPI), which was implemented by the French national health insurance. In 2012, the program was extended to all GPs and to some specialists for a set of specific indicators and was renamed *Rémunération sur Objectifs de Santé Publique* (ROSP) (Cashin et al. 2014). Private physicians are enrolled automatically in the program, though they are free to opt out (L'Assurance Maladie 2016). However, even though the contract can be interrupted without any penalty, two thirds of French GPs choose not to participate. According to a cross-sectional survey with 1,016 respondents, the perception of ethical risks associated with the program seemed to have been the reason why most physicians did not sign the contract. These included “discomfort that patients were not informed of the signing of a P4P contract by their doctors” (OR = 8.24, 95% CI = 4.61–14.71), “the risk of conflicts of interest” (OR = 4.50, 95% CI = 2.42–8.35), “perceptions by patients that doctors may risk breaching professional ethics” (OR = 4.35, 95% CI = 2.43–7.80), and “the risk of excluding the poorest patients” (OR = 2.66, 95% CI = 1.53–4.63) (Saint-Lary et al. 2013).

*P4P and Chronic Conditions in France* ROSP is meant to encourage physicians to better care for chronically ill patients. For diabetes patients, there have been improvements from late 2011 to late 2015 in HbA1c results and other diabetes indicators. These are indispensable to avoid further diabetes-related complications and comorbidities. HbA1c levels improved positively by 8.7% after 2011. Similarly, diabetic patients with high risk of cardiovascular disease improved by 7.2% (L'Assurance Maladie 2016). No information about the impact of the program on costs was found.

## 2.5 P4P in Countries Under a National Health Insurance Model

Countries that have adopted the NHI model include Australia, Canada, Taiwan, and South Korea. This section will focus solely on Taiwan's P4P program.

### 2.5.1 Taiwan

In 1995, Taiwan implemented a national health insurance program (Cheng et al. 2012). Health-care utilization in Taiwan is very high, with patients averaging 13.5 visits per year in 2004, compared to an average of 6.7 in other developed countries (Chang et al. 2012). In 2001, a pay-for-performance program for diabetes was implemented to create incentives for providers to deliver quality care, particularly regular checkups. The program was not mandatory and, after 5 years, fewer than 30% of diabetes patients were enrolled (Chang et al. 2012).

*P4P and Chronic Conditions in Taiwan* Various studies conducted in Taiwan saw improvements in quality of care and somewhat lower costs for diabetic patients enrolled in the program (Chiu et al. 2017). A population-based natural experiment used data from 2005 to 2006 and found that patients in the P4P program received significantly more diabetes-specific exams than patients who were not enrolled and had an average of two more physician visits (Lee et al. 2010). Also, patients in the program had fewer diabetes-related hospitalizations. The program was associated with lower hospitalization costs, though the overall cost of care for patients in the program was significantly higher; however, the total incremental expense was small. A large survey conducted in 2013 of 1458 diabetic patients found that P4P enrollees likely received better patient-centered care and that better perceptions of care also had better clinical outcomes (Chiu et al. 2016).

However, studies in Taiwan found that patients with greater disease severity (Chen and Chung 2010; Hsieh et al. 2015a, b) as well as patients with poly chronic conditions (Chen and Chung 2010; Hsieh et al. 2015a, b) were disproportionately excluded from the P4P diabetes program. This is likely due to the design of the program, which encourages physicians not to enroll their most complicated patients. In late 2006, the program was reformed to include achievement of intermediate health outcomes, but a study found that, even after the reform, sicker patients and patients with comorbidities were more likely to be excluded from the program, and the additional incentive for patients' intermediate outcomes moderately aggravated patient risk selection (Hsieh et al. 2015a, b). There are various suggestions to combat this, including reexamining the program's design (Lee et al. 2010; Hsieh et al. 2017) and making participation mandatory (Chen and Chung 2010).

A recent study analyzed the cost-effectiveness of a pay-for-performance program for diabetes patients with poly chronic conditions. Hsieh et al. (2015a, b) investigated cost-effectiveness of the P4P program for patients with diabetes alone and for patients with diabetes and comorbid hypertension and hyperlipidemia. Data from population-based longitudinal databases was used, and cost-effectiveness was compared between P4P and non-P4P diabetes patients. The study found that the program was cost-effective for both cohorts, and the return on investment was 2.60:1 in the diabetes alone cohort and 3.48:1 in the poly chronic cohort. Thus, the P4P diabetes program in Taiwan enables long-term cost-effectiveness and cost savings, especially for patients with poly chronic conditions. Similar results were also documented by Huang et al. (2016) in a cohort study of diabetes.

## 2.6 Value-Based Payment System as an Alternative Strategy

Value-based payment and diagnosis-related groups are vastly different cost-containment strategies, and they can even be implemented together. The evidence for both is mixed, and it is clear that neither strategy is consistently associated with cost-effectiveness or better outcomes for chronic conditions. Diagnosis-related groups have largely been linked to higher total costs, but in some countries, they are also correlated with higher efficiency. In the United States, the DRG system has mostly been effective in reducing inflation in total costs. There is also little evidence of its impact on caring for poly chronic conditions.

Evidence of pay-for-performance programs' effect on costs is scarce. P4P has been reportedly found to be cost-effective in Taiwan (Chiu et al. 2016), in the Netherlands (Pomp 2010), Portugal (Chipman 2015), and in some of the UK's indicators within the quality and outcomes framework. In terms of health outcomes, the evidence is mixed, though most cases reviewed seem to have moderately positive results. Some of the pay-for-performance programs involve patient-centric care and disease management, as is the case in the United Kingdom and Portugal, where multidisciplinary teams have been employed. The lack of fully integrated care in many health-care systems for chronic disease care or management is the fundamental concern in both high-income and low-income countries.

## 2.7 Concluding Remarks

The key lesson learned from this chapter is that successful health system and policy reforms need to execute concomitantly in the development of PHM, irrespective of the income status of a nation. Although both reform strategies might be suitable to alleviate the burden of chronic diseases within a PHM framework, it seems difficult to ensure the success of the strategies prior to implementation. Different nations have had different success rates with both strategies, though it remains hard to assess the causes due to many confounding factors such as the variation in health insurance coverage, the ability to integrate the medical care system with the social service system, and the meaningful use of health information technology and implementation. The effectiveness of the P4P movement is a lever of cost containment. However, the program's success must be maximized by employing multiple strategies in the improvement of the delivery system, particularly in the implementation of integrated care and continuity of care to avoid any drawbacks or ill side effects. Furthermore, every nation has to refine outcome-based measurements and payment schemes to develop innovative and equitable rewards for key players or stakeholders in the health-care delivery system, to incentivize patients who are in tune to lifestyle changes (e.g., cessation of smoking, prevention and treatment of substance abuses, encouragement of patient participation in nutritional and dietary changes), and to facilitate patient engagement in self-care practice of chronic disease management and prevention.

The availability of administrative and patient-care data generated from electronic medical records and personal health records has potential for clinicians, health services researchers, and data scientists to collaborate in the construction of valid, reliable, and practical predictive analytics to guide the promotion of PHM and research.

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