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End-Stage Renal Disease and Economic Incentives: The International Study of Health Care Organization and Financing

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Abstract

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ABSTRACT

End-stage renal disease (ESRD), or kidney failure, is a debilitating, costly, and increasingly common medical condition. Little is known about how different financing approaches affect ESRD outcomes and delivery of care. This paper presents results from a comparative review of 12 countries with alternative models of incentives and benefits, collected under the International Study of Health Care Organization and Financing, a substudy within the Dialysis Outcomes and Practice Patterns Study. Variation in spending per ESRD patient is relatively small and is correlated with overall per capita health care spending. Between-country variations in spending are reduced using an input price parity index constructed for this study. Remaining differences in costs and outcomes do not seem strongly linked to differences in incentives embedded in national programs.

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A. INTRODUCTION

End-stage renal disease (ESRD) is a debilitating medical condition of chronic kidney failure, which requires intensive and costly treatments of dialysis and/or transplantation. In fact, ESRD is generally defined by its treatment. The prevalence and incidence of ESRD have increased in all high-income countries for several reasons, including the aging of the population, increasing diabetes rates, improved survival from heart disease, and greater acceptance to dialysis therapy. Health systems are grappling with allocating resources within their ESRD programs while balancing the competing objectives of cost containment and achieving good outcomes. Payment incentives to providers have experienced some changes in recent years, but it is not clear how or whether different approaches undertaken by various countries have affected outcomes and the delivery of care. In this paper, we present results from a comparative review of case studies in 12 countries that represent alternative models of incentives and benefits, collected under the International Study of Health Care Organization and Financing (ISHCOF). We discuss whether variations or changes in costs and outcomes might have been caused by incentives or by identifiable factors other than incentives, and what causes remain unknown. Specifically, after providing data and an analytic description of various ESRD payment and organizational systems in different countries, we identify some incentives that, based on the data, seem to affect variations in outcomes and expenditures. Then we reverse the form of analysis and ask more generally what might account for the variation in these factors. Finally, we draw some policy conclusions from these analyses.

This 12-country comparison of ESRD organization and financing represents a much larger set of comparators than any other study of ESRD costs and outcomes, and encompasses a much larger set of measures of quality, outcomes, and costs. Other analyses have typically looked at a single country (Cass et al., 2006; Hidai, 2000; Lee et al. 2002) or examined costs in several countries without relating them to specific outcome measures (De Vecchi et al., 1999). However, our ability to draw rigorous, generalizable conclusions about the incentive structures is still necessarily limited by the fact that we have only 12 systems. While the data presented are generally more complete than in any other study of this type, the limited number of countries still challenges our ability to establish a link between differences in costs or outcomes and differences in incentives per se (as opposed to other influences that vary across countries). In addition, while the quality of the cross-country data is not perfect, this study is the first to provide reasonably reliable comparative measures of costs as well as outcomes and to adjust those comparisons for cross-country differences in input prices.

The ISHCOF is a substudy of the Dialysis Outcomes and Practice Patterns Study (DOPPS). The DOPPS is a multifaceted, multiyear international study focused on the treatment and outcomes of hemodialysis (HD) patients. It is a prospective, observational study involving adult HD patients randomly selected from nationally representative dialysis facilities (Young et al., 2000; Pisoni et al., 2004). The first phase of the DOPPS (1996–2001) collected data from 309 facilities and approximately 17,000 patients in seven countries (France, Germany, Italy, Japan, Spain, the United Kingdom, and the United States). The second phase of the DOPPS (2002–2004) collected detailed data from 320 facilities and more than 12,000 patients in 12 countries (Australia, Belgium, Canada, New Zealand, and Sweden in addition to the seven DOPPS I countries). The DOPPS sampling plan and study methods have been described elsewhere (Young et al., 2000; Pisoni et al., 2004). Institutional review boards approved the study and patient consent was obtained in accordance with local requirements.

The ISHCOF is based primarily on one-time surveys (2004–2005) and subsequent papers by authors from each of the 12 DOPPS countries. The unit of analysis of the ISHCOF is the country. The ISHCOF surveys were designed and implemented by the University Renal Research and Education Association, an organization in Ann Arbor, Michigan, USA, now known as the Arbor Research Collaborative for Health. The surveys were directed to economic investigators in each of the 12 countries, who then used them to produce a series of papers for their respective country. This manuscript is a summary of those country-specific reports. Statistics and data supplied in the surveys were all secondary data based on published articles, government documents, government Web sites, local medical institutions, and investigator judgment. Wherever possible, we conducted an external validation of the survey data, using the DOPPS, country registries, and external publications. Figures and tables in this paper are based on the best information available; data sources are noted in the figures. For data from the DOPPS, sampling weights have been applied to account for varying facility sizes.

One aspect of this study focuses on the "profit" status of dialysis facilities. It is generally acknowledged that institutions operated for-profit have an incentive to be efficient in production; it has also been alleged that for-profit institutions have an incentive to lower quality in non-competitive markets. One characteristic of for-profit institutions is they pay taxes; not-for-profit institutions do not. Japan has a large number of solo-practice, usually small, dialysis facilities. These institutions pay taxes although they are not formally identified as for-profit, as for-profit medical institutions are not legal in Japan. In this paper the general term for for-profit facilities is "tax-paying".

All costs are reported in United States dollars (US$), which were converted from national currency units using Organisation for Economic Co-operation and Development purchasing power parities (PPPs) (OECD, 2006) or our own input price parity (IPP), discussed later in the paper. All monetary estimates, which were not available for the same year for every country, were inflated or deflated by 3% per year to obtain an estimate for the same year across countries. Typically, this only required a one- or two-year correction.

In this paper the term ESRD refers to chronic kidney disease patients with less than 15% of kidney function (CKD stage 5) and who receive dialysis or kidney transplantation. The only cases of ESRD counted by disease registries are those that are treated (by dialysis or transplantation). In this paper the term ESRD should be understood as "receiving treatment for ESRD."

Study Objectives

For three major reasons, ESRD provides a good context for performing a cross-national comparison of economic incentives in medical delivery. First, ESRD pertains to a well-defined medical condition with clearly identifiable treatment options that are relatively homogeneous across high-income countries. Thus any comparative analysis of incentives should be less severely affected by technology, health status, and cultural variation. Second, given the relative simplicity in defining ESRD by its treatments (as opposed to disease models such as cancer and heart disease, which contain numerous variants and treatments), identifying corresponding payment rules in each country is relatively less complex than for the medical care system as a whole (but, as will be shown below, can still be quite complex and challenging). Third, compared with other diseases and because ESRD financing systems within ISHCOF countries are often self-contained, it is comparatively easy to isolate total cost and to spot variations in payment rules and policies between countries. This last point should not be interpreted to mean that cost data for ESRD are ideal, but, compared with other diseases, reliable information on ESRD is available.

Since the 12 countries differ in terms of institutional and financing arrangements, the most fundamental question we have tried to answer is whether and how those differences affect the real resources used to provide care to ESRD patients, and whether and how differences in the available resources affect outcomes. We are interested in three links: (1) between incentives and resources; (2) between resources and outcomes; and (3) between incentives and outcomes, as a summary measure. Results that bear on link (1) we have termed "direct incentive effects." We have called evidence on link (2) "health production function effects." We have sought to show these effects' magnitude, as illustrated by cross-country data; and their "efficiency," to the extent that different countries may obtain different outcomes from the same real resources. We have called link (3) "global incentive effects." We use quantitative comparisons across countries and the inferences drawn by the individual country authors from their own analysis to provide general conclusions. Because of our interest in making inferences on a variety of complex issues, the technical aspects of our analysis focus on dialysis, the main treatment for ESRD. We leave the parallel analysis of kidney transplantation issues for future research. However, given the importance of transplantation, we briefly survey incentives for transplantation, organ recovery, and kidney allocation rules.

The remainder of this paper is divided into six sections, followed by two appendices. Section B provides initial descriptive observations on ESRD in the 12 ISHCOF countries: incidence and prevalence, mortality rates, expenditures, and ESRD-specific financing systems. Section C gives detailed descriptions of various national approaches to health care payment systems, with subsections on dialysis centers, hospitals, physicians, and transplantation. Section D lays out clinical outcomes and processes of care. Section E describes the incentives that the study was able to identify (peritoneal dialysis, transplantation, vascular access, rationing, and others). Section F examines in more detail the 12 countries' overall outcomes and expenditure levels, with notes on correlations between the two. Section G, the paper's conclusion, is followed by two appendices: Appendix A provides a short primer on ESRD care, and Appendix B gives methodological detail on the "Input Price Parity index" used in our analyses.

B. Overview of ESRD in ISHCOF Countries: Initial Observations

Incidence and Prevalence

The concepts of prevalence and incidence describe the levels of risk of a particular medical condition in the population. Table 1 reports the prevalence and incidence rates for ESRD treatment for all ISHCOF countries. The prevalence rate is defined as the proportion of all treated ESRD cases in the total population on a certain date (point-prevalence), while the incidence rate is defined as the proportion of new treated ESRD cases in the total population, in a defined time period, usually one year. Both measures depend on differences in disease risk factors, but also potentially on the availability and effectiveness of preventive measures and treatment. Note that a person with kidney failure who does not obtain treatment with dialysis or a kidney transplant is not counted. The rates given are not necessarily accurate measures of the prevalence and (especially) the incidence of disease, but of treatment. However, in this paper, the terms ESRD and renal replacement therapy are used interchangeably.

In 2002, ESRD incidence and prevalence rates varied widely across ISHCOF countries: prevalence ranged from a low of 626 cases per million population in the United Kingdom to a high of 1,726 per million population in Japan. One-year incidence ranged from 97 in Australia to 340 in the United States. Between 1998 and 2002, the average annual change in the incidence rate ranged from a low of -0.2% in Sweden (the only country that experienced any decline) to approximately 5% in Belgium, France, and New Zealand. However, countries with the greatest increases in incidence over five years did not have low ESRD burdens initially; in fact, a correlation between change in incidence over five years and the earlier of the two prevalence rates is nonexistent (r = -0.01, $P = 0.98$), suggesting that countries are not converging toward a steady-state prevalence.[1] In the general environment of rising health care costs worldwide, the rising incidence of ESRD underscores the necessity of better understanding financial incentives in national ESRD programs and the impact of these incentives on resource allocation.

Mortality

Certain measures such as crude and risk-adjusted mortality rates are commonly used outcome measures for various chronic disease populations. Crude mortality rate is a particularly unreliable measure for purposes of cross-country comparisons, because it does not take into account the underlying distribution of major determinants of mortality, such as age, comorbidities, socioeconomic status, or ethnic differences. For instance, failure to adjust for age might lead to overstating mortality in countries with higher proportions of the elderly.

Mortality rates are sensitive to the choice of risk-adjusters and estimation methods (Aron et al., 1998; Birkmeyer et al., 2002; Goodkin et al., 2003; Green et al., 1991; Pine et al., 1997). To create a standardized measure for the ISHCOF countries, we turned to the World Health Organization (WHO) and the DOPPS. Results are summarized in Table 2, which presents separate mortality rates for males and females and for both sexes combined. To control for age, mortality rates are reported for the group aged 55–69 years, a cohort chosen to represent the average age of HD patients and to reflect mortality rates similar to those observed for the all-ages DOPPS population. For this age group, rates are shown for both the general population, as

[1] France was excluded from this correlation because prevalence rates were not available for a five-year period.

reported by the WHO (2006),[2] and the HD population, as observed in the DOPPS. Comparing age-specific mortality rates between these two populations further controls for some underlying variation in health status between countries. For example, if the general US population has a high rate of cardiovascular disease that increases mortality in the general population, we would expect the HD population also to have a higher mortality rate than in countries with less cardiovascular disease. A strong correlation between dialysis patient mortality and general population mortality was recently reported, based on international data (Yoshino et al., 2006). The ratio of HD to general population mortality (also shown in Table 2) provides an estimate of how much sicker HD patients are compared with the average inhabitant of their specific country in the group aged 55–69 years.

The variation in the age-specific mortality rate for the general population was comparatively small. The lowest mortality rates are found in Japan and Australia (with about 0.8 deaths per 100 patient years) and the highest in the United States and the United Kingdom (1.2 deaths per 100 patient years each). Spain, Italy, and Canada represent the median range, at about 1.0 deaths per 100 patient years.

Not surprisingly, mortality rates for the HD population were substantially higher than those seen for the general population (Table 2). The more dramatic finding is the very large variation in HD mortality, with Japan, at 5.2%, having one-third the mortality rate found in most other countries.[3] The HD population also stands out because female age-specific mortality rates exceed male age-specific mortality rates in several countries; females have lower age-specific

[2] Mortality rates are reported in the WHO life tables for each five-year age interval . The U.S. Census Bureau's midyear, age-specific population estimates for each country were used to calculate mortality rates for the longer, 15-year interval (the cohort aged 55–69 years) (U.S. Census Bureau, 2006).
[3] The Japanese Society for Dialysis Therapy reports a mortality rate of 9.2% among HD patients (Nakai et al., 2002). Although this figure is much higher than the DOPPS estimate, using a rate of 9.2% would not alter our findings that Japan has, by far, the lowest mortality rate in the HD population.

mortality in the general population. This finding is consistent with the view that the differences in mortality between men and women in the general population are attributable to differences in the incidence of serious illness, rather than to differences in the survival rate once an illness has occurred.

Expenditures

Figure 1 shows annual ESRD expenditures per ESRD patient in the ISHCOF countries in 2003, adjusted for PPP, the usual method for converting currencies based on differing overall price and wage levels. We defer discussion of an ESRD-specific input price index, which sheds light on the issue of cross-country variation in care-specific input prices, to Section F and Appendix B. We found substantial variations in spending levels per patient among the ISHCOF countries, ranging from a low of US$24,000 per ESRD patient in New Zealand to a high of US$60,000 in the United States. One interesting observation is that Belgium is second to the United States, with about US$54,000 spent per ESRD patient, despite having a much different health care system. Another interesting observation from Figure 1 is that there is a correlation between per capita expenditures on health care overall and per capita expenditures on ESRD patients alone ($r = 0.70$, $P = 0.01$).

At the national level, health care expenditures are a function of both the underlying characteristics of the populations (input prices and demographic, ethnic, cultural, and case-mix factors) and incentives for quality and efficiency. Identifying the separate weights of these factors in explaining variation in observed outcomes and spending is a challenging task, especially when a relatively small group of countries is observed. However, the absence of a one-to-one correspondence between ESRD spending and general health care spending suggests that ESRD may be a special case in terms of its organization and financing.

Organization and Financing of ESRD Systems

Health care systems in the ISHCOF countries appear to be markedly different, ranging from the relatively market-based system in the United States to the national health service models that have the government as the sole owner and payer for healthcare (United Kingdom, Sweden, Spain, and Italy). Single payer systems, with a degree of competition among providers (Canada, New Zealand, and Australia), and "Bismarckian" models, which have competing sick funds (Belgium, France[4], and Germany), occupy the middle ground. As in the United States, the Japanese model has multiple payers. But in Japan, services are provided by both public and private (tax-paying, but not for profit) institutions, the government has a high degree of control over pricing for each service item, and health insurance is virtually mandatory. ESRD programs, however, tend to have much more in common than the national health care programs. Most importantly, ESRD programs in all ISHCOF countries are primarily funded through social insurance programs, with relatively low levels of copayments required of patients. In the United States, ESRD represents a unique case of a medical condition that has practically universal coverage by Medicare, without regard to the age or income of patients. Thus, in all countries almost all ESRD care is publicly financed, regardless of how the health care system is financed and organized in general. In all countries, including the United States, tax financing pays for the great bulk of care, which is purchased by a single public buyer. Differences, to the extent they exist, may not be entirely on the demand side but on the supply side, with various mixes of government and private ownership of providers.

While in several ISHCOF countries the organization and financing of ESRD services are integrated fully into the main national health care systems, in others, ESRD programs are

[4] France has three sick funds; however, one of them represents 90% of health expenditures. In addition, competition between these sick funds does not result in more efficient purchases.

governed separately from the rest of the health care system with somewhat different payment rules and incentives. For instance, in Australia, New Zealand, and certain Canadian provinces, programs specific to ESRD are administered locally under regional health authorities. Similarly, in Belgium separate ESRD budgets are allocated to the French-speaking and Flemish-speaking regions of the country.

Inputs and Outcomes: A First Look

The fundamental objective of this study is to understand the relationship between incentives and financing, on the one hand, and health and resource-use outcomes, on the other. To address these relationships, we must first consider the question, "What is the appropriate outcome measure for analysis?" We begin by considering the age- and sex-specific mortality variable presented above. While our measure is an improvement over mortality rate lacking any adjustment, we acknowledge that several other sociodemographic and clinical factors contribute to mortality and could alter the rankings of our estimates. Because of the limited number of countries in this study, we were unable to adjust statistically for these suspected confounders. However, not wishing to ignore their impact, we investigate the relationship between several clinical variables and financing, independent of mortality. Because these other clinical measures occur more frequently than mortality, we have more data to observe, which allows us to make stronger statistical inferences.

Having observed substantial variations in death rates (Table 2), we posed the question, "Can variations in spending easily explain these variations in mortality?" Figure 2 shows the relationship between age-specific ESRD mortality and ESRD expenditures in the ISHCOF countries ($r = 0.30$, $P = 0.35$ for PPP-converted data; $r = 0.38$, $P = 0.22$ for IPP-converted data). There are substantial unexplained variations across countries, and a causal relationship is by no means obvious. For instance, Japan, the country with the best apparent health outcome (lowest mortality) spends only the average amount on ESRD patients (US$39,027; PPP 2002), about the same as many countries with high mortality rate. No apparent association between ESRD spending and mortality can be discerned (Figure 2). In the absence of accounting for potential confounding factors, differences among the countries must be interpreted with caution. Even with adjustment for age and sex, there may still be differences in severity that cause both poor health outcomes and high costs. Thus, it will be challenging to use these data to determine whether higher levels of resources lead to better outcomes or reflect inefficiency.

C. ESRD Payment Systems

In most ISHCOF countries, ESRD delivery programs are administered separately from the rest of the health care system or at least have payment rules specific to ESRD, a consequence of the unique disease model it represents. ESRD payment systems seem to converge, notably in the United States, with a public sector agency (e.g., national health authority, social security) as the predominant single payer, setting fees and/or budgets. However, there is a great degree of variation in the design of payment systems between countries; similarly, there are important differences in payment rules and the design of incentives as applied to different components of the ESRD continuum of care within each country. As we shall see, these payment rules often reflect health care financing principles that are specific to a country. Newer features, designed to introduce incentives for competition and improved efficiency, emerge in countries on a case-by-case basis.

Dialysis Centers and Treatment

Even with the dominant role of public sector programs in the financing and administration of ESRD programs in all ISHCOF countries, dialysis providers are often private organizations, and in each country we studied, privately and publicly owned facilities coexist . In the ownership mix, we find both Sweden and the United Kingdom with dominant public sectors, the United States with mostly privately owned facilities, and Japan with mostly small for-profit clinics as well as dialysis facilities affiliated with university-based medical centers or non-governmental organizations. There has been some speculation in economics that internal incentives within organizations are fundamentally different between private and public firms (Chalky & Macomson, 1998; Dawson, 1994) even if they are subject to common external incentives. Whether organizational form affects costs or outcomes is an open question.

At the level of external incentives, three types of models tend to dominate payments to dialysis centers. The first model uses per-treatment prices that are administratively set at a national level. In the second model, payment systems may be based on capitation, i.e., a fixed payment per patient or episode of care. The third model is global budgeting, whereby a regional administrative authority or a major hospital at the head of a local network is responsible for allocating an overall budget to various activities and units under their administrative control. While we use these models for definitional purposes, it should be noted that they are not mutually exclusive. Thus, in some countries the regional authority is allocated a global budget, while individual units and providers are compensated using per-treatment or capitation pricing. In addition, payment rules for private and public facilities may differ within countries.

Per-treatment reimbursement is found in Italy and Spain. The main modality for in-center dialysis is HD. In these countries, the public insurance system pays facilities for each individual session on a fee-for-service basis. It should be further noted that seemingly unambiguous terms, such as "fee-for-service," can have different meanings in practice, somewhat blurring the distinction between pricing models as defined above. For instance, in Italy, the fee-for-service payment is bundled, covering all direct care, ancillary care, and prescription drugs, albeit differentiated by type of modality. This creates incentives similar to those under prospective payments (see Section E).

Capitated payments. Capitated payments for centers are found in Belgium, Germany, and the United States . In Belgium and Germany, the payment is made per patient, per week, whereas in the United States, the capitated rate is per patient, per treatment . However, the "product" for payment is similarly defined in all of these countries, e.g., three HD sessions weekly, with a protocol of at least three hours per session (at least four hours in Germany), which all providers are expected to follow. In Germany and the United States, payment rates have been declining in real terms, providing incentives to reduce costs and increase efficiency because there is some monitoring of quality in these countries (see Section E).

Global budgets. Canada and New Zealand are examples of countries that manage a relatively "hard" form of budgeting for ESRD.[5] In both countries, regional ESRD authorities are given overall budgets, which they allocate to various providers (and through hub hospitals in some Canadian provinces) on the basis of budgetary rules.

While hard budgeting at the regional level may appear arbitrary and rigid, it actually allows regional authorities greater flexibility in allocating resources among centers based on needs and patient flows. However, hard budgeting can result in inefficiencies when individual centers incur unplanned deficits that cannot easily be cross-subsidized by other units in their network.

"Mixed" global budgets. Other countries have more flexible systems that modify global budgets with market incentives; actual revenues can differ from budgeted amounts depending on

[5] In both countries, however, the ESRD programs are set in the context of a more typical global budget for regional health care overall, where allocation rules such as diagnosis-related group and case-mix adjustment apply.

how the provider behaves in response to incentives . For example, before 2006, global budgets in Germany for ESRD (as well as all other medical services) were negotiated with physician associations and regional hospitals that acted as intermediaries and self-regulating agencies. In turn, individual providers were free to compete, usually on a fee-for-service basis, so that an individual provider might earn more or less than the budget, subject to caps and limits set by the intermediaries.

The UK National Health Service (NHS) model is another example of a hybrid system that balances the incentives of global budgets with other pricing models . Funds for ESRD are allocated at the regional level. Although all main dialysis centers are owned and operated by the NHS, regional ESRD budgets are allocated on the basis of special contracts and competitive bidding, thus creating an "internal market" mechanism. Each dialysis center is contracted to treat a specific number of patients, subject to a case-mix adjustment. Although the overall payment is increased if the unit exceeds its expected volume, care for excess patients is reimbursed at a lower rate. Other risk-sharing arrangements that pertain to hospitals and other providers are not used in this setting.

Some countries use mixed payment formulas for dialysis that combine features from the various compensation models more explicitly. In Australia, a typical system of public payment for dialysis services comprises two components: a "capitation grant" covering medical services at the center but payable to the "parent organization" (hospital systems) and a diagnosis-related group (DRG) payment to the dialysis center to cover variable costs. In Japan, there is a prospective rate per HD treatment (up to 14 treatments per month) that covers roughly 40% of the total cost (physician, staffing, and maintenance components). Ancillary services and supplies that compose the remaining 60% of the total cost (such as dialysate, anticoagulants, and saline) are paid on a fee-for-service basis. In other countries, payment rules are mixed in the sense that different methods are applied to different parts of the system. For instance, the social security system in France reimburses private dialysis centers purely on a fee-for-service basis, while public free-standing dialysis centers (satellites) are allocated funds from the main hospital's global budget.

Hospitals

ESRD patients are frequently hospitalized for comorbid conditions that may or may not be directly related to dialysis treatments. Because hospital care is so costly, differences in the rate of use and the unit cost of inpatient hospitalization affect total cost as much as the more frequent provision of dialysis. For reimbursement purposes, hospital admissions for ESRD patients are treated the same as all hospital admission in all ISHCOF countries. Payment methodologies for inpatient care range from general funding under global budgets to case-based payments using DRGs. In countries with a mixture of public and private hospitals, payment rules may vary by type of ownership. (Transplantation is an important exception, where distinct payment rules may exist, as discussed in Section E.) As with other components of the health care system, payment rules for ESRD may be grouped.

Per diem or per treatment reimbursement. In Spain, hospitals are reimbursed on a per treatment basis, with government-determined prices (fee-for-service). In Belgium, costs of medical care in both public and private hospitals are completely covered by social security, based on negotiated prices. However, patients are fully responsible for "hotel costs" and for any non-covered medications or supplies.

DRGs (Diagnosis-Related Groups). Hospital DRGs, originally introduced in the US in 1983 under the Medicare prospective payment system, are beginning to spread to other countries

(Australia, France, Germany, Italy, Japan, and the UK). Under DRG-based payments, also referred to as case-based payments, a hospital is paid a lump sum for a given type of hospitalization. Since DRG payments are independent of actual costs incurred, they create an incentive for the hospital to reduce costs per admission in order to maximize profit (if the enterprise is concerned about profit); they offer different incentives for reducing the number of admissions depending on whether the payment rate is above or below the (minimum) cost per admission. Cost-reducing policies can have mixed consequences: efficiency may be increased as intended, but an unintended lowering of quality may also result, generating negative cost offsets later. Nevertheless, as more countries pursue cost-containment objectives, various versions of DRG-based methods are being adopted. Notable examples are France and Germany[6], which have recently switched from a combination of per-diem reimbursement for private hospitals and fixed budgets for public hospitals, in favor of Australian type DRGs, which use a slightly more refined classification than that of the US.

Global budgets. In Canada and Sweden, hospitals operate under a capped global budget that is "prospective" in the sense of using the prior year's budget as the base, often with adjustments for changes in population base and demographic characteristics.

Mixed models. Japan and New Zealand are hybrid models. In Japan, the government sets all prices (as it does for other providers), and insurance entities typically reimburse hospitals on a fee-for-service basis; however, since 2003, hospitals also have the choice of using a DRG system. In New Zealand, DRGs are used in conjunction with regional global budgets. However, even with this mixed system, many hospitals still incur deficits because actual costs remain above

[6] Hospitals in Germany are financed by a dual system whereby sick funds cover operating costs, and regional governments cover capital costs (investments). For hospital-based ESRD treatment, reimbursement rates are negotiated regionally between hospital carriers and sick funds .

budgeted expenses. Ashton and Marshall (2007) report that New Zealand is phasing out DRGs and fee-based reimbursement systems altogether and returning to a system of population-based budgeting for hospitals, counter to the policy trend seen in other ISHCOF countries.

Physicians

While most health facilities in ISHCOF countries tend to be owned and operated in the public sector, both primary care physicians and nephrologists (physicians who specialize in kidney disease and ESRD) tend to be private practitioners rather than government employees. However, most physicians in the ISHCOF countries are reimbursed directly by their country's social insurance plans or indirectly via competing sick plans. Consequently, physician compensation is subject to payment rules set in the public sector. In addition, physicians and nephrologists are generally reimbursed separately from hospitals and dialysis centers, as described above. Payment models for physicians can be categorized as follows:

Salary model. In Italy and Spain, ESRD physicians are always salaried employees of centers.

Fee-for-service model. Variations on fee-for-service (FFS) payments are found in different countries. In Belgium, fees are determined by social security in negotiations with professional associations, but physicians are permitted to balance-bill. In Germany, physician associations exercise more autonomy in setting fees, but must do so within global budgets negotiated with social security. In Canada, provinces tend to have various mixtures of FFS payments and capitation that vary from province to province. However, ESRD payments are an exception because physicians are given the option of being paid entirely on a fee-for-service or capitated basis; the vast majority choose FFS.

Capitation . In New Zealand only a small proportion of physicians (about 10%) are salaried. The vast majority is found in private group practices, but the country is transitioning from fee-for-service to a capitation-based system. In the US, physicians treating ESRD patients (usually nephrologists) are paid on a capitated basis for providing dialysis-related services and on a fee-for-service basis for hospital-related services. In Sweden, physician payments for dialysis are included in the global budget.

Mixed models. As is the case with payments to dialysis centers, payments for physician services in certain ISHCOF countries may also be based on blend of the above payment systems. In Australia all private physicians receive 85% of the Medicare base rate, supplemented by a patient share which may include both the standard copayment and a balance-billing component. There is a slightly different mix for physicians in public hospitals, most of whom are salaried. In the UK, hospital-based physicians, including nephrologists, are usually salaried, while primary care physicians receive a mix of FFS and capitated payments, most payments being capitated.

It is important to note that explicit incentives for quality provision of ESRD care by physicians are not found in any of the ISHCOF countries. To the extent that pay-for-performance aspects are used in physician payments, they appear to be limited to rewards for volume when and if a fee-for-service payment exceeds the marginal cost of a service. Separate from FFS models in which compensation is directly linked to volume, there are risk-sharing provisions in the mixed models of UK and Australia, with partial compensation provided above the FFS or capitated rate to compensate for case-mix severity or volumes that exceed baseline contractual levels. Interestingly, even in the FFS models there is no added compensation for time spent with patients.

There are substantial variations in both primary care physician (PCP) incomes and nephrologist incomes among ISHCOF countries. The lowest annual nephrologist incomes are found in Sweden and Spain ($58,000 – $72,000, PPP) and the highest are in the US and Canada (roughly $250,000, PPP). It has been anecdotally observed that in Japan, specialists make less than PCPs, possibly reflecting the unique aspects of the Japanese value system, which sets lower payment levels for academic physicians and views acute medical and surgical intervention adversely. The only other countries in which PCP incomes are greater than incomes for nephrologists are Italy and Sweden, but the differences are relatively small. In Sweden and Spain — and in the UK, which appears to have mid-level physician incomes — nephrologist and PCP incomes are about the same, though PCP incomes are outpacing hospital-based consultant incomes in the UK in 2007. Large differences between the specialties are found in the high income countries of the US and Canada, with nephrologist incomes exceeding PCP incomes by an average of 44%. Belgium is an outlier – with PCP income only a fraction of nephrologist income. Van Biesen et al. (2007) explain that in Belgium, some nephrologists are expected to put some of this money back into their dialysis units.

Table 3 summarizes payment rules for several components of health care in the ISHCOF countries. Considering the many payment rules possible for each component or provider (hospital, physician, dialysis center), numerous combinations are possible. Looking at rows in the tables that represent particular countries, it is apparent that there is substantial variation in payment methods within countries.

The ISHCOF countries demonstrate a fair degree of experimentation and flexibility in provider payment methods, which suggests that these health systems are searching for rational incentives while trying to accommodate the competing goals of quality and efficiency.

Transplantation

In contrast to the often complex payment rules for dialysis providers, payments for kidney transplantation tend to be simple and straightforward. For the most part, transplant costs are paid fully by the relevant national health authority. Citing data from Sweden, Wikström et al. (2007) note the cost-effectiveness of transplantation relative to dialysis, when organs are available. In Canada, France, Germany, Italy, Spain, and Sweden, there is no patient cost-sharing. In the UK and Belgium, patients face nominal copayments for antirejection drugs, but these appear to be symbolic. In the United States, payment is based on a DRG specific to kidney transplantation. A more ethically challenging but economically important area of payment policy pertains to rewarding organ procurement, discussed below.

Patient Incentives

Patient care and outcomes depend to a great extent on provider incentives, since patients tend to follow the advice of providers and accept the care that providers are willing to render. However, there may be some patient behavioral response to the incentives they face. The most obvious potential patient incentive is the obligation for out-of-pocket payment — whether the universal insurance for ESRD patients makes all care free or not. Obligations for copayments or co-insurance exist in some countries, although they are everywhere waived for poor patients. But in the United States, for example, patients who are not poor may be required to cover 20% of the cost of some services, or to pay in full for some outpatient drugs, based on general provisions of US Medicare law. Such obligations are not always binding and many patients have supplementary insurance coverage, but they do impact some people. A less obvious obligation for out-of-pocket payment occurs when a person with kidney disease is not accepted for treatment in the ESRD system, but is instead “rationed out.” Technically, such a person faces a

100% copayment obligation, but in practice care is almost never purchased; the patient goes without, and is not counted in ESRD reports. Such patients have very low rates of survival. While overall observed out-of-pocket payments are low, potential out-of-pocket liability at the margin is the highest of all. Those differentially rationed out in different countries include both ends of the distribution covering severity of illness and prospect for success: the very old and frail, and those with only mild disease whose clinical need for dialysis is not (yet) so urgent.

Another patient incentive comes from the presence or absence of opportunity for choice among different providers. Where such opportunities exist, patients in principle have an incentive to choose the provider they think provides the highest quality care. Where there is a single local provider, or where patients are assigned to providers (Australia, Italy, Spain, UK), this incentive does not exist.

D. Clinical Outcomes and Processes

Here, we focus on intermediate clinical outcomes (CO) for which internationally established quality target levels exist; and process variables, which can be thought of as inputs in the production of better outcomes. We want to describe the variation in the outcome measures, and see if it can be related to total resource intensity and inputs (production function effects).

Inputs and Outcomes: Methodology

Intermediate outcomes are variables that are known to predict survival and quality of life for ESRD patients. The intermediate outcome variables in this analysis are anemia, as measured by hemoglobin level, and nutrition, measured by albumin level. The US National Kidney Foundation's Kidney Dialysis Outcomes and Quality Initiative (KDOQI) has defined clinical guidelines for the management of both anemia (hemoglobin ≥ 11 g/dL) and nutrition (albumin ≥

4.0 g/dL) (NKF, 2006a; NKF, 2000), which have been adopted by guideline committees in most of the ISHCOF countries. Accordingly, quality can be thought of as adherence to these clinical guidelines. Table 4 shows the percentage of ESRD patients meeting CO targets in each ISHCOF country.

Process variables are inputs that go into producing the bundled treatment for kidney failure (Table 5). The treatment of ESRD is technologically complex, and it is difficult to know what the optimal input mix might be (allocative efficiency). However, as with intermediate outcomes, certain inputs have established target levels that can be measured in the ISHCOF countries. Other inputs may not have clinical guidelines, but they have been associated with outcomes in scientific studies. For ESRD patients, the inputs linked to positive outcomes are transplantation (Wolfe et al., 1999), fistula use (Pisoni et al., 2001), and higher dialysis dose (Kt/V) (Port et al., 2004); whereas catheter use is associated with negative outcomes for patients (Pisoni et al., 2001). For the remaining inputs — dialyzer reuse, physician-patient contact time, staff-patient contact time, physician and staff incomes, and peritoneal dialysis — conclusive evidence for associations with good outcomes does not exist, an issue discussed below.

A summary of clinical aspects of ESRD care and basic definitions are provided in Appendix A. As shown in Table 5, process variables are divided into two groups: medical technology variables (dialysis dose, type of vascular access, dialyzer reuse, treatment modality), and labor inputs (physician and staff contact time per patient). Precise targets are defined for Kt/V (a measure of dialysis adequacy) and for vascular access type. While no specific targets have been established for dialyzer reuse, and conclusive evidence has not demonstrated increased mortality with reuse (Twardowski, 2006), the general consensus in the medical community is that reuse should be minimized. Labor intensity is outside the purview of the international guideline agencies, but it is obviously an important input to patient-perceived quality and satisfaction.

Outcomes and the Process of Care: Findings

There is substantial variation among countries in the CO variables[7]. However, there appears to be little consistency in terms of achieving the two main targets, anemia and nutrition. In most countries, at least 60% of patients reach the anemia target but less than 40% of patients reach the nutrition target. Moreover, good results for one CO measure do not imply good results for the other (r=-0.37, p=0.23). For instance, Sweden had the highest achievement rate for anemia, but next to the lowest rate for nutrition. Germany has the highest percentage of patients meeting nutrition goals, but has merely a median value for anemia. It is important to note that albumin may be largely outside the control of the dialysis unit, as it reflects inflammation as well as nutrition.

The rank orderings of the process variables in Table 6 are even more disparate. The least dispersion is found for Kt/V, with compliance rates for most countries in the 70%-88% range. Germany was the low outlier, with a 61% compliance rate despite its high ESRD per capita expenditure[8]. Substantially greater variation is found in the use of catheters, the relatively lower-quality form of vascular access, with about half of ISHCOF countries meeting the target (10% or less of patients in a facility having catheters), and the remaining half in the 25%-36% range. The most dramatic variation is found in the case of dialyzer reuse: the vast majority of ISHCOF countries have less than 1% of patients reusing dialyzers, Canada and U.K. each have 18%, and

[7] Some countries set anemia guidelines at hemoglobin (Hgb) ≥10 g/dL, below the KDOQI and European Best Practice Guidelines specification of Hgb ≥ 11 g/dL. Japan has aimed for the lower target of Hgb ≥10 g/dL, but this goal was revised up to 11 g/dL in 2005 . Whereas only 22.9% of DOPPS II patients in Japan have Hgb ≥ 11 g/dL, 52.9% have Hgb ≥ 10 g/dL . Another example is the UK (which does have a guideline of 10 g/dL): 58.8% have Hgb ≥ 11 g/dL, 78.5% have Hgb ≥ 10 g/dL .

[8] In 2006, Germany introduced, a clinical practice guideline for dialysis dose (Kt/V ≥ 1.2) (Dialsestandard, 2006).

the US stands out as the outlier with 57% of patients reusing dialyzers. It should be noted that even in Canada and the UK, very few facilities reuse dialyzers, those that did in 2002 tended to be large and to have at least 85% of patients reusing them[9].

While these measures are not generally and consistently either complements or substitutes, one explicit example of substitution between technological inputs in a very narrowly defined part of the care process is given by Luño (2007):

> "This low mean dialysis time in Spain is associated with the use of dialyzers with relatively high membrane surface areas (average 1.72 sq. m) and overall mass transfer coefficients (KoA: 861 ml/min); the higher blood flow rate allowed by these dialyzers permits a dialysis efficacy similar to that seen in countries with higher mean hemodialysis time. However, the DOPPS finding that lower mortality risk is associated with longer treatment time at the same level of Kt/V suggests an opportunity to improve outcomes in Spain through longer treatment time."

When defining labor inputs, we considered per patient contact time for physicians and dialysis center staff. While it would have been possible to further stratify staff time by type of profession, we opted for the simpler, more aggregated measure because of the high degree of substitution between nurses and ancillary health care professionals and variations in training levels in different countries. In contrast to the high variation in physician contact time, highly-trained staff contact time is clustered at a relatively constant 2-2.5 hours per hemodialysis treatment (with the exception of the upper and lower outliers, Sweden and Germany)[10]. Although substitutions between the two classes of medical labor may occur in individual cases, for the most part we find no correlation between physician time and staff time. The very high physician contact time seen in France, Italy and Spain occurs over and above the "usual" or average staff time. Thus,

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[9] There is some uncertainty about the fraction of patients being treated with reused dialyzers in the UK. The 18% is a weighted estimate derived from the DOPPS representative random sample of all UK dialysis facilities and is based on a crude estimate of 9.5% reusing dialyzers. In contrast, the UK Renal Registry reports that only 4.2% of patients were treated with reused dialyzers and that this occurred in 2 facilities in England (Ansell et al., 2003). The representativeness of the UK Registry estimates, while based on a large sample, is unknown.
[10] Highly trained staff refers to those with greater than 2 years of formal nursing education (Mapes et al. 2001).

alternative explanations based on differences in physician opportunity cost of time provided appear to be more relevant than substitutions between labor types.

There is much greater variation in physician contact time than in staff contact time. Despite their disparate health care systems, all Anglophone countries appear to use physician time less intensively (at 11-27 minutes per patient) than the Latin countries of Spain, Italy, and France (130-140 minutes per patient). The most striking pattern that emerges from these data is plotted in Figure 3. The figure shows a negative correlation between nephrologist income and per patient contact time (r=-0.32, p=0.31). Though this finding is statistically non-significant, it is interesting because standard economic theory would have predicted a positive relationship, an upward-sloping supply curve. The diagram may reflect an indirect effect: in countries with high physician incomes, the high unit price leads to lower use of their time. The unit price could be high either because of overpricing or because of high opportunity costs. In either case, there would be an incentive to move away from intensive use of high-priced inputs toward lower-priced staff time and (perhaps) technology. Again, we have the possibility of substitutions as a plausible explanation for a high degree of variation[11].

Several authors of the ISHCOF country-specific reports speculate that the ultimate cause here is how many physicians (including nephrologists) a country decides to train. When medical education is widely available at low cost, the market is flooded with physicians, who then must accept low incomes and high rates of time commitment. The harder question to answer is whether income is endogenous (in this fashion) or is itself affected by reimbursement policy; some suggest that if payment rate to physicians (given some supply) are reduced too much, there

[11] An alternative explanation is that we have plotted a demand curve in Figure 3, rather than a supply curve. This is not likely since in all of the ISHCOF countries, payments to providers are bundled in one way or another, and patients do no have explicit choice as to which aspects of the treatment will be offered in greater proportion. See our discussion of payment incentives (section E).

may eventually be less work supplied, which could result in potential harm to quality and demand for other costly inputs.

Another important process-clinical outcome measure that varies across countries is the main method of treatment. Patients may either receive dialysis or transplantation. Within dialysis, they may be treated with peritoneal dialysis, hemodialysis with a fistula, hemodialysis with a synthetic graft, or hemodialysis with a catheter. Of the hemodialysis modalities, fistulae are associated with the best and catheters with the worst health outcomes (longer survival and fewer hospitalizations)(Pisoni et al, 2005). Transplantation is unusually common in Spain, peritoneal dialysis in New Zealand, and hemodialysis with a catheter in the United States and Sweden. These national preferences are discussed in the following section.

E. IDENTIFIABLE INCENTIVES

The choice of modality seems to be a major factor in the variation seen in clinical outputs, processes, and costs. In the cases of peritoneal dialysis and transplantation, high rates appear to be associated with strong and focused incentives. In the case of PD, the incentive involves setting dialysis payment rates so low that only PD is fully covered because it is cheaper than hemodialysis. In the case of transplantation, the incentives take the form of generous resources made available to recruit donors and procure organs. We first discuss these two clear cases, and then move on to less transparent incentives.

Incentives for Peritoneal Dialysis

The high use of PD in New Zealand may not necessarily be a reflection of an explicit provider choice about modalities; rather it as consequence of shortage of dialysis facilities capable of offering the alternative machine-based dialysis (HD) in that country (Ashton and

Marshall, 2007). (The reasons for the shortage may ultimately be linked to social decisions about resource allocation based on comparative costs, income, and preferences.) To some extent, interference in the price mechanism — manipulating prices to create incentives favoring one modality over another — can be thought of as a form of rationing, since it may yield choices that would not occur in an unfettered market. Thus, Ashton and Marshall describe a subtle form of rationing, whereby patients are steered from hemodialysis to lower-cost dialysis techniques based on home care. However, payment is not the only influence. Low population density makes hemodialysis centers relatively less efficient than peritoneal dialysis, because the larger scale needed for efficient production of hemodialysis would require patient travel or relocation.

Incentives for Transplantation

In the field of transplantation, available organs are the limiting resource. In all ISHCOF countries there is a persistent and sizeable waiting list for kidney transplantation, which signifies that the number of patients seeking a transplant exceeds the supply of transplants. All of the ISHCOF countries have instituted public policy efforts to increase the supply of transplantable organs — i.e., to increase the fraction of technically transplantable organs recovered for transplantation.

Since some kidney donors give organs when they are alive, and since individual and family wishes usually govern deceased donation, providing incentives to potential donors is of crucial importance. Incentives range from appeals to altruism to possible explicit money payments (so far not used in ISHCOF countries). Each country in the study has developed incentives for donation and systems for rationing organs. In all ISHCOF countries (perhaps with the exception of Canada) there is a single agency (sometimes regionally defined) that establishes allocation rules and procedures based on biological criteria and ethical judgments. Biological matching criteria usually include ABO blood group determination, human leukocyte antigen (HLA) typing, screening for antibodies to HLA-phenotypes, and cross-matching (Danovitch et al., 2005). Ethical criteria typically entail priority for children; controversial issues include time accrued on the waiting list, severity of condition, likelihood of death without transplantation, and expected number of life years after successful transplantation. There is some variation in the precision and level of detail used to determine clinical matches. In Canada, tissue matching and time on the waiting list are the only criteria. The US and the UK use detailed multi-factorial scoring algorithms. These countries, along with France, have given first preference for allocating organs within the regions in which they were collected, while Italy and Spain manage organ distribution on a nationwide basis.

The constrained supply of organs, taken with rising prevalence rates of kidney failure, has yielded an increasing scarcity problem in all countries. Two or three years on a kidney waiting list is the norm in most ISHCOF countries. Different countries have taken markedly different approaches to alleviate the problem, with some countries tightening rationing criteria and others providing stronger incentives and resources, primarily to medical institutions, to induce them to find more living and deceased donors.

An example of tight rationing was reported in New Zealand, where recipients must have a life expectancy greater than two years. A less aggressive form of rationing is found in Germany's "old-for-old" program, in which transplant candidates over 65 may only receive organs from donors in their same age cohort. In Japan, cultural preferences against organ donation translate into financial incentives that are much more generous for treatment through dialysis, thus contributing uniquely to substitution away from transplantation. The low transplantation rate in Japan is strictly a question of supply. There are at least 12,000 patients on the deceased donor kidney transplant waiting list although most transplants in Japan are from living donors (TRANSPLANeT, 2007). There are also reports of Japanese (and other) ESRD patients going to China for deceased donor kidney transplants (McNeill and Coonan, 2006). The most dramatic improvement in donor rates has been in Spain, which provides financial incentives for providers and furnishes substantial resources to the most aggressive program of coordination, detection, and training of all ISHCOF countries; transplantation rates in Spain now match those in the US. Italy has recently implemented a program similar to Spain's.

Living donations occur almost entirely within families, where genetic matching is best and altruistic feelings are strongest. For reasons that are not well understood, there is substantial variation in this behavior across countries, with especially high rates in the US.

Several authors acknowledge the lack of augmented reimbursement for procuring organs in their countries as a reason for low rates of organ donation (Fukuhara et al, 2007; Nicholson and Roderick, 2007). Under Belgium's fixed payment per transplant, hospitals are reimbursed for procuring and harvesting organs, but only for those that are actually transplanted. In contrast, Spain's reorganized transplantation system fully and generously compensates physicians and hospitals for this procedure. France introduced supplemental payments for organ retrieval for hospitals in 2005.

It is clear that there is an upward sloping supply curve of organs and transplants: despite ethical strictures on money payment to donors, a health care system can obtain more organs if it is willing to invest more economic and administrative resources to do so. Some systems have matched this supply curve with stronger financial incentives to providers; it is not clear how these incentives affect outcomes (compared to the undoubtedly positive effect of larger allocation of resources in general). It is reasonable to assume, as many of the researchers on this project have, that higher compensation to providers for organ collection would lead to higher rates of transplantation and shorter waiting lists.

Incentives for Vascular Access and Other Dialysis Practices

The role of incentives in the other modality choice—the type of access for hemodialysis—is much less clear. Payment rates to surgeons do not seem to favor one method over another. There is some evidence that grafts may allow a dialysis unit to employ less skilled workers (Young et al. 2002); if so, low payment rates for dialysis may stimulate this method of access.

Despite strong evidence that type of access is related to outcomes (Pisoni et al. 2005; Pisoni et al. 2001; Combe et al. 2001; Furniss et al. 2006), the explicit use of differential incentives to motivate this choice has so far been uncommon. As already noted, attainment of different clinical outcomes seems highly variable and hard to attribute to incentives. Since the DOPPS was designed to measure variations in process and intermediate outcome measures that contribute to better final health outcome, the absence of a financial incentive linked to either "good" or "bad" levels of these indicators suggests that these choices are more a matter of physician practice style than economic motivation. This is precisely the same result as has been found by Wennberg and colleagues in their studies of variation in outcomes and costs in general medical practice in the United States and in other countries (Wennberg, 2002; Birkmeyer, 1998).

The only aspect of hemodialysis in which incentives appear to play a major role is in a few countries where aspects of treatment are either explicitly paid for or explicitly denied. For instance, in many countries payment for hemodialysis would be denied if dialyzers were reused. When higher prices were tied to the length of the dialysis session, as in Japan until recently, longer sessions tended to result. When Epo was first approved in the US, the payment was a fixed prospective price and low dosages resulted. When payment was switched to a per unit level, dosages increased substantially.

Though the various fixed payment methods for dialysis found in the ISHCOF countries may be quite different (prospective payments versus global budgets), to some degree they both impose a binding constraint on the level of resources made available to patients. Thus, these payment rules (fixed) may encourage more substitutions of inputs within the "bundled" package of dialysis care.

The incentives for dialysis units with fee-for-service payment systems are quite different. All of the ISHCOF counties that opt for a per-treatment or FFS payment system define "administrative prices," which are determined by the government or health program rather than by an unregulated and unsubsidized market. With administrative prices, units have an incentive to provide more services (volume), which is consistent with the observations we previously made for Italy, Spain, and other countries with FFS dialysis units.

Incentives for Dialysis Payment Levels and Regulation

In contrast to the absence of evidence that the form of hemodialysis payment matters, there is strong evidence that the level of payment strongly influences the intensity and types of resources used for dialysis treatment. The conceptual reason for this finding is simple: no organization can in the long run provide inputs that are more costly than the revenues it receives. This proposition is supported by a virtually universal concern expressed by the authors that cost containment (in the face of rising ESRD spending in their countries) runs a serious risk of compromising quality.

The empirical evidence for this concern is strongest in the United States. Compared to payment levels for other services in the Medicare program, payment rates for outpatient HD have been heavily constrained. It appears that this restraint, coupled with the provision of dialysis by organizations with a financial bottom line (most strongly if they are freestanding, for-profit firms, but even in most cases of larger non-profit enterprises), has led to the selection of technology whose cost has increased only very slowly over time, if at all. Cost-containing production efficiencies have been stimulated by payment rates that have barely budged. This greater economy is apparent in the cross-country comparisons of hemodialysis cost, where the US is one of the lowest using the PPP conversion (Table 7), and is probably the lowest of all using the more accurate IPP measure described below. The very low proportion of total medical spending on ESRD in the US, relative to other countries, is remarkable considering that the US has the second-highest ESRD prevalence rate (Table 1).

Low cost may well have had some negative impacts on quality at various points in time in the US. However, and somewhat unexpectedly, it appears that more intensive quality regulation can stave off negative effects even when costs are constrained. While most countries have not paid explicit and systematic attention to quality of dialysis treatment, the US and Germany have. Quality regulations in the US (and the attendant incentives to avoid violating regulations) include the Medicare Clinical Performance Measures project, which ranks outpatient dialysis centers on the basis of guidelines and quality indicators and then reports center-specific outcome measures to regional networks of facilities. The information is widely disseminated and available to patients, although the extent to which patients select or change providers based on these indicators is unknown. But the implied competitive incentives to providers, plus their general desire not to appear inferior, have apparently led to stabilization and improvement in quality (Szczech et al, 2006; Brooks et al, 2006). Similar ranking systems and more explicit minimum quality regulations have been recently created in Germany. Outpatient facilities are required to adhere to quality indicators and professional committees are beginning to strictly benchmark and monitor dialysis units. Sanctions, including exclusion from sick fund contracts, can be imposed for low quality.

However, no country has as yet implemented a payment system that rewards quality directly and explicitly ("pay for performance"). Part of the difficulty is that existing quality measures are still imperfect. In the UK, a "payment by results" reimbursement system is being phased in; according to the UK authors, this system will be based on a capitation rate that is partly negotiated between regional health authorities and local networks, but payment level will partially depend on actions taken towards improvement. In the US, a new Medicare project is evaluating the effectiveness (in terms of outcomes and cost) of treating ESRD with disease management programs, quality incentive payments are a part of that study.

Incentives and Rationing

The last aspect of ESRD care that seems responsive to financial incentives is the most fundamental: when resources are not adequate to provide care to all patients with kidney failure, some must be rationed out, and it is left to providers to implement this process. Few countries admit that rationing may take place. New Zealand, Canada, and the UK are exceptions. Ashton and Marshall (2007) state that "dialysis has always been rationed in New Zealand; at no point in the national history of dialysis have resources been universally available." They note, however, that there is increasing scrutiny of individual cases where the medical decisions made do not conform to public expectations. Indeed, the proximate cause of universal Medicare coverage for dialysis in the US (begun in 1972) was the difficulty of defending the rationing decisions. Up to a point, if countries can afford it, they appear willing to pay out real resources to avoid the necessity of overt rationing. But it appears that the general level of income in the country does affect the incidence rate, as shown for ISHCOF countries in Figure 4 ($r=0.72$, $p<0.01$). This finding has been previously noted in the literature for developing countries (Jha, 2004), and when we expand the list of countries to those in the 2004 USRDS Annual Report, which includes some low and middle income nations, the correlation diminishes but remains statistically significant ($r=0.45$, $p<0.01$)[12]. Removing Japan and the US from the analysis dampens this effect but does not eliminate it ($r=0.40$, $p=0.02$). This relationship may reflect underlying disease patterns, but it may also be affected by more permissive treatment patterns in high income countries; at the margin, greater income may lead to better access to treatment and consequent classification as an ESRD patient. This is almost surely the case in developing countries, and these data suggest it may also occur in more developed countries.

While we believe the correlation shown in Figure 4 is strong evidence that the level of income ultimately determines how many patients are treated for ESRD.

In the UK, there is anecdotal evidence of capacity limits at some dialysis centers, but patients turned away might be accepted by other centers. The expansion of palliative care programs in UK renal units, as an alternative to renal replacement therapy, suggests that kidney failure patients in the UK sometimes do not have a dialysis or transplant option. In a rare study of access to dialysis, Mendelssohn et al (1995) showed, by physician referral to ESRD practices in Canada, that many patients who would benefit from ESRD care were not being referred for such care. This finding is consistent with Manns et al. (2007), who report a shortage of dialysis stations in some Canadian centers and an incidence rate half that seen in the US, though a direct

[12] In the event of a discrepancy between ISHCOF and USRDS incidence rates (e.g. Australia), ISHCOF rates were used to maintain consistency between graphics and the country-specific papers. The ISHCOF data were taken directly from national registries that in many cases were updated since the USRDS publication.

causal relationship is not proven and other factors may also contribute to the lower incidence rates.

Although outright rationing of dialysis rarely takes place, low levels of resource commitment can lead to bottlenecks in ancillary services, resulting in delay and waiting lists. In particular, shortage of surgeon and operating room time may lead to waiting lists for the placement of fistulae or grafts, as in Canada, Japan, the UK, and Spain. However, these countries are also characterized by relatively high realized rates of fistula access, so "high demand" as well as supply limits may be at work. Yet it remains the case that there are insufficient resources sufficient to satisfy the demand for the more time-consuming and costly (in the short run) method of placing accesses.

F. Overall Outcomes and Expenditure Levels Re-examined

Given the limitations in the information and data on incentives noted throughout this paper, the general results must be investigated more deeply. What part of the international variation in resource use and outcomes can be explained? Answering this important question requires valid definitions and measures of both key indicators, a difficult task.

For mortality rates, as already noted, there are two (somewhat related) problems. First, if we are to make judgments about the contributions of resources, incentives, and efficiency to outcomes, we need outcome measures that are validly compared. The difficulty in achieving perfect risk adjustment means that differences in measured outcomes may always be attributable in part to differences in unmeasured aspects of risk that affect health and mortality. Not only is clinical comparability important, but other things that affect outcomes related to patient behavior, like income, education, and ethnicity, should ideally be held constant. The other problem is that there are differences across countries in establishing eligibility for ESRD care, which is what defines the population to be studied. We hasten to add that in our studies these thoughts are offered as speculation, not fact, but they should be considered in making comparisons of outcomes.

One issue that arises in international comparisons of expenditures is whether the now commonly accepted conversion measure the Purchasing Power Parity index (PPP) is always appropriate. PPP takes into account prices for a bundle of consumption or outputs. But if we seek an index of real input use (as opposed to a measure of opportunity cost imposed on the economy) in a context such as ESRD financing, it is more appropriate to think of a set of inputs constructed by deflating spending by corresponding relative input prices, since these are what the "purchaser" (i.e., the government or central health agency) are essentially paying for. Therefore, we constructed an Input Price Parity index (IPP) that is specific to ESRD inputs and builds on previous efforts (Danzon and Furakawa, 2003; Wordsworth and Ludbrook, 2005) by applying to a larger number of countries. The IPP index is described in detail in Appendix B.

Re-examination of ESRD expenditures (Figure 2) shows that after accounting for input price differences and IPP variation in per capita expenditures, the overall pattern of spending still remains, but differences between other countries and the US, Canada, and (to some extent) Japan shrink considerably. In relative terms, the US appears to be less of a high-expenditure country, and some low-cost countries rise closer to the average when using the IPP index.

The explanation of this observation is that the ratio of prices for medical goods and services relative to prices for other goods and services is higher in the US than in other countries. Using the ESRD-specific input price index makes our comparison of expenditures come closer to a comparison of real inputs (assuming that worker quality or productivity is similar across countries). That is, the IPP-converted numbers provide a better basis for comparing real annual input use per patient across countries. The PPP-converted numbers answer a different question; they better describe what consumption opportunities citizens in different countries must sacrifice to pay for treatment of an ESRD patient. However, the lower relative prices for medical inputs in countries other than the US do not seem to have led a higher level of demand for resources there. Based on the available data (see IPP rates in Figure 2), New Zealand, Spain, and Australia have the lowest ESRD costs. Belgium, Germany, the UK, and the US are clustered at the high end, with the remaining countries falling in between. Of course, the same failure to earmark specific payments for ESRD patients also makes measurement of actual costs more challenging.

Japan and Spain stand out in terms of costs and outcomes combinations. Japan's good outcomes (low mortality rate, high use of AV fistulae, low hospitalization rate, strong compliance with scheduled dialysis times) are exceptional, especially considering that the cost of care in Japan remains average. Japan achieves the best mortality results both for its entire population and its HD patients (Table 2, Figure 2) [13]. The reasons for Japan's good health outcomes, compared to those of other countries, are not well understood. The relatively slow and lengthy duration of dialysis in Japan has been hypothesized as one reason, and was incentivized by the Japanese payment system. However, the difference in outcomes is too large to be plausibly attributed to this dimension of dialysis practice alone. Another hypothesis is that because so few transplants are performed in Japan, the healthiest of ESRD patients (who would have been transplanted were they in other countries), remain on dialysis and decrease the HD mortality rates. Similar explanations are that the low prevalence of comorbid conditions among Japanese HD patients (Goodkin et al., 2003) and the high health status of the general population

[13] For the general population, Japan has the lowest mortality rate for males and females combined . However, among males aged 55-69 years, Australia and Sweden have lower mortality rates than Japan.

(Yoshino et al. 2006) imply lower mortality, low use of care, and low hospital costs (partly generated by greater family participation in inpatient care). Financing of ESRD care – either in terms of its generosity or its incentive structure – also does not seem to account for all of this good performance. However, Fukuhara et al. (2007) warn that these good outcomes could be in jeopardy if the level of resources for ESRD care is significantly cut below current levels.

In Spain, the relatively good health outcomes at low levels of spending seem largely attributable to an aggressive transplantation program. Low spending seems to be associated with very low incomes for health providers and high supply; this low income is especially true of physicians, and seems to be related to Spain's medical education system, which produces relatively large numbers of physicians. While the transplantation program seems largely to explain good health outcomes (and consequent low cost per ESRD beneficiary), low nephrologist income has not yet adversely affected outcomes or other costs, probably because it is offset by high access to physicians. Luño warns, however, that continuation or worsening of this low relative income could have adverse effects in the future (Luño, 2007).

The ordering of costs and outcomes for ESRD care is strikingly different from the standard international comparison of health system cost or efficiency in that the US does not appear to be an outlier in terms of cost; it does still display only modestly poorer health outcomes for ESRD care similar to those seen for general population health. This status is surprising, given the US reputation for such high costs. This relatively good showing is perhaps attributable to the strict administered pricing regimen to which ESRD care in the US is subject, a stricter discipline than prevails for the rest of the Medicare program or for private sector insurance. It is interesting that the unique universal insurance coverage for ESRD care in the US is not able to erase the difference in health outcomes relative to the other developed countries, although the US insurance coverage even for ESRD may be slightly less comprehensive than that elsewhere, particularly with regards to outpatient drugs . However, the US has adopted more widespread drug coverage since the period of focus of this study.

Correlations

While it is challenging to attribute causality with available data, simple correlations can be revealing. In Table 8 we present correlations between IPP-converted annual expenditures per ESRD patient and each of the process and intermediate outcome variables discussed above. Partially because of small sample size, nearly all correlations were statistically non-significant. Only dialyzer reuse showed a positive and statistically significant correlation with expenditures (r=0.65, p=0.02). Despite the lack of statistical significance, the direction of the effects is consistent with expectations. For instance, countries with a greater proportion of patients receiving PD seem to have a lower per-patient treatment cost, an observation consistent with US data (Hirth et al., 2001). Another example is that of catheter use, which is related to higher infection and hospitalization rates (Furniss et al., 2006; Combe et al., 2001), and yields an expected positive correlation with ESRD expenditure.

G. CONCLUSION

End-stage renal disease is unique among chronic diseases in that it is universally covered by government programs we examined, even the United States. Moreover, in most countries ESRD programs tend be administered separately from the rest of system, often with reimbursement rules that are particular to ESRD. We attribute this to fairly uniform treatment options and specificity of medical technologies, which set ESRD apart from most other treatment decisions. From the perspective of consumers, copayments for dialysis tend to be waived for most if not all patients. In the US, high-income patients nominally face coinsurance; however, the copayment effect may be mitigated by the presence of supplementary insurance. The theoretical literature has viewed low or even zero copayments as desirable in the case of preventive and maintenance services such as dialysis, since underprovision of such services may result in further illness and hence additional treatment costs in the future (Pauly and Held, 1990; Dor, 2004)[14].

Moreover, when we adjust ESRD expenditures more specifically to account for differences in purchasing power of medical inputs (our IPP index) in the countries studied, the variation in per capita expenditures on ESRD, while still high, is substantially reduced. Interestingly, adjusted ESRD per capita expenditures in the US, normally regarded as the leader in expenditures, fall below rates in Germany, Belgium, and the UK. This fundamental finding on convergence of systems and resources has not been acknowledged for ESRD in the past, although it has been noted for total medical spending (Pauly, 1993).

While different national systems are converging in terms of framework and resources devoted to ESRD, substantial variation remains in health outcomes and real costs. Excepting New Zealand, Australia, Japan, and Spain for the reasons discussed above, the remaining data seems quite similar to what Wennberg et al. have found for general and disease-specific outcome and spending variation across cities in the United States: there is no evidence of a relationship between higher spending and better outcomes, and no strong case for differences in either as due to economic incentive (Wennberg et al., 2002). That more real spending does not lead to improved health is usually interpreted as evidence for technical inefficiency — evidence that the

[14] Pauly and Held (1990) coined the phrase "benign moral hazard" to describe the rationale for providing full coverage for such services. Dor identifies the problem of higher overall costs due shifting care from dialysis centers to inpatient setting as "spillover effects" and myopic regulation.

medical care system does not have a clear and uniform idea on how to combine inputs to produce improved health outcomes, so that variations in patterns of practice which influence cost do not influence health and (to a considerable extent) vice versa. The ESRD data, like Wennberg's data, suggest that high expense is modestly associated with worse health outcomes, but this could be the result of incomplete controls for initial health status. As in Wennberg's analysis, we find "supply sensitive services" and costs — e.g., the use and cost of hemodialysis is explained in part by the comparative availability across countries in access to hemodialysis; a similar story holds for transplantation. But this tautology does not itself provide much information about what might be superior policy, since we do not know what determines supply or what the optimal supply should be.

Given the small sample size, we are unable to determine what the optimal mix of inputs might be; however, summary data from the DOPPS survey presented here reveal substantial variation in use of technology-related inputs between countries, but a fairly constant rate of use of non-physician time. The descriptive reports from the ISHCOF countries suggest that counties alter the mix of technology inputs for dialysis (dosage, duration, dialysis modality, transplant, vascular access) in response to financial incentives as well as practice patterns, which, in some cases, are culturally driven. Thus, while in the aggregate countries appear more similar than we initially expected they would, technology differences do persist.

This summary of a major cross country project shows the strengths and the weaknesses of such efforts. The DOPPS project has been successful in discovering variations in patterns of practice that affect health outcomes at various levels for HD patients, and thereby positively influencing practice to produce better outcomes. ISHCOF was intended to look for the economic "trace" of such patterns and, beyond the effect of supply and budgets per se, was generally not able to identify specific economic incentives for good or bad practices, or substantial cost consequences one way or the other. It does not appear that there were any powerful hidden or subtle economic incentives in the system of any of the studied countries, either for determining cost or outcomes. The "brute force" incentives of budgets—you can only spend what you have—and supply availability—you can only provide the care you have facilities for—are the ones that could be detected.

One insight from this study is the mirror image of this negative finding: these cross country studies using the best available data show that there is no single, simple change in the process of care already implemented in any of these countries that will have dramatic effects on costs or aggregate outcomes. Individual provider decisions will still be crucial and will largely be a function of the specific knowledge that providers have; there are neither major economic causes nor major economic effects. The study did however show high variability across countries, especially in input use and to some extent in intermediate outcomes—with neither being especially strongly related to final health outcomes. This provides more testimony, if testimony is needed, to the observation that there may be many opportunities to reduce the use of resources, to improve process, or to make better links between process and outcome.

However, this study also shows that overall resource availability eventually matters. When resources are scarce, rationing occurs, quality skates close to the bare minimum, and the possibility of adverse outcomes rises. That those outcomes appear only in the more extreme cases of resource limitation may be to the credit of medical providers that appear able to achieve good outcomes even with relatively limited resources, but there is a strong suggestion of serious danger if cost containment in treatment of a serious disease should get the upper hand.

There are two aspects of the care process whose influence at the system level was noted by several country authors: transplantation and vascular access. The delivery of transplantation, which can improve outcomes and is believed to lower costs, may be substantially expanded if countries are willing to invest sufficient administrative and economic effort. Dialyzing via catheters, as opposed to other forms of vascular access, is likely to be both harmful to patient health and costly. No definitive explanation for high catheter use rates appeared, but the potential for improvement in outcomes and reduction in long-term cost from arteriovenous fistulae or grafts seems clear.

For US observers, the finding of comparatively good performance in terms of efficiency will come as an unexpected and welcome surprise. There are no free gifts: the strict system of administered prices that brought this state about may have hazarded the risk of adverse outcomes to a greater extent than was prudent.

Finally, it is obvious that individual countries make decisions and achieve outcomes that are specific to their cultures, their political traditions, and the values they place on different kinds of health outcomes for their citizens. Diversity means the possibility of detecting some things that might usefully be spread to other countries, but it also means humility in making comparisons without adjusting for these differences.

From an overall policy perspective, one concern that arises from our review of the summaries is the relative rarity of rewarding quality in ESRD systems. Quality indicators are used either explicitly or implicitly to monitor facilities in only a few countries — the United States, the United Kingdom and Germany. As yet, no country has adopted a "pay for performance" payment system, and apparently no plans to design and implement such payment rules are on the horizon in most countries. ESRD seems to be a good candidate for pay for performance, since it has reasonably consistent clinical targets that are regularly measured. Thus one strong recommendation is that such measures be adopted more widely.

Table 1. Prevalence rates, incidence rates, and average annual percentage change in rates of end-stage renal disease, 2002

	ESRD Prevalence		ESRD Incidence	
Country	Per Million Population	Average Annual % Change *	Per Million Population	Average Annual % Change *
Australia	658	4.25	97	3.05
Belgium	835	4.69	156	5.69
Canada	927	6.86	158	2.89
France	866	2.67	123	5.36
Germany	918	4.70	174	4.13
Italy	864	2.39	142	2.72
Japan	1801	5.17	260	2.94
New Zealand	685	6.08	119	5.24
Spain	895	4.07	131	1.59
Sweden	756	3.30	125	-0.20
United Kingdom	626	3.81	101	1.81
United States	1446	3.71	340	3.31

* 5-year interval is 1998-2002, except for France (prevalence: 2003-2004, incidence: 1997-2001) and Japan (incidence: 2000-2004).

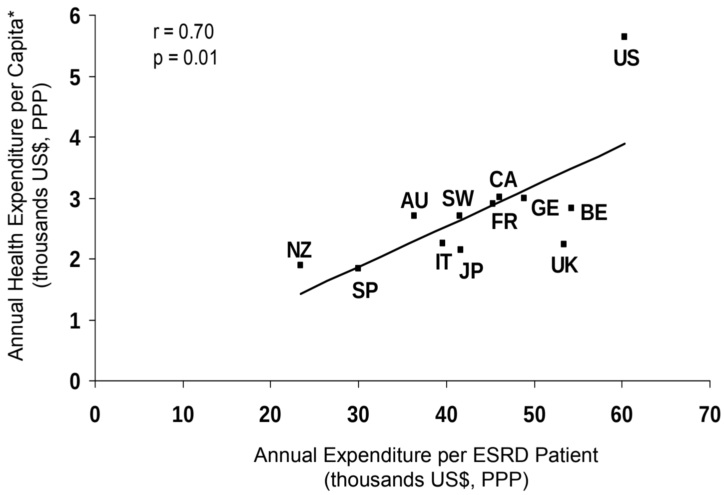
Note: Australia and NZ (ANZDATA, 2005); Belgium has 2000 data (NVBN 2002; GNFB, 2002; US Census Bureau, 2006); Canada (CORR, 2005); France incidence and prevalence are for 2003, incidence is based on only 7 of 25 regions from REIN (Couchoud et al, 2005; Jacquelinet et al, 2005; Macron-Noguès et al, 2005); Germany (Frei and Schober-Halstenberg, 2002); Italy (Conte, 2004; Ministero della Salute, 2004); Japan has so few transplant patients (<0.5%) that numbers reported above refer only to dialysis patients (JSDT 2005, 2006); Spain (Cebellos et al. 2005); Sweden (SRAU, 2002); UK's average annual percent change may be subject to reporting bias because the number of facilities reporting over these 5 years was increasing (Ansell et al, 2003; Ansell & Feest, 1999); US (USRDS, 2005).

Table 2. Death rates for the general and the DOPPS II hemodialysis populations aged 55-69, by country and sex

Country	Sex	Death Rates per 100 Patient Years: General Population* Age 55-69	Death Rates per 100 Patient Years: HD Population † Age 55-69	Ratio of HD to General Population Death Rates
Australia	Both	0.83	16.1	19.40
	Male	1.05	13.9	13.24
	Female	0.61	19.0	31.15
Belgium	Both	1.10	21.3	19.36
	Male	1.50	22.1	14.73
	Female	0.73	20.3	27.81
Canada	Both	0.97	16.1	16.60
	Male	1.22	17.3	14.18
	Female	0.73	14.3	19.59
France	Both	1.01	13.7	13.56
	Male	1.46	15.2	10.41
	Female	0.60	11.2	18.67
Germany	Both	1.13	15.6	13.81
	Male	1.54	15.6	10.13
	Female	0.74	15.6	21.08
Italy	Both	0.97	11.4	11.75
	Male	1.34	13.1	9.78
	Female	0.63	8.9	14.13
Japan	Both	0.82	5.2	6.34
	Male	1.16	5.3	4.57
	Female	0.49	5.1	10.41
New Zealand	Both	1.02	16.2	15.88
	Male	1.22	18.2	14.92
	Female	0.82	13.3	16.23
Spain	Both	0.98	15.7	16.02
	Male	1.44	14.8	10.28
	Female	0.55	17.5	31.82
Sweden	Both	0.85	18.7	22.00
	Male	1.05	18.4	17.52
	Female	0.65	19.3	29.69
United Kingdom	Both	1.16	16.5	14.22
	Male	1.45	18.0	12.41
	Female	0.89	14.1	15.84
United States	Both	1.22	19.0	15.57
	Male	1.50	18.5	12.33
	Female	0.97	19.6	20.21

* WHO Life Tables for 2001, 55-69 year age group.
† Unadjusted death rates from DOPPS II population aged 55-69 years (2002-2004).

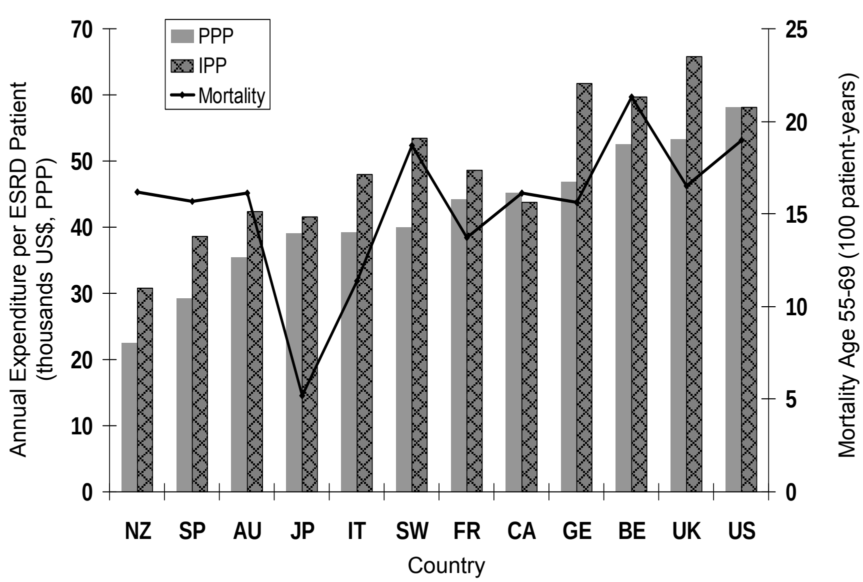
Figure 1. Annual expenditure per ESRD patient and general population health expenditure per capita, 2003



* OECD, 2004

Note: Detailed explanations of estimation methods for the expenditure per ESRD patient can be found in each country-specific manuscript (forthcoming publication in the International Journal of Health Care Finance and Economics). Estimates were based on: Australia (ANZDATA, Cass et al. 2005, You et al. 2002, Lee et al. 2002, and the USRDS); Belgium (University Hospital in Ghent); Canada (Lee et al. 2002, Laupacis et al. 1996); France (Babeau and Trigano 2004, ATIH 2001); Germany (German Statistics Office, DOPPS, and the USRDS); Italy (De Negri et al. 1997, Lee et al. 2002, DOPPS, and USRDS); Japan (NCME 2004, Japan Organ Transplant Network, and DOPPS); New Zealand (ANZDATA, Auckland Regional Renal Report, Laupacis et al. 1996, Cass et al. 2005, and the USRDS); Spain (NHS reimbursement rates, USRDS, DOPPS, and OECD); Sweden (USRDS, DOPPS, and OECD); UK (personal communication with Drs. H. Rayner and S. Smith, December 2005); US (USRDS 2005).

Figure 2. ESRD expenditures (PPP and IPP) and mortality, 2002



Unadjusted death rates for DOPPS II population aged 55-69 years

PPP: Purchasing Power Parity (OECD, 2006); IPP: Input Price Parity (see appendix for calculation)

Table 3. Payment systems for health care

Country	Overall System	Dialysis	Physicians	Inpatient Care
Australia	Single payer	Global	FFS	DRG
Belgium	Sick funds	Capitation	FFS	FFS
Canada	Single payer	Global	FFS	Global
France	Sick funds	Global, FFS	Salary, FFS	DRG*, global
Germany	Sick funds	Capitation, FFS	FFS	DRG*, global
Italy	NHS	FFS	Salary	FFSDRG
Japan	Private multiple payers	FFS	Salary, FFS	FFS, DRG
New Zealand	Single payer	Global	Capitation, salary	DRG, global
Spain	NHS	FFS	Salary	FFS
Sweden	NHS	Global	Global	Global
United Kingdom	NHS	FFS	Capitation, FFS	DRG
United States	Private	Capitation, FFS	Capitation, FFS	DRG

DRG = diagnostic related group; FFS = fee for service or fee per treatment session; NHS = National Health System.

Table 4. Intermediate outcomes for nutrition and anemia: percentages of hemodialysis patients achieving KDOQI guidelines

Country	Patients with albumin ≥ 4.0 g/dL (%)	Patients with hemoglobin ≥ 11 g/dL (%)
Australia	21.7	66.0
Belgium	32.9	66.4
Canada	14.4	69.5
France	29.5	59.5
Germany	43.4	64.4
Italy	37.5	62.3
Japan	33.9	22.3
New Zealand	35.4	36.2
Spain	28.6	69.6
Sweden	15.8	76.2
United Kingdom	20.5	58.8
United States	31.8	74.2

Data are from a cross-section at the start of the DOPPS II study. All data have been weighted by the number of patients per facility to account for varying facility sizes. Japan and the UK use a Hgb target of ≥ 10 g/dL. 52.9% of DOPPS II patients in Japan and 78.5% in the UK have Hgb ≥ 10 g/dL.

Table 5. Definitions of process variables and intermediate outcomes

Input Type	Input	Measure	Target
Technological	Dialysis dose	Kt/V	Kt/V ≥ 1.2
Technological	Vascular access	AV Fistula	N/A
		Catheter	Catheter < 10%
Technological	Dialyzer reuse	N/A	N/A
Technological	Dialysis modality	Peritoneal dialysis	N/A
Labor	Patient-physician contact time	Minutes per month	N/A
Labor	Patient-staff contact time	Hours per treatment	N/A

Table 6. Process variables and inputs

	Dialysis Modality[+]	Vascular Access**		Labor Inputs		Dialysis Dose**	Reuse Practice**
Country	Dialysis patients on PD (%)	Patients with AV fistulae (%)	Patients with catheters (%)	Physician-patient contact time (min/mo)	Highly trained staff-patient contact time (hrs/treat)	Patients with spKt/V ≥ 1.2 (%)	Patients who reuse dialyzers (%)
Australia	24.6	74.4	8.2	21	2.3	82.5	0
Belgium	8.1	61.0	36.1	78	2.1	69.7	7
Canada	20.1	53.0	33.0	59	2.3	88.6	18
France	8.7	80.2	10.6	141	2.4	84.5	0
Germany	4.7	82.7	5.8	79	1.5	61.4	0
Italy	10.6	85.6	9.1	140	2.0	79.3	0
Japan	4.3	92.1	0.9	70	2.1	69.3	0
New Zealand	48.1	51.6	23.5	5*	3.1*	73.9	0
Spain	9.1	78.2	11.2	132	2.3	77.3	0
Sweden	25.5	56.5	27.9	59	3.7	79.9	1
United Kingdom	27.3	68.3	24.8	11	2.2	82.1	18[†]
United States	8.1	32.5	24.5	27	2.1	88.0	57

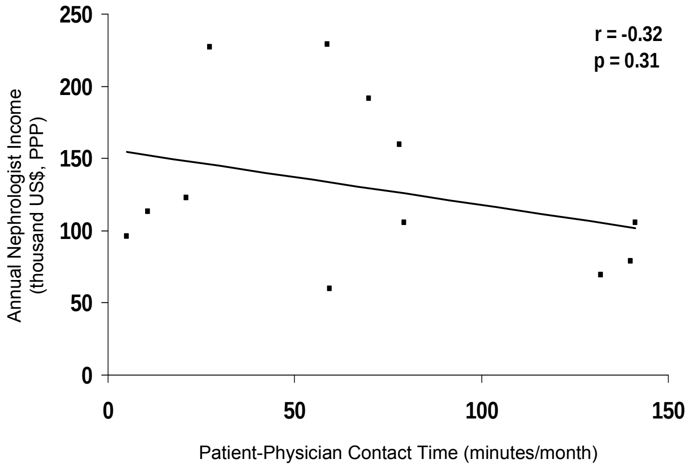
[+] Dialysis modality was obtained from country-specific renal registries. All Registry data represent the year 2002 except for Belgium (2000), France (2003) and Japan (2000). All other data represent the initial cross-section of DOPPS II patients (2002-2004).

* In New Zealand, only one facility responded to this question.

** Kt/V, vascular access type, and % reuse measures have been weighted by the number of patients per facility to account for varying facility sizes.

[†] The UK Renal Registry reports a lower estimate, 4.2% (Ansell & Feest, 1999).

Figure 3. Hemodialysis patient-physician contact time and nephrologist income, 2002



Contact time is for a cross-section of DOPPS II hemodialysis patients at study start.

Table 7. Cost and payment for hemodialysis (HD) treatments in 2002*

Country	Cost per HD Treatment (US$, PPP)	Payment per HD Treatment (US$, PPP)
Australia	-	116
Belgium	-	321
Canada	214	-
France	258	-
Germany	-	164
Italy	191	189
Japan	-	192
New Zealand	132	187
Spain	127	161
Sweden	-	271
United Kingdom	223	-
United States	141	124

Standardized to the year 2002 by inflating or deflating estimates in country currency by 3% per year and then converting to PPP. Data for Belgium, New Zealand, Sweden, and the United Kingdom are not comparable to the others for the reasons listed in the notes below.

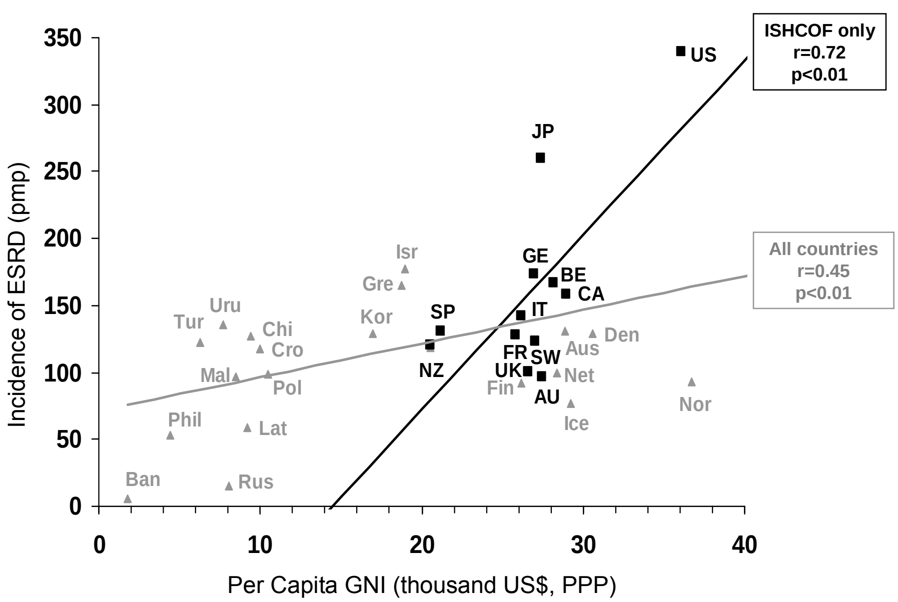
* Excludes non-routinely administered drugs, non-routine laboratory tests, vascular access procedures, nephrologists or physician services, radiology, inpatient hospital services, and any PD, home hemodialysis, or transplant services.

Note: Australia-Annual capitation grant in Victoria for hospital and satellite hemodialysis divided by 156 sessions per year; Belgium-Excludes hospitalization cost for the day (250-300 €); Canada (Lee et al., 2002; Laupacis et al., 1996); France–Echelle Nationale de Côuts (ENC) database for outpatient dialysis 2000/01; Germany–2003 weekly reimbursement rate divided by 3.2, the average number of weekly sessions per HD patient; Italy–weighted by facility type. Cost (De Negri et al., 1997), payment based on reimbursement rates for HD with a biocompatible membrane in 2001); Japan (JSDT, 2002); NZ-Cost reported by 2 public units. Reimbursement is the National Contract Price, which is considered an inter-district flow and does not include supplies; Spain-Cost for free-standing facilities is considered an underestimate for hospital-based facilities. Reimbursement rate does not include physician fees and is weighted by facility type (free-standing and hospital-based); Sweden - Cost includes all lab tests, nephrologists services, and radiology (excl drugs, vascular access, inpatient hospital service, home-treatment procedures) in Stockholm; UK-Excludes erythropoietin, weighted by type of facility; US–Free-standing facilities only. Cost as defined on the Cost Reports accepted by Medicare in 2003. Payment is the Medicare Allowable Charge (MAC). Medicare pays 80% of the MAC (~$100) and facilities collect the remainder from patients or their secondary insurance.

Table 8. Correlations between annual expenditure per ESRD patient and both process and outcome variables, 2002

Variable Type	Variable	Correlation with Annual Expenditure			
		PPP		IPP	
		r	*P*	r	*P*
Process	% dialysis pts. on peritoneal dialysis	-0.48	0.11	-0.37	0.23
	% ESRD pts. with transplant	-0.02	0.94	0.10	0.75
	% HD pts. with AV fistula	-0.28	0.38	-0.12	0.72
	% HD pts. with catheter	0.34	0.28	0.26	0.41
	% HD pts. in Kt/V guideline	0.18	0.57	-0.08	0.81
	% HD pts reusing dialyzers	0.65	0.02	0.39	0.20
	Patient-physician contact time	-0.09	0.79	-0.07	0.82
	Patient-staff contact time	-0.42	0.18	-0.33	0.30
	Nephrologist income	0.52	0.09	0.10	0.76
	Dialysis staff income	0.12	0.71	-0.28	0.38
Intermediate Outcome	% HD pts. in anemia guideline	0.40	0.19	0.45	0.14
	% HD pts. in albumin guideline	-0.07	0.84	0.02	0.95
Outcome	HD patient mortality	0.31	0.33	0.39	0.21

Figure 4. ESRD incidence and Gross National Income per capita, 2002



Note: GNI data from the World Development Indicators (World Bank, 2004). ESRD incidence for non-ISHCOF countries obtained from USRDS 2004 Annual Report. AU-Australia; Aus-Austria; Ban-Bangladesh; CA-Canada; Chi-Chile; Cro-Croatia; Cze-Czech Republic; Den-Denmark; Fin-Finland; FR-France; GE-Germany; Gre-Greece; Hun-Hungary; Ice-Iceland; IT-Italy; Isr-Israel; JP-Japan; Kor-Republic of Korea; Lat-Latvia; Mal-Malaysia; Net-Netherlands; NZ-New Zealand; Nor-Norway; Phi-Philippines; Pol-Poland; Rus-Russia; SP-Spain; SW-Sweden; Tha-Thailand; UK-United Kingdom; US-United States; Uru-Uruguay.

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APPENDIX A: ESRD CARE - A SHORT PRIMER

The medical and technological aspects of ESRD may not necessarily be of interest to economists per se. However, while outcomes are difficult to interpret, process measures are useful in terms of understanding the "product" of ESRD care.

Dialysis Modality

People who have lost kidney function accumulate toxins. Dialysis is the process of cleaning toxins from the blood. The two main types of dialysis are hemodialysis (HD) and peritoneal dialysis (PD). HD is by far the more common modality in ISHCOF countries.

Hemodialysis (HD) is the process of cleaning a patient's blood through an external filtering device (the dialyzer), through which blood circulates during treatment. HD is most frequently performed at dedicated outpatient dialysis clinics, partly because of the availability of support staff from nurses and other ancillary health care providers, and partly because of the size and expense of the equipment necessary. Home hemodialysis (HH) is an option for a small group of more stable and independent patients.

Peritoneal dialysis (PD) differs from hemodialysis in that the filtration is performed within the patient's body, instead of in a machine. For PD, the patient's abdomen is filled with a special fluid (dialysate), which allows toxins to be filtered across the peritoneal membrane (which lines the abdomen). Each time this fluid is exchanged, toxins are removed. The two main types of PD are continuous ambulatory peritoneal dialysis (CAPD), in which patients exchange their fluids via a catheter every 4-6 hours, and automated peritoneal dialysis (APD), for which a patient connects to a machine that pumps fluid in and out of the body several times overnight.

Hemodialysis Choices that May Affect Quality and Efficacy of Care

Dialysis duration and dosage (Kt/V): In most countries, hemodialysis treatment typically lasts three to four hours and is performed three times a week. (In Sweden and Germany, average treatment time is longer.) Kt/V is a measure of dialysis dose and is sometimes referred to as dialysis adequacy or dialysis clearance. It represents the amount of toxins that are cleared per patient size (volume). Calculating Kt/V involves several factors including: the ability of a particular dialyzer to remove urea (K), time on dialysis (t), and a patient's volume (V). Low Kt/V is strongly associated with higher mortality rates (Port et al., 2004). A higher Kt/V markedly improves clinical outcomes; however, a tradeoff between K and t exists in that higher dialyzer clearance can be balanced with a shorter time on dialysis and, equivalently, a longer t allows for a lower K. These two combinations could yield the same product Kt. However, more recent studies suggest that independent of Kt/V, longer time on dialysis is significantly associated with improved outcomes, particularly patient survival (Saran et al., 2006).

Vascular access: The site from which blood is taken from the body in hemodialysis is referred to as a vascular access. The three main types of access are: 1) arteriovenous fistulae (AV fistulae), which create a permanent, direct connection between an artery and vein in the arm; 2) grafts, which also connect an artery and vein, but the permanent connection is made with synthetic tubing; and 3) catheters, which are plastic tubes inserted into a major vein and connected directly to the dialysis machine. AV fistulae and grafts are completely inside the body and require the insertion of two needles to access the blood flow. In contrast, double-lumen catheters extend outside of the body and do not require needles; however, because they are foreign bodies and are open to the external environment, catheters are more prone to infection, and are indeed significantly associated with worse clinical outcomes (Pisoni et al., 2001; Pisoni et al., 2005). The US providers tend to utilize grafts and catheters relatively more frequently as compared to other ISHCOF countries. Most ISHCOF countries tend to use native fistulae (Table 6), which are less costly to maintain and have better outcomes overall.

Membrane type: The membrane inside the dialyzer and can be made of several types of material. Cellulose membranes (including cuprophane membranes) are less desirable than synthetic membranes. They are considered less bio-compatible membranes because they may induce an immune system response in patients, which could lead to lower survival (Hakim et al., 1994). In recent years, high-flux membranes, which have larger pores for filtration, have been introduced to increase the speed and effectiveness of hemodialysis (Mandelbrot, 2006). Dialyzer reuse refers to having a patient receive dialysis multiple times through the same membrane as a cost-saving measure, with the need for reprocessing (cleansing, sterilizing) of the filter/dialyzer after every treatment. In many countries, dialyzer reuse is not practiced, though it is quite prevalent in the United States.

Anemia management and ESRD: Anemia very often accompanies kidney failure. As kidneys fail, they cease to produce of erythropoietin, a hormone that stimulates the bone marrow to produce blood cells. Another common cause of anemia is the loss of blood from hemodialysis and low levels of iron or folic acid. International clinical guidelines, such as the Kidney Dialysis Outcomes Quality Initiative (KDOQI), specify a target level of hemoglobin ≥11 g/dL (NKF, 2006a) that may be achieved through the administration of two drugs — genetically engineered erythropoietin and iron.

Practice Guidelines: Clinical practice guidelines for dialysis patients have gained momentum over the past 10 years. One major effort to promote evidence-based, international guidelines is the National Kidney Foundation’s Kidney Dialysis: Improving Global Outcomes

(KDIGO). Some countries (Australia, Canada, the UK, and the US) and some international regions (Europe) have developed their own practice targets. Several of the countries use targets from the US KDOQI as cutoffs for describing dialysis quality. The following are the KDOQI target ranges for select[15] indicators:

Dialysis dose: Kt/V $\geq$ 1.2 (NKF, 2006b)

Anemia management: hemoglobin $\geq$ 11 g/dL (NKF, 2006a)

Nutrition: albumin $\geq$ 4.0 g/dL (NKF, 2000)

Vascular access: facility catheter use $\leq$ 10% (NKF, 2006b)

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[15] Other indicators not considered in this review include serum phosphorus (3.5 – 5.5 mg/dL) and serum calcium (8.5 – 9.5 mg/dL).

APPENDIX B: INPUT PRICE PARITY INDEX

$$\mathbf{IPP_i = \sum weight_{US} (Price_i / Price_{US})}$$

The IPP index is constructed from four input variables (capital/supplies, annual staff income, administration or "other" labor costs, and annual nephrologist income). Each of these inputs was weighted in the same way. Weights were obtained from the US national cost reports, which break costs into several components. However, physician costs are not one of these categories. To obtain a measure for nephrologist income, we assumed that nephrologists see patients for three treatments per week and that 17% of the US Medicare per-patient cost is for physician services. To calculate the weights, we added our estimate of physician costs into the total outpatient hemodialysis costs in the cost reports and then calculated the proportion of the total costs that was spent on the four input variables. These weights were then applied to each country's data.

Country-specific data for the four variables came from various sources. For capital, we assumed that all countries have the same cost and we used the cost from the US. For annual staff income, we obtained estimates of the income for various staff titles in each country from our investigators. Those estimates were weighted by the percentage of staff members in each staff title, as reported in the DOPPS II Unit Practice Survey. For administrative costs, we used annual per-capita Gross National Income converted by the World Bank's Atlas Method (World Bank, 2004). Nephrologist income was obtained from our investigators in each country.

Each country's values for the four variables were then divided by the values in the US, to obtain a relative input measure prior to applying the weights. We then summed the four products of each weight and corresponding relative input measure. This sum became the Input Price Parity

Index, which can be used to compare dialysis costs across countries while using the US as the reference country (IPP value = 1.00).

Table A1: Use of the IPP Index to Estimate Annual Expenditure per ESRD Patient in 2002

Country	Expenditure per ESRD Patient (US$, PPP)	IPP Index	Expenditure per ESRD Patient (US$, IPP)
Australia	35,513	0.84	42,277
Belgium	52,518	0.88	59,680
Canada	45,094	1.03	43,781
France	44,162	0.91	48,530
Germany	46,924	0.76	61,742
Italy	39,292	0.82	47,917
Japan	39,027	0.94	41,518
New Zealand	22,517	0.73	30,845
Spain	29,232	0.76	38,583
Sweden	40,054	0.75	53,504
UK	53,279	0.81	65,776
US	58,115	1.00	58,115

APPENDIX A: ESRD CARE - A SHORT PRIMER

The medical and technological aspects of ESRD may not necessarily be of interest to economists per se. However, while outcomes are difficult to interpret, process measures are useful in terms of understanding the "product" of ESRD care.

Dialysis Modality

People who have lost kidney function accumulate toxins. Dialysis is the process of cleaning toxins from the blood. The two main types of dialysis are hemodialysis (HD) and peritoneal dialysis (PD). HD is by far the more common modality in ISHCOF countries.

Hemodialysis (HD) is the process of cleaning a patient's blood through an external filtering device (the dialyzer), through which blood circulates during treatment. HD is most frequently performed at dedicated outpatient dialysis clinics, partly because of the availability of support staff from nurses and other ancillary health care providers, and partly because of the size and expense of the equipment necessary. Home hemodialysis (HH) is an option for a small group of more stable and independent patients.

Peritoneal dialysis (PD) differs from hemodialysis in that the filtration is performed within the patient's body, instead of in a machine. For PD, the patient's abdomen is filled with a special fluid (dialysate), which allows toxins to be filtered across the peritoneal membrane (which lines the abdomen). Each time this fluid is exchanged, toxins are removed. The two main types of PD are continuous ambulatory peritoneal dialysis (CAPD), in which patients exchange their fluids via a catheter every 4-6 hours, and automated peritoneal dialysis (APD), for which a patient connects to a machine that pumps fluid in and out of the body several times overnight.

Hemodialysis Choices that May Affect Quality and Efficacy of Care

Dialysis duration and dosage (Kt/V): In most countries, hemodialysis treatment typically lasts three to four hours and is performed three times a week. (In Sweden and Germany, average treatment time is longer.) Kt/V is a measure of dialysis dose and is sometimes referred to as dialysis adequacy or dialysis clearance. It represents the amount of toxins that are cleared per patient size (volume). Calculating Kt/V involves several factors including: the ability of a particular dialyzer to remove urea (K), time on dialysis (t), and a patient's volume (V). Low Kt/V is strongly associated with higher mortality rates (Port et al., 2004). A higher Kt/V markedly improves clinical outcomes; however, a tradeoff between K and t exists in that higher dialyzer clearance can be balanced with a shorter time on dialysis and, equivalently, a longer t allows for a lower K. These two combinations could yield the same product Kt. However, more recent studies suggest that independent of Kt/V, longer time on dialysis is significantly associated with improved outcomes, particularly patient survival (Saran et al., 2006).

Vascular access: The site from which blood is taken from the body in hemodialysis is referred to as a vascular access. The three main types of access are: 1) arteriovenous fistulae (AV fistulae), which create a permanent, direct connection between an artery and vein in the arm; 2) grafts, which also connect an artery and vein, but the permanent connection is made with synthetic tubing; and 3) catheters, which are plastic tubes inserted into a major vein and connected directly to the dialysis machine. AV fistulae and grafts are completely inside the body and require the insertion of two needles to access the blood flow. In contrast, double-lumen catheters extend outside of the body and do not require needles; however, because they are foreign bodies and are open to the external environment, catheters are more prone to infection, and are indeed significantly associated with worse clinical outcomes (Pisoni et al., 2001; Pisoni et al., 2005). The US providers tend to utilize grafts and catheters relatively more frequently as compared to other ISHCOF countries. Most ISHCOF countries tend to use native fistulae (Table 6), which are less costly to maintain and have better outcomes overall.

Membrane type: The membrane inside the dialyzer and can be made of several types of material. Cellulose membranes (including cuprophane membranes) are less desirable than synthetic membranes. They are considered less bio-compatible membranes because they may induce an immune system response in patients, which could lead to lower survival (Hakim et al., 1994). In recent years, high-flux membranes, which have larger pores for filtration, have been introduced to increase the speed and effectiveness of hemodialysis (Mandelbrot, 2006). Dialyzer reuse refers to having a patient receive dialysis multiple times through the same membrane as a cost-saving measure, with the need for reprocessing (cleansing, sterilizing) of the filter/dialyzer after every treatment. In many countries, dialyzer reuse is not practiced, though it is quite prevalent in the United States.

Anemia management and ESRD: Anemia very often accompanies kidney failure. As kidneys fail, they cease to produce of erythropoietin, a hormone that stimulates the bone marrow to produce blood cells. Another common cause of anemia is the loss of blood from hemodialysis and low levels of iron or folic acid. International clinical guidelines, such as the Kidney Dialysis Outcomes Quality Initiative (KDOQI), specify a target level of hemoglobin ≥11 g/dL (NKF, 2006a) that may be achieved through the administration of two drugs — genetically engineered erythropoietin and iron.

Practice Guidelines: Clinical practice guidelines for dialysis patients have gained momentum over the past 10 years. One major effort to promote evidence-based, international guidelines is the National Kidney Foundation's Kidney Dialysis: Improving Global Outcomes (KDIGO). Some countries (Australia, Canada, the UK, and the US) and some international regions (Europe) have developed their own practice targets (discussed throughout this special issue). Several of the accompanying papers use targets from the US KDOQI as cutoffs for describing dialysis quality. The following are the KDOQI target ranges for select[1] indicators:

Dialysis dose: Kt/V $\geq$ 1.2 (NKF, 2006b)
Anemia management: hemoglobin $\geq$ 11 g/dL (NKF, 2006a)
Nutrition: albumin $\geq$ 4.0 g/dL (NKF, 2000)
Vascular access: facility catheter use $\leq$ 10% (NKF, 2006b)

[1] Other indicators not considered in this review include serum phosphorus (3.5 – 5.5 mg/dL) and serum calcium (8.5 – 9.5 mg/dL).

APPENDIX B: INPUT PRICE PARITY INDEX

$$\mathbf{IPP_i = \sum weight_{US} (Price_i / Price_{US})}$$

The IPP index is constructed from four input variables (capital/supplies, annual staff income, administration or “other” labor costs, and annual nephrologist income). Each of these inputs was weighted in the same way. Weights were obtained from the US national cost reports, which break costs into several components. However, physician costs are not one of these categories. To obtain a measure for nephrologist income, we assumed that nephrologists see patients for three treatments per week and that 17% of the US Medicare per-patient cost is for physician services. To calculate the weights, we added our estimate of physician costs into the total outpatient hemodialysis costs in the cost reports and then calculated the proportion of the total costs that was spent on the four input variables. These weights were then applied to each country’s data.

Country-specific data for the four variables came from various sources. For capital, we assumed that all countries have the same cost and we used the cost from the US. For annual staff income, we obtained estimates of the income for various staff titles in each country from our investigators. Those estimates were weighted by the percentage of staff members in each staff title, as reported in the DOPPS II Unit Practice Survey. For administrative costs, we used annual per-capita Gross National Income converted by the World Bank’s Atlas Method (World Bank, 2004). Nephrologist income was obtained from our investigators in each country.

Each country’s values for the four variables were then divided by the values in the US, to obtain a relative input measure prior to applying the weights. We then summed the four products of each weight and corresponding relative input measure. This sum became the Input Price Parity

Index, which can be used to compare dialysis costs across countries while using the US as the reference country (IPP value = 1.00).

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