The financing and organization of medical care for patients with end-stage renal disease in Sweden

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Abstract

The total health care expenditure as a percentage of the gross domestic product in Sweden is 9.2%, and health care is funded by global budgets almost entirely through general taxation. The prevalence rate of end-stage renal disease (ESRD) in Sweden is 756 per million. Fifty-two percent of ESRD patients have a functioning transplant. Almost all ESRD treatment facilities are public. Compared with other Dialysis Outcomes and Practice Patterns Study (DOPPS) countries, the salaries for both nephrologists and professional dialysis unit staff are low. Sweden's high cost per ESRD patient, relative to other DOPPS countries, may be a result of expensive and frequent hospitalizations and aggressive anemia treatment strategies.

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Introduction

In Sweden, health care is a public service financed almost universally through taxes. The rationale for this system is to ensure equal access to high-quality health care for all residents, regardless of domicile or income level. The 290 Swedish local authorities and 21 county councils are responsible for providing a major part of all public services, including health care, and are entitled to levy taxes to finance their activities. Taxes are levied as a percentage of citizens' income. The average overall local tax rate is 31%.

The county councils' major responsibility is health care, which accounts for almost 90% of their activities. Other responsibilities include regional development and growth, and public transportation. On average, 10% of citizens' income (one-third of the local tax rate) is levied for county council activities (SCB, 2003).

With a population of nine million people living in an area of approximately 450,000 km^2, Sweden is one of the most sparsely populated countries in Europe. People are increasingly moving from rural to urban areas, and the majority of inhabitants live in the southern part of the country. Thus, economic and demographic conditions vary widely in different parts of Sweden. To ensure equality, a "local government equalization system" has been introduced. The state manages the system, which involves redistributing the revenues of the local authorities and county councils on the basis of their tax base and level of expenditure. The state levies property taxes, value added tax, and a graduated income tax.

The local government structure also applies to health care in Sweden. Health care institutions generally are funded by global budgets stipulated by the county councils according to the estimated need of health care in the population. The administrative organization of global budgets makes it difficult to calculate the cost of each specific treatment or illness. A physician decides each patient's treatment according to professional standards and virtually irrespective of the individual costs, although the total cost that can be covered by the budget still matters. Dialysis, a life-sustaining treatment, has high priority within the global budget, as does kidney transplantation, which is a more cost-efficient treatment overall for end-stage renal disease (ESRD). In effect, dialysis is judged to be worth the "opportunity cost" of lower priority services.

Methods

The International Study of Health Care Organization and Financing (ISHCOF), a substudy of the Dialysis Outcomes and Practice Patterns Study (DOPPS), aims to characterize economic structures and their impact on the delivery of dialysis care. The ISHCOF is based primarily on one-time commissioned surveys (2004–2005) and subsequent papers by authors from each of the 12 DOPPS countries. See (Dor et al., 2007) for details of the methods.

The data in this report are primarily based on the Svenskt Register för Aktiv Uremivård (SRAU). In this report, most data are for the year 2002–2003. Although more recent data exist for some statistics, the 2002–2003 data are presented to ensure comparable figures between the country-

specific papers. All monetary estimates were provided in national currency units and converted to U.S. dollars with Organisation for Economic Co-operation and Development (OECD) purchasing power parities (PPP) from the year of each figure (OECD, 2006). Due to the small number of economic investigators and countries in this study, all international comparisons reported here are informal and qualitative, unless otherwise noted.

The gross epidemiology of kidney disease and provision of care in Sweden

Sweden's point prevalent count of 6,761 ESRD patients in December 2002 implies an ESRD prevalence rate of 756 per million population, placing Sweden first among the five Nordic countries (USRDS, 2005) and ninth among the 12 DOPPS countries (Dor et al., 2007). More than half (52%) of the ESRD patients have a functioning transplant, which places Sweden seventh among 33 countries listed in the U.S. Renal Data System (2005). Among the DOPPS countries, only Spain and the United States have a greater transplant prevalence rate. Every incident ESRD patient is medically evaluated and, if medically suited, offered the opportunity to be placed on the kidney transplant waiting list. The only factor limiting the incidence of kidney transplantation is the supply of organs. In 2003, 403 patients were on the kidney transplant waiting list and 215 patients were transplanted with kidneys from recently deceased donors. The average waiting time for a deceased-donor organ was approximately 22 months (Scandiatransplant, 2003). In 2003, 38% (130) of all transplanted kidneys were from living donors. The proportion of deceased-donor kidneys decreased from 66% to 63% between 1998 and 2002 and continues to decrease. The incidence of kidney transplantation decreased 14% between 1998 and 2002, possibly due to a scarcity of donated kidneys (SRAU, 2003). Although other DOPPS countries (Canada, Germany, New Zealand, and Spain) observed a decrease in transplantation rates during this time period, none observed a decrease as large as Sweden's (data not shown).

The incidence of ESRD treatment has been roughly constant at 125 per million for some time. In 2002, Sweden experienced a slight (0.005%) decrease in the incidence of ESRD treatment, in contrast to the increasing incidence of ESRD treatments in all other DOPPS countries (Dor et al., 2007). One explanation is that the need for ESRD treatment in Sweden has been met and the stable incidence of ESRD treatment reflects stability in the incidence of underlying renal disease. However, because the incidence of ESRD treatment does not necessarily reflect the incidence of actual ESRD, a less favorable explanation is that all patients with renal failure are not treated. Sweden's stable incidence rate could indicate a decreasing tendency to initiate treatment in the very elderly. Using treated incidence rate (per million population) as a measure of access to ESRD, Sweden is ninth among the 12 DOPPS countries (Dor et al., 2007). Among the population aged 65–74 years, ESRD incidence in Sweden is consistently lower than in Denmark, but higher than in the other three Nordic countries reporting to the USRDS (USRDS, 2005).

Fifty-two percent of all ESRD patients have a functioning transplant. Of the 48% of ESRD patients dialyzed, 71% receive outpatient hemodialysis treatment, 25% receive peritoneal dialysis (PD), and 2% undergo home hemodialysis (SRAU, 2003). According to the DOPPS sample, 57% of hemodialysis patients use a fistula, whereas 28% dialyze with a catheter. This

rate of catheter use is the third highest among DOPPS countries, behind only Belgium and Canada (Dor et al., 2007).

Sweden's ESRD population is served by 65 dialysis facilities and four transplant centers. Ninety percent of the dialysis units are hospital based. While more patients in total use the hospital-based facilities, the average number of patients served by the typical hospital-based and typical freestanding facility is almost equal at 38 dialysis patients each. Ninety-five percent of the ESRD treatment facilities are public and four are private, for-profit; all are urban. The already small number of private centers has decreased over the past several years. When possible, PD may be preferred for patients living in rural areas who otherwise must travel vast distances to obtain treatment. Typically, the ESRD centers operate in two shifts between 7 am and 9 pm.

Primary care in Sweden is also geographically organized. The 6,253 primary care physicians in Sweden on average serve a geographic area with 1,430 inhabitants each. The number of inhabitants referred to a specific general practitioner varies by factors such as the age distribution in the area and the number of patients with a chronic illness who need more care. Primary care physicians (general practitioners) are typically responsible for preventive care and, to a large extent, for patients with mild renal failure. Generally speaking, these practitioners also care for patients who have been diagnosed with a renal disease by a nephrologist but have limited or no renal failure and have a disease with a low progression rate (i.e., the rate of loss of kidney function is low over time). Nephrologists and general practitioners collaborate in the care of patients with chronic renal disease, but when the renal failure progresses (typically to a serum creatinine ≥ 150 umol/l or a GFR of 40–50 ml/min), the patient is referred to a nephrologist. Though the number of nephrologists is limited by each county, these 245 specialists each serve approximately 28 dialysis or kidney transplant patients. However, this ratio is deceptive. In Sweden, like most other countries, nephrologists also treat patients with chronic renal failure who have not yet reached uremia to prevent the development of renal failure. This preventive care occupies the majority of Swedish nephrologists' work and is not represented in the ratio of 28 nephrologists per ESRD patient. In fact, this ratio conflicts with the view of the Swedish Society of Nephrology that there is a general shortage of trained nephrologists in Sweden.

The historic lack of physicians in several disciplines in Sweden has forced the development of very skilled nurses. Today, Swedish nurses perform several of the tasks medical doctors perform in other countries.

Sweden has roughly 20 kidney transplant surgeons. Considering the 300 transplant operations conducted each year, each surgeon serves approximately 15 patients per year. Available statistics, however, do not separate the surgeons performing transplantations on abdominal organs from the surgeons performing thoracic organ transplantations. Most of the kidney transplantations use deceased donor organs. The retrieval of such organs cannot be predicted, so the surgeons are constantly on call. The time between organ recovery and transplantation into the recipient is limited, and Sweden is a relatively large country geographically. At each of the four Swedish transplant centers, one team of surgeons must be on call for the organ retrieval and another for the actual transplantation. The transplant operation is started before the arrival of the organ to save time. The same procedure with two teams of surgeons is used in living-donor transplantations.

Sweden has no waiting lists for ESRD care, other than those for transplantation. Whether the absence of a dialysis wait list is because of adequate staffing ratios and a well-adapted ESRD health care system or because doctors adapt the dialysis patient inflow to the budgeted supply of ESRD care cannot be evaluated.

The average annual pre-tax salary of Swedish primary care physicians, at SEK 580,000 (US$62,000; PPP 2002), is the third-lowest salary among the DOPPS countries; only Spain and New Zealand have lower salaries (data not shown). Swedish nephrologists earn the lowest salary of all DOPPS countries, approximately SEK 560,000 (US$60,000; PPP 2002) per year (ISHCOF mean = US$130,000; data not shown). Similarly, at SEK 290,000 (US$31,000; PPP 2002), the average salary of dialysis nurses is also low among DOPPS countries (ISHCOF mean=US$34,460; data not shown). In comparing these salaries with salaries in other countries, the relevance of the Swedish tax system must be considered. The high taxes in Sweden mean that people do not need to save as much as in other countries for future health care or education costs. Swedish physicians earn quite a lot, in relation to other Swedes, even though a lengthy education generally does not result in higher pay in Sweden. However, there is little difference in salary among the various kinds of Swedish doctors. Even though county councils govern health care, the government runs the councils; in effect, there is only one employer for Swedish doctors and the powers of the free market are not allowed to play. Other forces, like politics, also govern salary levels. In addition, the proportional tax rate leads to very little economic gain from overtime work for Sweden's health care personnel.

Expenditures

While it is very difficult to determine the cost of each specific treatment in Sweden, the overall cost of health care is known with some precision. The opposite situation may be true in other ISHCOF countries. Any comparison of costs may thus be biased by these differences in financial systems. In 2002, the total health expenditure as a percentage of the gross domestic product in Sweden was 9.2% (7.5% for public health expenditures) (OECD, 2005). Sweden spends a relatively high amount per capita on health care costs, at SEK 24,289 (US$2,594; PPP 2002) per person (OECD, 2005). Health care is funded almost entirely through general taxation covering the entire population and accounting for 28.5% of the governmental budget. Only 8% of health care expense comes from private sources in the form of premiums for supplementary health insurance or out-of-pocket costs for patients. It is not possible to completely opt out of the general tax–funded health care system. Avoiding taxes is impossible, and the proportion of taxes assigned to health care is not specified when taxes are paid. Everyone pays according to his or her income, and even those who do not have a job and pay no taxes get health care at the same standards as everybody else.

While additional private insurance may be purchased for illness in general, ESRD patients cannot and need not purchase private insurance to cover their illness. The general tax–funded health care and welfare system covers all costs related to ESRD treatment, including chronic and acute dialysis, medications, lost wages and other sickness benefits. However, copayments do exist; each patient could pay a yearly maximum of SEK 900 (US$96; PPP 2002) for medical

care, SEK 1,800 (US$192; PPP 2002) for prescription drugs, SEK 1,400 (US$150; PPP 2002) for travel, and SEK 1,400 (US$150; PPP 2002) for extra supplies such as home dialysis machines. The county council decides the fee for each visit for medical care, approximately 200 SEK (US$21; PPP 2002). Health care for children under the age of 18 is free. Copayments are charged presumably so that patients seeking medical care might be shifted toward less specialized care, which has lower fees. There is no link between the fees paid by patients and the salaries of health care personnel.

The general tax–funded health "insurance" is administered through 21 county councils that operate independently on a global budget. Health care is, however, governed centrally by the government and/or by a coalition between the county councils. Economic inequalities between counties are lessened by a central allocation of funds, transferring money from rich to poor counties. This system worked well during times of economic growth but is becoming a political problem because opportunities for service expansion in urban areas are restrained by high taxes.

ESRD treatment is life-sustaining and has a high priority in the global health care financing system. Overall, the cost of ESRD treatment is not increasing uncontrollably. Private dialysis facilities contribute to lower costs because the treatment at these wards is generally given to patients with less concomitant and complicating diseases, and the price, accordingly, is lower. The county councils running the public sector also fund treatment in the private dialysis wards.

The cost of a functioning kidney transplantation is about one-fifth the cost of treating a hemodialysis patient during a year (during the initial year of transplantation, the cost is about one-half the cost of treating a hemodialysis patient). Because all citizens share the costs, and no one in particular benefits from health care company profits, it is in the interest of all to increase the number of kidney-transplanted patients.

Specific aspects of treatment and financing

Prescription Drugs

After the copayment, all drugs, dispensed according to formularies, are covered without limit by government insurance; this includes erythropoietin (EPO). The physician determines the use of such supplementary pharmacological therapies; there is no fixed protocol, only informal agreements among nephrologists. The nephrologists cooperate through the Swedish Society of Nephrology, which runs health care quality assessment registries on ESRD treatment. Internationally recognized measures of dialysis effectiveness are regularly recorded for each patient at each dialysis ward. The data are compiled and compared for nephrologists to obtain a practice norm. The goals for hemoglobin level, iron load, vitamin D treatment, among others, follow the National Kidney Foundation's Kidney Dialysis Outcomes and Quality Initiative (KDOQI) guidelines, which are based on the current scientific consensus.

Hospitalization

Sweden's point prevalent population of 6,761 ESRD patients had 6,781 hospital admissions during 2002, with an average hospital stay of 8.7 days. This is a hospitalization rate of approximately 1.0 per patient per year for the ESRD population. It is generally known that transplant patients have lower hospitalization rates than dialysis patients. The USRDS reports that transplant patients have 0.42 the hospitalization rate of dialysis patients (USRDS, 2005). With weights of 0.52 for transplant patients (i.e., 52% of the Swedish ESRD patients have a transplant) and 0.48 for dialysis patients, it can be estimated that the admission rate for dialysis patients in Sweden is 1.43 admissions per patient per year, the rate for transplant patients is 0.60 admissions per patient per year, and the overall rate is 1.0. A similar calculation based on the reported USRDS ratio of transplant hospital days per patient per year to the dialysis rate (0.42) yields 5.23 hospital days per transplant patient per year and 12.4 hospital days per dialysis patient per year.

Transplantation

Four of Sweden's 71 hospitals perform transplantations at no cost to patients. The average hospital stay for a transplantation is 10 days, an average that falls in the middle compared with 5 days in the United States (Hirth, 2007) and 20 or more days in Belgium (Van Biesen et al., 2007). Transplantations are not rationed in any way; in fact, more than half of the ESRD population has received a transplant.

Dialysis

Because each county in Sweden operates on its own global budget, no national statistics for the costs of dialysis are available. In Stockholm, the mean reimbursement rate per outpatient hemodialysis treatment (including supplies, laboratory services, fixed capital, staff salaries, nephrologist services, and radiology) in 2005 was SEK 2,700 (US$290; PPP 2004); yet across Sweden, the reimbursement rate was closer to SEK 2,900 (US$311; PPP 2004) (S.H. Jacobson, personal communication, November 2006). For private centers, the cost of outpatient hemodialysis treatment was about SEK 2,400 (US$240; PPP 2004) per treatment (B. Wikström, personal communication, November 2006). These figures appear to be much higher than those of the other DOPPS countries (Dor et al., 2007); however, they also include several costs not included in the estimates from other countries (e.g., all laboratory tests and nephrologist salaries). Due to the limitations of global budgeting in Sweden, a truly comparable number cannot be determined with the currently available data.

Patients have very little choice of dialysis center and are referred to private centers only for medical reasons and within their county of residence; private facilities are available in only a few counties.

Specialist physicians provide both outpatient and inpatient care, and all treatments are at the dialysis unit or are ambulatory dialysis. Like some DOPPS countries, Sweden provides very little home dialysis, which is available only in about 10 centers. Approximately 1.1% of ESRD patients receive home hemodialysis (USRDS, 2005).

The national standard and the average dialysis dose (Kt/V) are comparable to other DOPPS countries at 1.2 single pool Kt/V. There are no official limits on dialysis dose. The treatment time is specific to the individual and is guided by the measures of effectiveness and clinical evaluation. Average treatment time is 240 min (245 min/1.73m2 body surface). This refers to the time when the patient is "hooked up" to the machine and the blood purifying process is ongoing. A patient spends an average of 360 min total in the treatment center, including pre- and post-dialysis arrangements. A patient has to be prepared for dialysis and, in addition, often eats after dialysis. Generally, dialysis patients obtain their overall health care at the dialysis centers from nephrologists.

Office visits to specialists and primary care physicians are approximately 30 min per visit. When patients miss or shorten sessions, which is generally not a problem, it is usually for medical reasons.

Compared with other DOPPS countries, Sweden has a high proportion of patients using catheters (28%) and a low proportion using arteriovenous (AV) fistulae (57%) for vascular access (Dor et al., 2007). The high rate of catheter use may be partially explained by a high prevalence of peripheral vascular disease (Jacobson et al., 2004; Locatelli et al., 2002), which often is associated with generally small and narrow vessels unfavorable for creation of functioning AV fistulae. Another explanation is the long waiting list for AV fistula operations. Because a patient might wait many months for the operation, catheters are placed as the initial access. Often, once patients are used to dialyzing with a catheter, they are reluctant to undergo fistula-creation surgery. Furthermore, placing a catheter is much less time-intensive than creating a fistula, and a referral to a radiologist for this procedure is often easy.

Trends and Outcomes

Each county council continuously evaluates health care financing within its geographic area of responsibility. The National Board of Health and Welfare assesses the overall quality of care. The board sponsors the SRAU, the registry run by the Swedish Society of Nephrology, which has published descriptive statistics yearly since 1990. The mortality among dialysis patients decreased during the first years of the new millennium. In fact, the age-adjusted survival has gradually improved since the start of the registry. For example, the likelihood of a male patient, aged 65 years at the start, surviving 5 years of treatment has increased over time. In 1991, this likelihood was 58% for males with kidney transplants and 22% for males on dialysis. In 2000, the corresponding likelihoods were 73% and 31%, respectively.

In 2002, the major cause of death among patients on dialysis was cardiovascular disease (43%), while 18% of the dialysis patients died from uremia and 12% from infections. Also among patients with a functioning kidney transplant, the most common cause of death was cardiovascular disease (38%), while malignancies were the cause of death for 17% and infections for 9%.

Discussion

Comparing health care costs and outcomes among countries is difficult. Measures that totally and completely describe the costs, performance, and outcomes of the health care system in one country are never perfect. But imperfect measures for comparison among countries are useful if for no other reason than to provide an outline for future research. Throughout the world, there is a push to examine health care costs and to match the cost to the value of various treatment practices. The process becomes more intense each year in part because of the gap between the growth in health care costs and the slower growth in the economy that ultimately has to support medical care (Kjellstrand and Moody, 1994). An aging population is a common phenomenon in most, and if not all, of the DOPPS countries. As demands for medical care for the elderly grow, the pressure for greater efficiency in health care is amplified. Sweden is not exempt from these trends.

The treatment of patients with ESRD is a marvel of modern medicine that provides many years of productive and frequently high-quality life. If one compares its treatment with that of non-kidney organ failures, e.g., liver failure, one quickly recognizes the power of the treatment of kidney disease (the treatment of kidney disease is more widespread and less costly than the treatment of liver disease). But the care of patients with ESRD is very expensive and highly visible to the public given that it requires treatment week after week and year after year (Kjellstrand, 1996). Because the costs, prevalence, and visibility of ESRD are so high, the potential benefits of research, which improve efficiency of care and levels of outcome, are that much more important. But the research on efficiency cannot be done if there are no measures of costs and/or payments.

Table 1 shows a set of indicators of the cost of treating ESRD in Sweden. The left side of the table identifies a few conditions that would suggest that Sweden may have relatively low costs compared with other DOPPS countries, while the right side lists some conditions that would suggest relatively high costs.

Table 1. Indicators of cost for ESRD patients in Sweden

Indicators of lower relative costs	Indicators of higher relative costs
Sweden spends a modest fraction (9%) of GDP for health care (e.g., compared with the United States [15%] and Germany [11%])	The cost per hospital day for the general population as reported by the OECD is relatively high
Incidence and prevalence rates of ESRD are relatively low	The hospital admission rate for dialysis patients is relatively high
The transplant population is large	Staff hours in dialysis facilities are high
Professional salaries are low	EPO doses are relatively high

Table 2. Estimated total expenditures for ESRD patients in Sweden, 2002

Modality	Count*	Weight	Cost/patient/year (US$; PPP)
Hemodialysis	2,322	0.34	70,796
Home hemodialysis	152	0.02	41,770
Peritoneal dialysis	796	0.12	46,018
Functioning transplant	3,230	0.47	14,159
Incident transplant	307	0.05	70,000
Total ESRD	6,807	1.00	40,054

*SRAU 2003. Home hemodialysis was assumed to account for the difference in the total patient count and the sum of hemodialysis, PD, and transplant patients.

As stated above, the nature of the global budgeting system for medical care in Sweden precludes specific cost estimates for treating ESRD. Appendix 1 contains a set of synthetic estimates of the cost of treating ESRD in Sweden. These estimates are based on some known Swedish inputs, practitioner judgment, and results of other studies of the cost of ESRD in other societies. Table 2 summarizes these synthetic estimates.

Conclusion

The ESRD program in Sweden is embedded in the overall health care system and reflects the basic tenets of the Swedish system. Access to health care is determined solely on medical need, regardless of the economic circumstances of the patient. The medical system is almost totally funded by progressive taxes and primarily administered by public institutions. The incidence and prevalence of treated ESRD in Sweden is relatively high for the Nordic countries but modest compared with the rest of the DOPPS countries (Dor et al., 2007). The incidence of treated ESRD appears to be reasonably stable. Whether this situation is the result of stability in underlying renal disease or a rationing of access to selected groups is uncertain.

Sweden's ESRD treatment protocol is heavily focused on transplantation, with approximately 52% of the ESRD patients living with a functioning transplant. Like almost all DOPPS countries, Sweden has a shortage of kidneys for transplantation; however, living donors are more common than in other DOPPS countries. Hemodialysis is the primary dialysis modality. A modest number of patients are treated with PD while very few are treated with home HD.

Compared with the ESRD population as observed in other DOPPS countries, there is a substantial number of nephrologists (Ashton and Marshall, 2007; Durand-Zaleski et al., 2007; Hirth, 2007; Kleophas and Reichel, 2007; Luño, 2007; Nicholson and Roderick, 2007; Pontoriero et al., 2007; Van Biesen et al., 2007), although the Swedish Society of Nephrology maintains that a shortage of nephrologists exists. Earnings for both nephrologists and professional dialysis unit staff are low compared with salaries in other DOPPS countries; however, this is consistent with salaries of all medical professionals in Sweden.

Because of the use of global budgets for dialysis units, hospital procedures, and physician payments, virtually no financial incentives exist to conduct more treatments, keep patients in the hospital for longer periods of time, or see more patients. In fact, physicians negotiate the annual budget with the government based on their expected patient load in the following year. If a

center has experienced substantial growth, the unit may receive a larger budget than the previous year; however, if a physician underestimates the number of treatments he or she will give, each treatment will be reimbursed at a lower rate than originally negotiated.

In 2002, Sweden spent a relatively low proportion of its gross domestic product (9.2%) on health care compared with the United States (14.6%)(WB, 2005). The global budgeting system generally precludes specific cost estimates for particular services; however, there are several indications that the cost per ESRD patient in Sweden is relatively high compared with other DOPPS countries and partly reflects the choice of first-rate medical care. First, the cost per hospital day, according to the OECD, tends to be high for European DOPPS countries. Second, the hospital admission rate for dialysis patients in Sweden is moderate to high. Third, synthetic cost estimates for dialysis patients and transplant patients are in the moderate to high range among DOPPS countries (Dor et al., 2007). Other indicators suggest a low cost structure for ESRD, including a strong emphasis on transplantation, which has lower per capita costs and low salaries for medical professionals.

An aging population with growing numbers of ESRD patients, combined with a heavily loaded retirement system, is expected to increase the costs of medical care. It should be noted that, in spite of cost pressures, ESRD in Sweden is given high priority compared with other conditions. Yet the paucity of information regarding treatment costs is notable and should shape future planning and research.

As mentioned previously, exact cost data do not exist for Sweden and this attempt to elucidate them, though rough, is a basis for future research. Many of the DOPPS research efforts associate measures of inputs with outcomes of treatment. For example, the dialysis unit staffing, dialyzer size, dialyzer efficiency, EPO dose, and nephrologist contact time with patients are all measures of resource use that vary by country. Costs for some of these measures can be elusive, but there is no question that each country treats ESRD in different ways and these differences in both outcomes and resource use offer us a natural laboratory of experimentation and cost finding. The current study is only an initial investigation of how costs may affect resource use and outcomes. Hopefully, future efforts will continue to discover what works best in the treatment of ESRD patients and how much various approaches cost.

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Appendix: Synthetic Estimate of the Expenditure for ESRD in Sweden, 2002–2003

Because of a lack of data on disease-specific expenditures in Sweden, we have attempted to estimate the costs/payments for various components of ESRD care in 2002–2003.

Estimating Hemodialysis Costs

Per treatment cost

In Table A1, we estimate the component costs per hemodialysis patient over 1 year. According to the authors' personal investigations, the cost per outpatient hemodialysis treatment in Stockholm was SEK 2,700 (US$290; PPP 2004) in 2005. We will assume that this reimbursement rate grew at 3% per year, so the cost in 2002 would have been SEK 2,464 (US$263; PPP 2002). Assuming a patient receives 156 hemodialysis treatments per year, the annual cost for treatments would be US$41,028 (263 × 156). This measure includes radiology, laboratory tests, and nephrologist payments; however, it excludes drugs, such as EPO, and hospitalizations. For this reason, estimates for these costs are estimated separately in Table A1.

Table A1. Estimated annual expenditure for a hemodialysis patient in Sweden (2002–2003)

Component	Estimated expenditure (US$)
Hemodialysis	41,028
Hospitalizations	11,631
Non-dialysis-physician service costs	6,230
Erythropoietin	7,682
Other medications	4,225
Total	70,796

Hospitalization cost

Hemodialysis patients often require hospitalization for reasons other than dialysis treatment (Rayner et al., 2004). In this paper, Sweden's point prevalent population of 6,761 ESRD patients were reported to have had 6,781 hospital admissions during 2002 with an average hospital stay of 8.7 days. This is a hospitalization rate of approximately 1.0 per patient per year for the ESRD population. It is generally known that transplant patients have lower hospitalization rates than dialysis patients. The USRDS reports that transplant patients have 0.42 the hospitalization rate of dialysis patients (USRDS, 2005). With weights of 0.52 for transplant patients (i.e., 52% of Swedish ESRD patients have a transplant) and 0.48 for dialysis patients in Sweden, it can be estimated that the admission rate for dialysis patients in Sweden is 1.43 admissions per patient per year. Using the average length of stay and the number of admissions per year, we find that Swedish hemodialysis patients spend 12.4 days per year as an inpatient.

We assume that the daily cost of hospitalization in Sweden is the same for hemodialysis patients as for the general population and, therefore, we can use OECD data. These data suggest an inpatient cost of US$750 per person per year, but the average person is hospitalized only 0.16 times per year for an average of 5.0 days (OECD, 2004, 2005). Therefore, the cost per person

who is hospitalized per year is US$938 per day ($750/[0.16 × 5]). The total annual hospitalization cost per hemodialysis patient is US$11,631 (12.4 × 938).

Non-dialysis physician service costs

Hemodialysis patients incur outpatient expenditures in addition to their hemodialysis treatments (e.g., visits to cardiologists, endocrinologists, and gynecologists). The USRDS (2005) reported that 8.8% of the total cost per hemodialysis patient was spent on services other than nephrologist physician services in 2003. Assuming that this percentage also applies to Sweden, the annual cost for non-dialysis-physician visits and treatments was US$6,230.

Medications

EPO costs were estimated from the DOPPS data (Pisoni et al., 2004), demonstrating that 94% of Swedish patients take EPO at an average dose of 12,202 units per week. In 2004 the cost of EPO was SEK 120 per 1,000 units (US$12.88; exchange rate 2004). Multiplying these three values together yields an annual EPO expenditure per patient of US$7,682.

Assuming that drugs other than EPO cost 55% of EPO, which is true in Canada (Lee et al., 2002), our estimate becomes US$4,225.

Summing these costs suggests a total expenditure of US$70,796 per hemodialysis patient.

Estimating the Cost per ESRD Patient

Dialysis

Hemodialysis cost estimates were demonstrated above. We now assume that home hemodialysis costs 59% of outpatient hemodialysis (Lee et al., 2002) or US$41,770. We also assume that PD costs 65% of hemodialysis. This percentage is the mean of the 53% observed in Lee et al. (2002), the 69% observed in Cass et al. (2006), and 73% observed in the USRDS (2005). Patient cost per PD is US$46,018 (Table 2).

Transplantation

Functioning transplants are estimated at 20% of the cost of hemodialysis (see expenditures section) or US$14,159. Personal communications with transplant surgeons in Sweden (G. Tufveson and J. Wahlberg, December 2006) suggest that incident transplants cost about US$70,000.

Our last step is to weight the several modality cost estimates by the proportion of patients receiving each modality in Sweden to obtain an annual expenditure of US$40,054 per ESRD patients (Table 2).

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