Chapter 14

Higher Volume and Better Outcomes Relationship in Kidney Transplant

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Additional information is available at the end of the chapter

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1. Introduction

End-stage renal disease (ESRD) is a serious public health and medical problem in the world. The incidence and prevalence rates grow up in many countries (Figure 1). According to the recent United States Renal Data System (USRDS) report, the incidence of ESRD increases from 346 per million people in 2004 to 371 per million people in 2009 in the United States.(1) ESRD also has financial impacts on the health care delivery and insurance systems. For instance, in Taiwan, 68,000 chronic renal failure patients constitute 0.3% of national population, but they cost nearly 10% of health insurance resource in 2010.(2) In United States, total Medicare spending with ESRD cost 29 billion dollars in 2009.(3) Some developing countries and theirs patients with ESRD are unable to afford the tremendous cost of dialysis and kidney transplant. This leads to extremely public health and medical problem due to no substitute therapy can be provided owing to economic reason.(4)

2. Kidney transplant and donor shortage

Since Joseph Edward Murray successfully achieved the first kidney transplant surgery in 1954, kidney transplant has become one of the standard therapies for patients with ESRD. Hemodialysis, peritoneal dialysis and kidney transplant are regarded as replacement therapies for patients with ESRDs. Kidney transplant is widely believed to be the best option among all therapies.(5) Patients who receive kidney transplant are more likely to have higher satisfaction rate, better quality of life, and lower long-term utilization and cost than those who receive dialysis therapy.(5, 6) Although the death rate of patients within two weeks after receiving renal transplant surgery is 2.8 fold higher than those with hemodialysis therapy, the overall death rate 68% is lower than dialysis.(7)

The annual cost of dialysis is around $35,000 to $80,000 USD. The cost of kidney transplant is similar to dialysis in the first year, but the medical cost after surgery is lower than that

receiving dialysis.(8-16) As a result, many countries promote kidney transplantation given the medical and financial benefits. Nevertheless, the amount of donated kidneys cannot satisfy the rapidly increasing need. The waiting times for kidney transplant surgery are from 3 to 6 years, and even longer in several countries such as United Kingdoms, Brazil, and Taiwan.(17-20) Therefore, many countries encourage expanded criteria donor (ECD) and donor after cardiac death (DCD). These two polices can increase amount of transplant surgery and reach good transplant results under well-planned and cooperative organizations.(21)

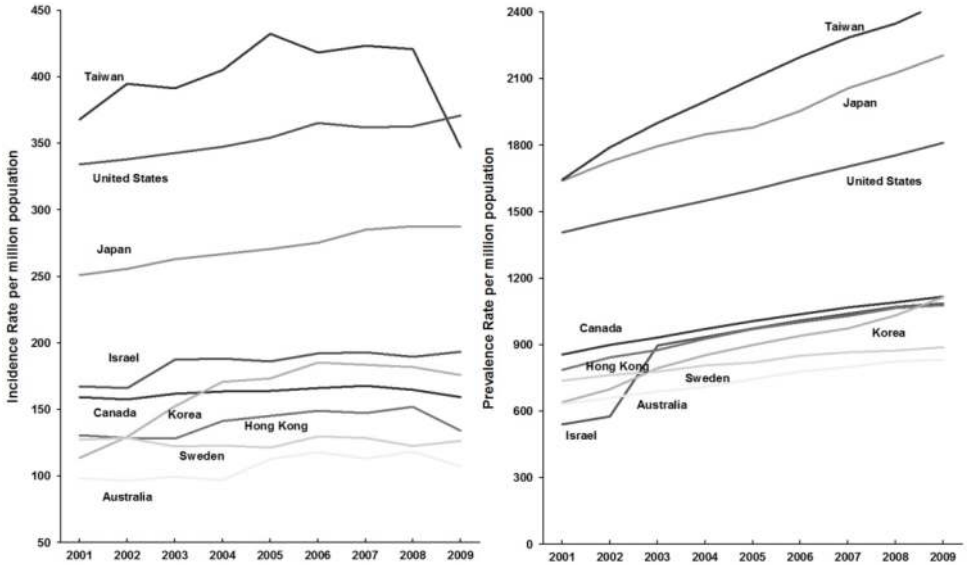

Figure 1. the incidence and prevalence of people with end-stage renal disease in different countries (retrieved parts of the statistics from the 2011 Annual Data Report, United States Renal Data System, http://www.usrds.org/2011/pdf/v2_ch012_11.pdf)

3. Organ procurement and allocation

The allocation and utilization of donated organs is as important as procurement. In developed countries, such as United States and United Kingdom that have executed organ transplant surgeries for decades, they have had well-established organ procurement organizations for procuring donors, organ harvest, and transplant. Whenever an organ donor is obtained, the transplant center distributes them according to the blood type, tissue matching result, disease severity, age, location, waiting time, and the shortest ischemic time to achieve the optimal transplant result. Health authorities will also request these centers must follow their patients to evaluate whether pre-set goals are achieved, such as efficiency of promotion, ratio of using expanded criteria donor, survival rate, and growth of transplant rate. The aim of disclosure of processing and outcome information of transplant to the public is not only providing necessary information to all patients, but also acting as performance parameters of all transplant centers.

However, such an organ procurement and allocation system is still at the beginning stage in many countries. Hospitals or the health care systems have to establish their own waiting and priority list. Usually there are few communications and cooperation across transplant centers, thus the limited donated organs cannot be fully utilized and allocated to the most needed recipients. To improve the efficiency of utilization and fairness of allocation, many countries such as Taiwan and Brazil have established a coordinating organization. They procure organ donation and set up the waiting list and the priority of organ utilization based on medical and ethical considerations. Patients with ESRDs have equal opportunity to share the limited organs as long as they fit the matching criteria. Previous studies showed that the number of kidney transplant increased significantly after establishment of the central coordinating organizations.(19)

4. Volume-outcome relationships in high-risk surgeries

Many studies have demonstrated that patients who receive surgery at higher-volume hospitals are more likely to have better outcomes.(22-30) The evidence for a positive relationship between provider volume and subsequent clinical outcomes for inpatients is substantial and compelling since its introduction in the literature mainly by Luft (31) and Flood (32, 33) in the 1980s. During the past 30 years, especially after 1995, a large body of studies has focused on measuring and explaining the relationship between inpatient outcomes and volume of services provided by hospitals and physicians. For certain diseases and procedures, a "higher volume and better outcomes" relationship has been recognized in several large-scale reviews.(30, 34) The Institute of Medicine released its synthesis of the evidence that 77% of peer-reviewed studies found significant inverse relationships between hospital volume and mortality (34); and another systematic review by Dudley et al (30, 34) reported similar findings. Extremely strong volume-outcome relationships have been chiefly identified for rare and high-risk procedures, including coronary artery bypass graft surgery,(35-40) pediatric cardiac surgery,(41-43) unruptured abdominal aortic aneurysm repair,(39, 44, 45) total hip replacement, (30, 34, 46, 47) and very high risk cancer surgeries such as for the pancreas,(48-52) esophagus,(50, 53, 54) and liver cancers.(53)

5. Causes for volume-outcome relationships

Although the association between the volume of inpatient services and outcomes of health care is substantial for many studies, the direction of causality has not been well defined. Three principal hypotheses have been advanced to explain this relationship:

First, the "practice makes perfect" hypothesis. Many studies support the "practice makes perfect" hypothesis, in that higher-volume providers develop more effective skills and treatments that result in better outcomes.(31, 55) According to this hypothesis, there is a learning effect among providers; that is, higher-volume providers develop more effective skills and treatments which result in better outcomes.(32, 33) It is plausible that regular experience is crucial to keep up skills and the lower-volume providers have poorer outcomes because they have lost a necessary edge.(56, 57) However, several studies that

track changes in individual hospital volume over time found that fluctuating numbers of cases within the same hospital have no or minimal effects on outcomes.(36, 58) This implies that volume-outcome associations may reflect fixed differences in the overall quality of care between high and low-volume providers, rather than the hypothesis of "practice makes perfect" alone.(59)

Second, the "selective referral" hypothesis. Luft et al (60) argued that volume could be higher in hospitals with better outcomes because patients seek care at facilities with reputations for better performance. It is possible that for elective procedures providers who are well known might receive more referrals or self-referrals from patients themselves.(57) However, this is implausible in the case of emergency procedures where the opportunity for selective referral is low. Furthermore, given the fact that physicians do not usually use outcome information to make referrals,(61, 62) nor do patients flock to hospitals based on their outcome information,(63) selective referral alone cannot explain the whole story well. Luft et al (31) adopted a simultaneous-equation model to test the relative importance of the two explanations, and suggested that both hypotheses are valid and that the relative importance of the practice or referral explanation varies by diagnosis or procedure.

Third, the "outcome-related processes of care" hypothesis. An alternative hypothesis is that there is no direct causal relationship between volume and inpatient outcomes, and their correlation is due to other more specific intervening factors; that is, volume may be probably a proxy measure for other factors that affect care.(59) High-volume providers may have the economies of scale to improve their structural characteristics, such as recruiting experienced medical staff and investing in required equipment and information systems. These structural advantages may enable high-volume providers most likely to perform better processes of care, such as well-designed care plans, streamlined procedures, and higher adherence to evidence-based guidelines that improve clinical outcomes.(64-66) These findings are consistent with the framework of "Structure-Process-Outcome" hypothesized by Donabedian, that structure of care influences process which in turn influences outcomes.(67)

6. Volume-outcome relationship in kidney transplant

The outcome of kidney transplant is determined by a recipient's health status, surgical techniques, competency of the surgeons and staff, multidisciplinary care, infection control, and the ability to manage graft rejection after surgery. Kidney transplantation has achieved significant improvement for the past two decades. According to the USRDS 2010 annual report, one year survival of kidney transplant is about 98.7% for living donors, 96.7% for deceased donors, and 95.4% for synchronous pancreas and kidney transplant.(68)

Accumulating evidences have demonstrated the positive relationship between surgical volume and patient outcome in transplantation. The incidence and prevalence rates of ESRD are high in the United States and many European countries. The number of kidney transplant surgeries and the volume-outcome studies are also high in these countries. Axelrod et al. found that transplant outcomes are better at the higher volume centers.(24)

The unadjusted rate of renal graft loss within 1 year was significantly lower at high volume than low volume transplant centers. After adjustment, kidney transplant at low and very low volume centers was associated with a higher incidence of graft loss when compared with high volume centers. However, they did not identify clear minimal threshold volume for kidney transplantation. Edwards et al. (22) also found that as a group, liver-transplantation centers in the United States that perform 20 or fewer transplantations per year have mortality rates that are significantly higher than those at centers that perform more than 20 transplantations per year. They argued that information regarding the outcome of liver transplantation at transplantation centers should be made widely available to the public in a timely manner. Kim et al. (25) also found significant center-specific variation in the success of renal transplantation in Canada. There was significant center-specific variation in recipient and transplant characteristics (e.g. age, diabetes mellitus, donor source and center volume) as well as covariate-adjusted facility-specific outcome rates. There was a 3- to 4-fold difference in hazard rates of renal transplant outcomes among the 20 centers studied in Canada. Centers performing less than 200 transplants over the study period were associated with lower graft and patient survival. Using the North American Pediatric Transplant Cooperative Study database, Schurman et al. (23) found outcomes between groups existed, including the increasing rates of cadaver donor graft thrombosis and acute tubular necrosis with decreasing pediatric renal transplant center volume. Decreasing graft survival for decreasing center size groups was noted at 3 months after transplant. Superior graft survival in the high-volume centers noted at 3 months after transplant appears predominantly the result of lower rates of cadaver donor graft thrombosis and acute tubular necrosis.

For those with high incidence and prevalence rates of ESRD but low donation rates, such as Japan, Taiwan, Hong Kong, many hospitals and surgeons in these countries compete for limited number of renal transplant surgeries. The outcome and efficiency of transplant surgeries varied substantially among hospitals of different surgical volumes. One recent study based on a nationally representative data base in Taiwan revealed that kidney transplants performed at high-volume hospitals were more likely to result in fewer surgical complications, lower mortality, and higher survival for patients and transplanted grafts than those performed at low-volume hospitals.(69) Even though the mean age of the kidney recipients was older and the initial graft rejection rate was higher for patients at high surgical volume hospitals than at lower volume hospitals, the survival rates for recipients and grafts were significantly better at high- than low-volume hospitals. The mean transplant surgery cost was also lower at high- than low-volume hospitals. This study highlights the fact that nearly 77% of the surgeries were performed at six high-volume hospitals, which provided better quality of care than the low-volume counterparts. If all kidney transplants were performed at these high-volume hospitals, more patients and transplanted grafts would be saved and costs could be contained.

High volume hospitals are inevitably more likely to receive risky cases which in turn influence the outcomes of transplantation. This is to some extents the social responsibility of these high-volume and center-of-excellence hospitals. These hospitals can make efforts to

minimize the influences of increasing risky cases. First of all, the differences in performance of surgeons and the surgical team will be more significant in high-risk than the average-risk cases. Transplant centers with the state-of-art techniques and well-trained surgical teams are more likely to increase the success rates of kidney transplant of risky cases than their counterparts. High volume of transplant cases means that the hospitals have enough capacity and capability to treat all kinds of patients. Secondly, the high-volume hospitals will not always treat risky cases as long as the establishment of the organ procurement and transplantation network. The allocation of the donated kidneys follows the pre-set standard of procedure including disease severity and many other factors such as tissue matching results, age, location, waiting time, and the shortest ischemic time.

7. The volume-based policies in risky surgeries and transplant

Evidence of the volume-outcome relationship has important and practical policy implications. Although volume has not been widely accepted as a quality indicator, it is a structural characteristic that is easy to calculate and that is often associated with quality in the literature. (70) If the "higher-volume and better-outcome" association exists and is strong in magnitude, it would support the concentration of some specific medical interventions in regional, high-volume centers in an attempt to increase patient safety and reduce mortality.(30, 71) Several other reasons to proceed with volume-based regionalization are: first, it is one of the few strategies that is feasible before the introduction of more reliable quality indicators; second, on average, it is more likely to result in better outcomes for patients; and third, it also creates an incentive for hospitals to collect and report the data needed to measure quality more accurately.(72)

The volume-based selective referral or regionalization policies have been implemented for certain risky surgeries as well as in organ transplantation in the United States.(73, 74) Several states in the United States have used certificate-of-need (CON) programs to review proposals for new construction and expanded services in an effort to control costs and to improve quality of care. These programs tend to regionalize cases in high-volume hospitals only.(75) Some studies found that the CON and regionalization of some high-risk procedures improves the quality of care in certain surgeries such as heart transplantation,(76) pancreas cancer,(77) and CABG.(78) Moreover, several independent organizations have begun providing the population with information about volumes at hospitals in their areas. Moreover, purchasers have the power to influence referral patterns by contracting with health plans even without direct support from the medical community. (79) Several large employers and health care purchasers in the US have combined to leverage improvements in health care quality such as the *Leapfrog Group*.(28) The purchasers set annual volume standards for some high-risk procedures and encourage patients to utilize hospitals that perform a high volume of these procedures.(80)

There is no rigid volume threshold for kidney transplantation after reviewing the literature available. However, kidney transplantation is usually conducted at limited number of transplant centers in the United States, Canada, and European countries. A number of

studies have demonstrated the importance of the "center effect" as a prognostic factor in kidney transplantation.(26, 81-89) The variability in one year graft survival amongst US transplant centers has been shown to range from 30% to 40%. This effect has persisted despite advances in transplantation, which have led to improvements in short- and long-term graft and patient outcomes.(89, 90) No volume-based policy can be identified for countries with low donation rates.

Given the different socioeconomic status, culture, health care delivery and reimbursement systems, several factors shall be considered when health care authorities or hospitals plan to adopt the volume-based policies for high-risk surgeries. First of all, concentrating kidney transplant in a few high-volume hospitals could not only potentially decrease the quality of care because of work overload, but also reduce the proficiency of the remaining hospitals and their physicians in delivering kidney transplantation.(91, 92) Two controlled studies of perinatal regionalization showed no significant improvement in mortality.(93) One recent study by Hamilton et al.(58) found that the regionalization of major surgical procedures in Canada had minimal impact on death and readmission rates but showed a significant decline in the length of stay. Additionally, a volume-based referral program does not generate information about the causes of differences in quality among hospitals of varying volumes. It will also not help providers to determine how to improve quality of care except by boosting volume.

The second concern is for patient accessibility. There is clearly a tradeoff if time to treatment is increased by referring patients to high-volume centers or operators. Regionalization and selective referral could result inevitably in adverse outcomes by limiting patient choice and access to care, increasing unreasonable transfer and travel burdens and reducing the availability of surgical services in many locations, particularly in rural areas remote from the high-volume centers.(94, 95) The volume-based referral policy also may have unintended consequences for patients at lower-volume hospitals who have conditions that are not on the selective referral list. (79)

Third, patients might not benefit equally from regionalization or selective referrals. Nallamothu et al.(92) found that the beneficial effects of high-volume hospitals are only concentrated in a subgroup of patients with moderate to high risks of death. The experiences from the centralization of trauma centers further confirm that the higher-volume and better outcome benefits are only evident in high-risk patients.(95, 96) Thus, Nallamothu et al. suggest a transfer policy targeted at patients with moderate or higher risk.(71)

Finally, volume-based referral strategies would have substantial implications for hospitals, payers, and the society. First, regionalization and selective referral could create an unfair impact on the economic viability of small- to moderate-sized providers of lower-volume services.(97) Losing service volume could threaten the financial viability of local hospitals and their ability to recruit and retain physicians. (94) Second, reduced competition among providers may result in increased prices in many areas. Third, volume-based referral should not be expected to greatly reduce direct health care costs since the current evidence does not

indicate that higher-volume hospitals achieve shorter lengths of hospital admissions.(74) Finally, the volume standards would inevitably create financial incentives for providers to increase the number of procedures, whether they are medically indicated or not.(98, 99).

8. Policy implications and suggestions

The relationship between hospitals' volume of kidney transplant surgery and patients' outcomes has been a quite debated issue. Although many studies have demonstrated that patients who receive surgery at higher-volume hospitals are more likely to have better outcomes, the volume-based healthcare policies shall be tailored according the prevalence of ESRD patients, the number of organ donors, the availability of high-quality transplant providers, the healthcare delivery and reimbursement systems, and the culture and social norms in each country. There is no one magic bullet to solve all problems in every country.

For many developed countries with abundant medical resources, well-experienced providers, and high organ donation rates, the release of transplant outcome information of each transplant center may be more important than using the volume of surgery as a proxy indicator. Therefore, the healthcare authorities had better establishing solid organ procurement and allocation systems so that the limited organs can be utilized in an efficient way.

On the other hand, the need and number of kidney transplant surgeries are also growing rapidly in many countries where organ donation has not been a social norm. When many hospitals and surgeons compete for the limited sources of donors, the medical societies and healthcare policy makers worth to concern the differences in quality and efficiency of kidney transplants between high- and low-volume hospitals . We suggest that policy makers consider the following volume-based strategies to improve the quality of kidney transplants. First, the healthcare authority can consider adopting a 'center of excellence policy", that is, regionalizing kidney transplant surgeries to hospitals that have performed kidney transplant surgeries above a certain volume threshold. This volume threshold can be decided by healthcare authorities, transplant expert groups, hospitals, and patient representatives. However, this policy shall take into consideration of the country's size, distribution of medical resources, and convenience of transportation. Second, the 'center of excellence' hospital should be accountable for regional kidney transplant quality and outcomes. All high-risk patients shall be referred to high-volume hospitals for intensive care. If kidney transplants for high-risk patients are allowed to be performed at low-volume hospitals, they shall be supervised by the 'center of excellence' hospitals. Third, the health care authorities can use a 'certificate of need' policy to review proposals for new construction and expand services in an effort to control costs and to improve kidney transplant quality.

9. Conclusions

When surgical quality information for kidney transplantation has not been systemically collected or disclosed to the public, hospital's volume of kidney transplants has served a

convenient proxy quality indicator for patients and donors. In summary of all evidences available, patients who receive kidney transplant at high-volume hospitals are more likely to have better outcomes than at low-volume ones. This positive relationship has also been documented in many other high-risk surgeries. For areas with low organ donation rates and low volume of kidney transplant surgeries, volume-based strategies can be considered to ensure the quality of kidney transplant surgeries and to facilitate the highest utilization of limited kidney donors. Any regionalization or selective referral policy needs to be tailored based on the healthcare delivery and reimbursement systems, availability of medical resources, and culture background of the country. Hospital kidney transplant volume is just a proxy indicator on the population basis. The ultimate goal is that recipients and donors can access to comprehensive and transparent quality information of kidney transplant.

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