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Higher Volume and Better Outcomes Relationship in Kidney Transplant

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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 their 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 policies can increase amount of transplant surgery and reach good transplant results under well-planned and cooperative organizations.(21)

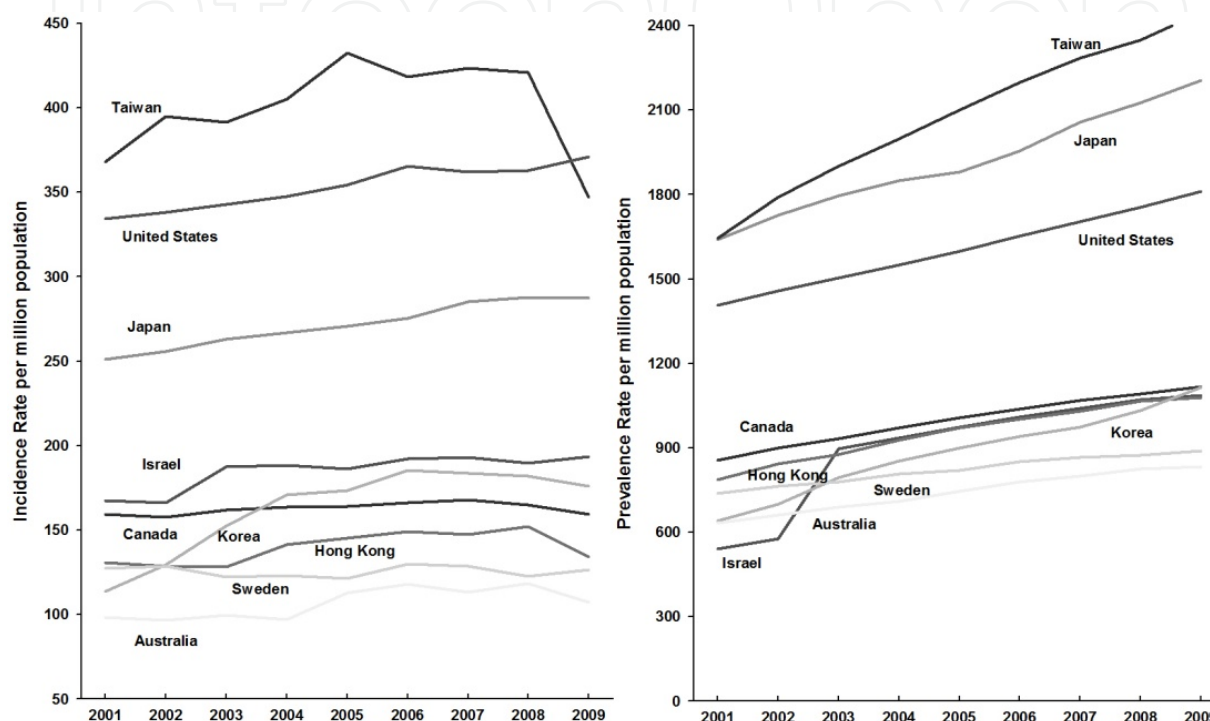


Figure 1. the incidence and prevalence of people with end-stage renal disease in different countries (retrieved parts of the statistics from the 2011 Annual Data Report, United States Renal Data System, http://www.usrds.org/2011/pdf/v2_ch012_11.pdf)

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. Nallamothe 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, Nallamothe 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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10. References

- [1] Annual Data Report. United State Renal Data System; 2011 Chapter 12, International Comparison. Available from: http://www.usrds.org/2011/pdf/v2_ch012_11.pdf.
- [2] Medical Utilization of Major Illness/Injury [database on the internet]. Bureau of National Health Insurance, Republic of China; 2010-[cited 2012 May 20]. Available from http://www.nhi.gov.tw/webdata/webdata.aspx?menu=17&menu_id=661&WD_ID=689&webdata_id=4004
- [3] Annual Data Report [database on the internet]. United State Renal Data System; 2011-[cited 2012 May 20]. Chapter 11, Costs of ESRD. Available from: http://www.usrds.org/2011/pdf/v2_ch011_11.pdf
- [4] Shrivastava A, Singh P, Bhandari M, Kumar A. Economics of Organ Transplantation in India. *Transplantation Proceedings* 1998;30:3121-2.
- [5] Manninen DL, Evans RW, Dugan MK, Rader B. The costs and outcome of kidney transplant graft failure. *Transplantation proceedings*. 1991;23(1 Pt 2):1312-4.

- [6] Niu SF, Li IC. Quality of life of patients having renal replacement therapy. *J advanced nursing*. 2005;51(1):15-21.
- [7] Wolfe RA, Ashby VB, Milford EL, Ojo AO, Ettenger RE, Agodoa LYC, Held PJ, et al. Comparison of Mortality in all patient on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *N Engl J Med* . 1999;341:1725-30.
- [8] Biesen WV, Lameire N, Peeters P, Vanholder R. Belgium's mixed private/public health care system and its impact on the cost of end-stage renal disease. *Int J Health Care Finance Econ*. 2007;7:133-48.
- [9] Kleophas W, Reichel H. International study of health care organization and financing: development of renal replacement therapy in Germany. *Int J Health Care Finance Econ*. 2007;7:185-200.
- [10] Pontoriero G, Pozzoni P, Vocchio LD, Locatelli F. International Study of Health Care Organization and Financing for renal replacement therapy in Italy: an evolving reality. *Int J Health Care Finance Econ*. 2007;2-3:201-15.
- [11] Manns BJ, Mendelssohn DC, Taub KJ. The economics of end-stage renal disease care in Canada: incentives and impact on delivery of care. *Int J Health Care Finance Econ*. 2007;7:149-69.
- [12] Hirth RA. The organization and financing of kidney dialysis and transplant care in the United States of America. *Int J Health Care Finance Econ*. 2007;7(4):301-18.
- [13] Harris A. The organization and funding of the treatment of end-stage renal disease in Australia. *Int J Health Care Finance Econ*. 2007;7:113-32.
- [14] Fukuhara S, Yamazaki C, Hayashino Y, Higashi T, Eichleay MA, Akiba T, et al. The organization and financing of end-stage renal disease treatment in Japan. *Int J Health Care Finance Econ*. 2007;7(2):217-31.
- [15] Durand-Zaleski I, Combe C, Lang P. International Study of Health Care Organization and Financing for end-stage renal disease in France *Int J Health Care Finance Econ*. 2007;7(2-3):171-83.
- [16] Ashton T, Marshall MR. The organization and financing of dialysis and kidney transplantation services in New Zealand. *Int J Health Care Finance Econ*. 2007;7(4):233-52.
- [17] Organ Donation [database on the internet]. NHSBT; 2012-[cited 2012 May 20]. Waiting time to transplant. Available from http://www.organdonation.nhs.uk/ukt/about_transplants/waiting_time_to_transplant/waiting_time_to_transplant.asp
- [18] Organ Procurement and Transplantation Network [database on the internet]. US department HHS; 2012- [cited 2012 May 11] . Waiting Time by Kidney PRA. Available from <http://optn.transplant.hrsa.gov/latestData/rptStrat.asp>
- [19] Medina-Pestana JO. Organization of a High-Volume Kidney Transplant Program- "Assembly Line" Approach. *Transplantation*. 2006;81:1510-20.
- [20] Vathsala A, Chow KT. Renal Transplantation in Singapore *Ann Acad Med Singapore*. 2009;38:291-9.

- [21] James F. Whiting FD, Paul Morrissey, Giacomo Basadonna, Scott Johnson, Richard Rohrer, Kevin O'Connor, et al. Clinical Result of an Organ Procurement Organization Effort to Increase Utilization of Donors after Cardiac Death. *Transplantation*. 2006;81:1368-71.
- [22] Edwards EB, Roberts JP, McBride MA, Schulak JA, Hunsicker LG. The effect of the volume of procedures at transplantation centers on mortality after liver transplantation. *N Engl J Med*. 1999;341(27):2049-53.
- [23] Schurman SJ, Stablein DM, Perlman SA, Warady BA. Center volume effects in pediatric renal transplantation. A report of the North American Pediatric Renal Transplant Cooperative Study. *Pediatric nephrology (Berlin, Germany)*. 1999;13(5):373-8.
- [24] Axelrod DA, Guidinger MK, McCullough KP, Leichtman AB, Punch JD, Merion RM. Association of center volume with outcome after liver and kidney transplantation. *Am J Transplant*. 2004;4(6):920-7.
- [25] Kim SJ, Schaubel DE, Jeffery JR, Fenton SS. Centre-specific variation in renal transplant outcomes in Canada. *Nephrol Dial Transplant*. 2004;19(7):1856-61.
- [26] Lin HM, Kauffman HM, McBride MA, Davies DB, Rosendale JD, Smith CM, et al. Center-specific graft and patient survival rates: 1997 United Network for Organ Sharing (UNOS) report. *JAMA*. 1998;280(13):1153-60. Epub 1998/10/20.
- [27] Hannan EL, Racz M, Ryan TJ, McCallister BD, Johnson LW, Arani DT, et al. Coronary angioplasty volume-outcome relationships for hospitals and cardiologists. *JAMA*. 1997;277(11):892-8.
- [28] Birkmeyer JD, Siewers AE, Finlayson EV, Stukel TA, Lucas FL, Batista I, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med*. 2002;346(15):1128-37.
- [29] Vakili BA, Kaplan R, Brown DL. Volume-outcome relation for physicians and hospitals performing angioplasty for acute myocardial infarction in New York state. *Circulation*. 2001;104(18):2171-6.
- [30] Dudley RA, Johansen KL, Brand R, Rennie DJ, Milstein A. Selective referral to high-volume hospitals: estimating potentially avoidable deaths. *JAMA*. 2000;283(9):1159-66.
- [31] Luft HS, Hunt SS, Maerki SC. The volume-outcome relationship: practice-makes-perfect or selective-referral patterns? *Health Serv Res*. 1987;22(2):157-82.
- [32] Flood AB, Scott WR, Ewy W. Does practice make perfect? Part II: The relation between volume and outcomes and other hospital characteristics. *Med Care*. 1984;22(2):115-25.
- [33] Flood AB, Scott WR, Ewy W. Does practice make perfect? Part I: The relation between hospital volume and outcomes for selected diagnostic categories. *Med Care*. 1984;22(2):98-114.
- [34] Halm EA, Lees C, Chassin MR. How is volume related to quality of care? A systematic review of the research literature. In: Hewitt M, ed. *Interpreting the volume-outcome relationship in the context of health care quality*. Washington, DC: Institute of Medicine; 2000.
- [35] Showstack JA, Rosenfeld KE, Garnick DW, Luft HS, Schaffarzick RW, Fowles J. Association of volume with outcome of coronary artery bypass graft surgery. Scheduled vs nonscheduled operations. *JAMA*. 1987;257(6):785-9.

- [36] Farley DE, Ozminkowski RJ. Volume-outcome relationships and in-hospital mortality: the effect of changes in volume over time. *Med Care*. 1992;30(1):77-94.
- [37] Grumbach K, Anderson GM, Luft HS, Roos LL, Brook R. Regionalization of cardiac surgery in the United States and Canada. Geographic access, choice, and outcomes. *JAMA*. 1995;274(16):1282-8.
- [38] Hannan EL, Siu AL, Kumar D, Kilburn H, Jr., Chassin MR. The decline in coronary artery bypass graft surgery mortality in New York State. The role of surgeon volume. *JAMA*. 1995;273(3):209-13.
- [39] Hannan EL, O'Donnell JF, Kilburn H, Jr., Bernard HR, Yazici A. Investigation of the relationship between volume and mortality for surgical procedures performed in New York State hospitals. *JAMA*. 1989;262(4):503-10.
- [40] Hannan EL, Kilburn H, Jr., Bernard H, O'Donnell JF, Lukacik G, Shields EP. Coronary artery bypass surgery: the relationship between inhospital mortality rate and surgical volume after controlling for clinical risk factors. *Med Care*. 1991;29(11):1094-107.
- [41] Chang RK, Klitzner TS. Can regionalization decrease the number of deaths for children who undergo cardiac surgery? A theoretical analysis. *Pediatrics*. 2002;109(2):173-81.
- [42] Hannan EL, Popp AJ, Tranmer B, Fuestel P, Waldman J, Shah D. Relationship between provider volume and mortality for carotid endarterectomies in New York state. *Stroke*. 1998;29(11):2292-7.
- [43] Sollano JA, Gelijns AC, Moskowitz AJ, Heitjan DF, Cullinane S, Saha T, et al. Volume-outcome relationships in cardiovascular operations: New York State, 1990-1995. *J Thorac Cardiovasc Surg*. 1999;117(3):419-28.
- [44] Dimick JB, Pronovost PJ, Cowan JA, Ailawadi G, Upchurch GR, Jr. The volume-outcome effect for abdominal aortic surgery: differences in case-mix or complications? *Arch Surg*. 2002;137(7):828-32.
- [45] Pronovost PJ, Jenckes MW, Dorman T, Garrett E, Breslow MJ, Rosenfeld BA, et al. Organizational characteristics of intensive care units related to outcomes of abdominal aortic surgery. *JAMA*. 1999;281(14):1310-7.
- [46] Solomon DH, Losina E, Baron JA, Fossel AH, Guadagnoli E, Lingard EA, et al. Contribution of hospital characteristics to the volume-outcome relationship: Dislocation and infection following total hip replacement surgery. *Arthritis Rheum*. 2002;46(9):2436-44.
- [47] Matsen FA, 3rd. The relationship of surgical volume to quality of care: scientific considerations and policy implications. *J Bone Joint Surg Am*. 2002;84-A(8):1482-3.
- [48] Birkmeyer JD, Finlayson SR, Tosteson AN, Sharp SM, Warshaw AL, Fisher ES. Effect of hospital volume on in-hospital mortality with pancreaticoduodenectomy. *Surgery*. 1999;125(3):250-6.
- [49] Gordon TA, Burleyson GP, Tielsch JM, Cameron JL. The effects of regionalization on cost and outcome for one general high-risk surgical procedure. *Ann Surg*. 1995;221(1):43-9.
- [50] Gordon TA, Bowman HM, Bass EB, Lillemoe KD, Yeo CJ, Heitmiller RF, et al. Complex gastrointestinal surgery: impact of provider experience on clinical and economic outcomes. *J Am Coll Surg*. 1999;189(1):46-56.

- [51] Simunovic M, To T, Theriault M, Langer B. Relation between hospital surgical volume and outcome for pancreatic resection for neoplasm in a publicly funded health care system. *Cmaj*. 1999;160(5):643-8.
- [52] Sosa JA, Bowman HM, Gordon TA, Bass EB, Yeo CJ, Lillemoe KD, et al. Importance of hospital volume in the overall management of pancreatic cancer. *Ann Surg*. 1998;228(3):429-38.
- [53] Begg CB, Cramer LD, Hoskins WJ, Brennan MF. Impact of hospital volume on operative mortality for major cancer surgery. *JAMA*. 1998;280(20):1747-51.
- [54] Patti MG, Corvera CU, Glasgow RE, Way LW. A hospital's annual rate of esophagectomy influences the operative mortality rate. *J Gastrointest Surg*. 1998;2(2):186-92.
- [55] Luft HS, Bunker JP, Enthoven AC. Should operations be regionalized? The empirical relation between surgical volume and mortality. *N Engl J Med*. 1979;301(25):1364-9.
- [56] Khuri SF, Daley J, Henderson W, Hur K, Demakis J, Aust JB, et al. The Department of Veterans Affairs' NSQIP: the first national, validated, outcome-based, risk-adjusted, and peer-controlled program for the measurement and enhancement of the quality of surgical care. National VA Surgical Quality Improvement Program. *Ann Surg*. 1998;228(4):491-507.
- [57] Hlatky MA, Dudley RA. Operator volume and clinical outcomes of primary coronary angioplasty for patients with acute myocardial infarction. *Circulation*. 2001;104(18):2155-7.
- [58] Hamilton SM, Johnston WC, Voaklander DC. Outcomes after the regionalization of major surgical procedures in the Alberta Capital Health Region (Edmonton). *Can J Surg*. 2001;44(1):51-8.
- [59] Halm EA, Lee C, Chassin MR. Is volume related to outcome in health care? A systematic review and methodologic critique of the literature. *Ann Intern Med*. 2002;137(6):511-20.
- [60] Luft HS. The relation between surgical volume and mortality: an exploration of causal factors and alternative models. *Med Care*. 1980;18(9):940-59.
- [61] Hannan EL, Stone CC, Biddle TL, DeBuono BA. Public release of cardiac surgery outcomes data in New York: what do New York state cardiologists think of it? *Am Heart J*. 1997;134(6):1120-8.
- [62] Schneider EC, Epstein AM. Influence of cardiac-surgery performance reports on referral practices and access to care. A survey of cardiovascular specialists. *N Engl J Med*. 1996;335(4):251-6.
- [63] Chassin MR, Hannan EL, DeBuono BA. Benefits and hazards of reporting medical outcomes publicly. *N Engl J Med*. 1996;334(6):394-8.
- [64] Chen J, Radford MJ, Wang Y, Marciniak TA, Krumholz HM. Do "America's Best Hospitals" perform better for acute myocardial infarction? *N Engl J Med*. 1999;340(4):286-92.
- [65] Canto JG, Every NR, Magid DJ, Rogers WJ, Malmgren JA, Frederick PD, et al. The volume of primary angioplasty procedures and survival after acute myocardial

- infarction. National Registry of Myocardial Infarction 2 Investigators. *N Engl J Med*. 2000;342(21):1573-80.
- [66] Hannan EL, Popp AJ, Feustel P, Halm E, Bernardini G, Waldman J, et al. Association of surgical specialty and processes of care with patient outcomes for carotid endarterectomy. *Stroke*. 2001;32(12):2890-7.
- [67] Donabedian A. Evaluating the quality of medical care. *Milbank Mem Fund Q*. 1966;44(3):166-206.
- [68] The U.S. Organ Procurement and Transplantation Network and the Scientific Registry of Transplant Recipients. The 2010 OPTN / SRTR Annual Report: Transplant Data 2000-2009. Available from http://www.srtr.org/annual_reports/2010/
- [69] Tsao SY, Lee WC, Loong CC, Chen TJ, Chiu JH, Tai LC. High-surgical-volume hospitals associated with better quality and lower cost of kidney transplantation in Taiwan. *Journal of the Chinese Medical Association : JCMSA*. 2011;74(1):22-7. Epub 2011/02/05.
- [70] Epstein AM. Volume and outcome--it is time to move ahead. *N Engl J Med*. 2002;346(15):1161-4.
- [71] Nallamothu BK, Saint S, Eagle KA. Volume and outcome. *N Engl J Med*. 2002;347(9):693-6.
- [72] Urschel JD, Urschel DM. The hospital volume-outcome relationship in general thoracic surgery. Is the surgeon the critical determinant? *J Cardiovasc Surg (Torino)*. 2000;41(1):153-5.
- [73] Birkmeyer JD, Finlayson EV, Birkmeyer CM. Volume standards for high-risk surgical procedures: potential benefits of the Leapfrog initiative. *Surgery*. 2001;130(3):415-22.
- [74] Birkmeyer JD, Skinner JS, Wennberg DE. Will volume-based referral strategies reduce costs or just save lives? *Health Aff (Millwood)*. 2002;21(5):234-41.
- [75] Chassin MR. Assessing strategies for quality improvement. *Health Aff (Millwood)*. 1997;16(3):151-61.
- [76] Krakauer H, Shekar SS, Kaye MP. The relationship of clinical outcomes to status as a Medicare-approved heart transplant center. *Transplantation*. 1995;59(6):840-6.
- [77] Gordon TA, Bowman HM, Tielsch JM, Bass EB, Burleyson GP, Cameron JL. Statewide regionalization of pancreaticoduodenectomy and its effect on in-hospital mortality. *Ann Surg*. 1998;228(1):71-8.
- [78] Robinson JL, Nash DB, Moxey E, O'Connor JP. Certificate of need and the quality of cardiac surgery. *Am J Med Qual*. 2001;16(5):155-60.
- [79] Dudley RA, Johansen KL. Invited commentary: Physician responses to purchaser quality initiatives for surgical procedures. *Surgery*. 2001;130(3):425-8.
- [80] Milstein A, Galvin RS, Delbanco SF, Salber P, Buck CR, Jr. Improving the safety of health care: the leapfrog initiative. *Eff Clin Pract*. 2000;3(6):313-6.
- [81] Gjertson DW, Terasaki PI. The large center variation in half-lives of kidney transplants. *Transplantation*. 1992;53(2):357-62. Epub 1992/02/01.
- [82] Gjertson DW, Terasaki PI, Cecka JM, Takemoto S. Reduction of the center effect by HLA matching. *Transplantation proceedings*. 1993;25(1 Pt 1):215-6. Epub 1993/02/01.
- [83] Cho YW, Cecka JM. Center effect in the UNOS Renal Transplant Registry. *Clinical transplants*. 1992;333-46. Epub 1992/01/01.

- [84] Cho YW, Cecka JM. Organ Procurement Organization and transplant center effects on cadaver renal transplant outcomes. *Clinical transplants*. 1996;427-41. Epub 1996/01/01.
- [85] Benlahrache C, Cecka M, Mickey MR, Cicciarella J. The center effect. *Clinical transplants*. 1987;325-37. Epub 1987/01/01.
- [86] Porte RJ, Ploeg RJ, Hansen B, van Bockel JH, Thorogood J, Persijn GG, et al. Long-term graft survival after liver transplantation in the UW era: late effects of cold ischemia and primary dysfunction. European Multicentre Study Group. *Transplant international : official journal of the European Society for Organ Transplantation*. 1998;11 Suppl 1:S164-7. Epub 1998/07/17.
- [87] Evans RW, Manninen DL, Dong F. The center effect in kidney transplantation. *Transplantation proceedings*. 1991;23(1 Pt 2):1315-7.
- [88] Morris PJ, Johnson RJ, Fuggle SV, Belger MA, Briggs JD. Analysis of factors that affect outcome of primary cadaveric renal transplantation in the UK. HLA Task Force of the Kidney Advisory Group of the United Kingdom Transplant Support Service Authority (UKTSSA). *Lancet*. 1999;354(9185):1147-52. Epub 1999/10/08.
- [89] Schaubel DE, Jeffery JR, Mao Y, Semenciw R, Yeates K, Fenton SS. Trends in mortality and graft failure for renal transplant patients. *Cmaj*. 2002;167(2):137-42. Epub 2002/08/06.
- [90] Hariharan S, Johnson CP, Bresnahan BA, Taranto SE, McIntosh MJ, Stablein D. Improved graft survival after renal transplantation in the United States, 1988 to 1996. *N Engl J Med*. 2000;342(9):605-12. Epub 2000/03/04.
- [91] Rosemurgy AS, Bloomston M, Serafini FM, Coon B, Murr MM, Carey LC. Frequency with which surgeons undertake pancreaticoduodenectomy determines length of stay, hospital charges, and in-hospital mortality. *J Gastrointest Surg*. 2001;5(1):21-6.
- [92] Nallamothu BK, Saint S, Ramsey SD, Hofer TP, Vijan S, Eagle KA. The role of hospital volume in coronary artery bypass grafting: is more always better? *J Am Coll Cardiol*. 2001;38(7):1923-30.
- [93] Siegel E, Gillings D, Campbell S, Guild P. A controlled evaluation of rural regional perinatal care: impact on mortality and morbidity. *Am J Public Health*. 1985;75(3):246-53.
- [94] Finlayson SR, Birkmeyer JD, Tosteson AN, Nease RF, Jr. Patient preferences for location of care: implications for regionalization. *Med Care*. 1999;37(2):204-9.
- [95] Nathens AB, Jurkovich GJ, Maier RV, Grossman DC, MacKenzie EJ, Moore M, et al. Relationship between trauma center volume and outcomes. *JAMA*. 2001;285(9):1164-71.
- [96] Nathens AB, Maier RV. The relationship between trauma center volume and outcome. *Adv Surg*. 2001;35:61-75.
- [97] Birkmeyer JD. Should we regionalize major surgery? Potential benefits and policy considerations. *J Am Coll Surg*. 2000;190(3):341-9.
- [98] Chassin MR, Koseoff J, Park RE, Winslow CM, Kahn KL, Merrick NJ, et al. Does inappropriate use explain geographic variations in the use of health care services? A study of three procedures. *JAMA*. 1987;258(18):2533-7.

- [99] Leape LL, Park RE, Solomon DH, Chassin MR, Kosecoff J, Brook RH. Does inappropriate use explain small-area variations in the use of health care services? JAMA. 1990;263(5):669-72.

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