

Safety of Invasive Procedures in End-Stage Liver Disease Patients

Safety of cardiac catheterization in patients with end-stage liver disease awaiting liver transplantation. *Sharma M, Yong C, Majure D, Zellner C, Roberts JP, Bass NM, et al.* Am J Cardiol 2009;103:742-746.

Abstract

Patients with end-stage liver disease (ESLD) are predisposed to bleeding complications due to thrombocytopenia, reduced synthesis of coagulation factors, and increased fibrinolytic activity. The exact incidence of vascular access site and bleeding complications related to cardiac catheterization in this group remains unknown. Eighty-eight consecutive patients with ESLD who underwent left-sided cardiac catheterization from August 2004 to February 2007 were identified. Eighty-one patients without known liver disease matched for age, gender, and body mass index who underwent left-sided cardiac catheterization during the same period were chosen as the control group. Vascular complications were defined as hematoma >5 cm, pseudoaneurysm, arteriovenous fistula, or retroperitoneal bleeding. Patients with ESLD had lower baseline mean hematocrit ($32.3 \pm 6.0\%$ vs $39.2 \pm 6.2\%$, $p < 0.001$) and mean platelet count (90.1 ± 66.3 vs $236.1 \pm 77.1 \times 10^9/L$, $p < 0.001$) compared with controls. They also had higher mean serum creatinine (1.9 ± 1.7 vs 1.2 ± 0.8 mg/dl, $p = 0.002$) and mean international normalized ratio (1.6 ± 0.7 vs 1.1 ± 0.2 , $p < 0.001$). There were more complicated pseudoaneurysms in the patients with liver failure (5.7% [5 of 88]), compared with 0% in controls ($p = 0.029$). Patients with ESLD had lower starting hemoglobin levels and greater reductions in hemoglobin after cardiac catheterization, resulting in greater need for packed red blood cell transfusion (16% vs 4%, $p = 0.008$), fresh frozen plasma (51.7% vs 1.2%, $p < 0.001$), and platelet transfusions (48.3% vs 1.2%, $p < 0.001$). Major bleeding was higher in the ESLD group (14.8% vs 3.7%, $p = 0.014$), driven mainly by the need for blood transfusion. In conclusion, despite severe coagulopathy, left-sided cardiac catheterization may be performed safely in this patient population, with correction of coagulopathy and meticulous attention to procedural technique.

COMMENTS

Patients with end-stage liver disease (ESLD) who are evaluated for liver transplantation will possibly undergo invasive diagnostic procedures. Two of the most

common of these invasive procedures are liver biopsy and cardiac catheterization. Each procedure has an associated risk, but in this high-risk population, can the risk become prohibitive?

The risks and benefits of liver biopsy are well known to healthcare professionals who are primary caretakers of ESLD patients. Al Knawy and Shiffman¹ reviewed percutaneous liver biopsy with respect to the complications of pain, hypotension, hemorrhage, perforation of the gallbladder or colon, pneumothorax, and intrahepatic arteriovenous fistula. In this study, the mortality rate from complications was found to be as high as 0.1%. Pawa et al.² reported that the presence of end-stage renal disease in association with ESLD did not produce an increased risk of complications following percutaneous liver biopsy. Ahmad et al.³ studied the use of transjugular liver biopsy in ESLD patients with end-stage renal disease and found that this technique was safe and caused fewer complications than percutaneous liver biopsy. Sporea et al.⁴ have reminded us that the liver biopsy is not a perfect test.

Care providers who are not primarily involved with ESLD patients but who perform other invasive procedures such as cardiac catheterization are more apprehensive of the possible complications in this high-risk population. One of the complications of cardiac catheterization is contrast-induced nephropathy. The development of renal failure in a potential liver transplantation candidate would significantly increase post-transplant mortality. Mehran et al.⁵ developed a risk score for predicting contrast-induced nephropathy after coronary intervention. These authors identified 8 variables predicting nephropathy, including hypotension, use of the intra-aortic balloon pump, congestive heart failure, chronic kidney disease, diabetes, age > 75 years, anemia, and volume of contrast used. ESLD was not a factor in this analysis, and thus it remains uncertain if the presence of ESLD would increase the incidence of renal dysfunction following cardiac catheterization.

In this review, Sharma et al. studied the safety of cardiac catheterization in patients with ESLD prior to liver transplantation. They studied 129 consecutive patients with ESLD who underwent left-sided catheterization (88 patients) and/or right-sided cardiac catheterization from June 2004 to June 2007. The comparison group consisted of 129 patients (81 with left-sided cardiac catheterization) without ESLD matched for age, gender, and body mass index who underwent cardiac catheterization during the same time period. The tech-

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; EBV, Epstein-Barr virus; ESLD, end-stage liver disease; HAT, hepatic artery thrombosis; ICU, intensive care unit; IgE, immunoglobulin E; MELD, Model for End-Stage Liver Disease.

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nique of cardiac catheterization, including the compression time of the femoral site, was similar in both groups. There were 5 (6%) complicated pseudoaneurysms in the ESLD group and only 1 in the control group. All 5 pseudoaneurysms in the ESLD group required intervention with thrombin injection, open surgical repair, or both. The 1 complicated pseudoaneurysm in the control group required only extended manual compression. There were no intracranial or retroperitoneal hemorrhages in any group. Major bleeding (a decrease in hemoglobin > 3 g/dL or a transfusion of ≥ 2 units of packed red blood cells) was seen in significantly ($P = 0.014$) more patients with ESLD (14.8%) than in controls (3.7%). Significantly ($P < 0.001$) more patients with ESLD required platelet and fresh frozen plasma transfusions than the control group. Right-sided heart catheterization was not associated with major bleeding or transfusion requirements in any group. No mortality data were given in this report.

As the authors point out, this study has the limitations of being confined to a single center and having a retrospective design, and the results should not be generalized to all patients with liver disease. With proper caution, cardiac catheterizations can be performed in this high-risk group.

REFERENCES

1. Al Knawy B, Shiffman M. Percutaneous liver biopsy in clinical practice. *Liver Int* 2007;27:1166-1173.
2. Pawa S, Ehrinpreis M, Mutchnick M, Janisse J, Dhar R, Siddiqui FA. Percutaneous liver biopsy is safe in chronic hepatitis C patients with end-stage renal disease. *Clin Gastroenterol Hepatol* 2007;5:1316-1320.
3. Ahmad A, Hasan F, Abdeen S, Sheikh M, Kodaj J, Nampoory MR, et al. Transjugular liver biopsy in patients with end-stage renal disease. *J Vasc Interv Radiol* 2004;15:257-260.
4. Sporea I, Popescu A, Sirli R. Why, who and how should perform liver biopsy in chronic liver diseases. *World J Gastroenterol* 2008;14:3396-3402.
5. Mehran R, Aymong ED, Nikolsky E, Lasic Z, Iakovou I, Fahy M, et al. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: development and initial validation. *J Am Coll Cardiol* 2004;44:1393-1399.

Acute Physiology and Chronic Health Evaluation Scores for Predicting Outcomes in Urgent Liver Transplants

Clinical value of APACHE scores in patients who require intensive care before liver transplantation. *Park KM, Kim KH, Lee SG, Lee YJ, Hwang S, Ahn CS, et al. Hepatogastroenterology* 2008;55:2135-2139.

Abstract

Background/Aims: Although many prognostic indices have been used to predict outcomes after liver transplantation, the actual correlations between these indices and outcomes are inconsistent. The APACHE

scoring system, which reflects a patient's clinical course, may be a better prognostic indicator of outcomes after liver transplantation. **Methodology:** Of 621 liver transplant recipients from January 2000 through December 2004, 41 adult patients with hepatic failure received ICU care prior to liver transplantation. Their records were analyzed retrospectively and the correlation between APACHE score and mortality after liver transplantation was determined. **Results:** Of the 41 patients with fulminant hepatic failure, 31 survived after liver transplantation. The mean APACHE II scores of the survivors and nonsurvivors differed significantly (22.50 ± 5.89 vs 18.19 ± 5.89 , $p < 0.05$), as did the mean APACHE III scores (100 ± 22.6 vs. 78.3 ± 23.9 , $p < 0.05$). The r^2 value between APACHE III scores and postoperative ICU stay was 0.14. The areas under the receiver operating characteristic (ROC) curve for APACHE II and APACHE III were 0.713 and 0.737 respectively ($P < 0.05$). **Conclusions:** The APACHE scoring systems have significant clinical value in predicting the outcomes after urgent liver transplantation in patients with fulminant hepatic failure.

COMMENTS

A plethora of prognostic tests are available for predicting post-liver transplant survival.¹ Some investigators view prognostic models as imperfect tools for supporting clinical practice, whereas other authors view such models as a hindrance.² Jacob et al.³ conducted a systematic review to assess the quality of studies predicting post-liver transplant mortality. These researchers reviewed 5 published prognostic models and determined that all of them were suboptimal. The area under the receiver operating characteristic curves was below 0.7 in all of the models, indicating their poor discriminatory ability. Jacob et al. concluded that the currently available prognostic models of mortality after liver transplantation can have only a limited role in clinical practice.

One area in which clinical liver transplantation could benefit tremendously from having a reliable prognostic model for posttransplantation survival is the management of patients in the intensive care unit (ICU) who are awaiting transplantation. In this setting, the transplant team is faced with several questions. One question is how to avoid performing a futile liver transplant,⁴ in which a valuable donor organ is transplanted into a patient having little or no chance of survival. The use of Model for End-Stage Liver Disease (MELD) scores to predict post-liver transplant survival in an acute liver failure population has both supporters and detractors.⁴ Brandão et al.⁵ reported that the receiver operating characteristic curve for the MELD score in predicting posttransplant survival was 0.60. What other models can a liver team use to predict liver transplantation survival for ICU patients in urgent need of a liver?

In this review, Park et al. analyze the Acute Physiology and Chronic Health Evaluation (APACHE) score for its ability to predict posttransplant survival in patients requiring an ICU stay prior to liver transplantation. The APACHE scoring system was designed to classify dis-

ease severity and predict prognosis in ICU patients. The APACHE II score uses the variables of age, rectal temperature, heart rate, mean arterial pressure, respiratory rate, oxygenation, arterial pH, serum sodium, potassium, creatinine level, hematocrit, white blood cell count, venous HCO_3^- , and the Glasgow coma scale. The APACHE III score excludes potassium and bicarbonate from the APACHE II score, while adding blood urea nitrogen, glucose levels, albumin, bilirubin, and mean urine output. Park et al. report on 41 adult patients from January 2000 to December 2004 who received ICU care before receiving an urgent liver transplant. Patients undergoing liver-kidney transplantation or liver retransplantation were excluded. Patients receiving living donor liver transplantation were included in the study only if the graft-to-recipient weight ratio was >0.8 . Of the 41 study patients, 33 were males, and 8 were females, with an average age of 45.9 years (range, 20-60 years). Three patients underwent deceased donor liver transplantation, and 38 underwent adult living donor liver transplantation. The mortality rate was 24.3% (10 deaths). There was no difference in the average age between survivors and nonsurvivors. The mean APACHE II scores of the survivors (22.5 ± 5.89) were significantly higher ($P < 0.05$) than those of the nonsurvivors (18.19 ± 5.89). Likewise, the mean APACHE III scores of the survivors (100 ± 22.6) were significantly higher ($P < 0.05$) than those of the nonsurvivors (78.3 ± 23.9). The receiver operating characteristic curve was 0.713 ± 0.092 for the APACHE II scores and 0.737 ± 0.092 for the APACHE III scores.

From Park et al.'s review, it can be seen that the discriminatory ability of both the APACHE II and APACHE III scores was above 0.70. This is better than the ability of some previous models but not high enough to provide certainty when one is making life and death decisions. Until stronger predictive models are developed, the best approach is to use the available models and confirm the findings with mature clinical judgment.

REFERENCES

1. Perkins JD. Plethora of posttransplant survival prognostic models: how useful for clinical practice? *Liver Transpl* 2007;13:619-621.
2. O'Grady JG. Prognostication in acute liver failure: a tool or an anchor? *Liver Transpl* 2007;13:786-787.
3. Jacob M, Lewsey JD, Sharpin C, Gimson A, Rela M, van der Meulen JH. Systematic review and validation of prognostic models in liver transplantation. *Liver Transpl* 2005;11:814-825.
4. Perkins JD. When is a liver transplant futile? *Liver Transpl* 2008;14:899-900.
5. Brandão A, Fuchs SC, Gleisner AL, Marroni C, Zanotelli ML, Cantisani G, et al. MELD and other predictors of survival after liver transplantation. *Clin Transplant* 2009. doi://1111/j.1399-0012.2008.00943.x. Available at: <http://www3.interscience.wiley.com>.

The Evolving Story of New Food Allergies Following Liver Transplantation

Food allergy after liver transplantation in children: a prospective study. *Ozbek OY, Ozcay F, Avci Z, Haberal A, Haberal M. Pediatr Allergy Immunol* 2009. doi://10.1111/j.1399-3038.2009.00867.x. Available at: <http://www3.interscience.wiley.com>.

Abstract

Food allergy has been increasingly reported in children who had orthotopic liver transplantation (OLT). We aimed to conduct a prospective study to investigate the prevalence of sensitizations and food allergy in pediatric OLT recipients. We also aimed to identify potential risk factors. The study group consisted of 28 children (14 male, 14 female, mean age 4.96 ± 0.76 yrs) who had OLT. Total eosinophil count (TEC), total IgE, and specific IgEs were studied before and 3, 6, 12 months after OLT. Six patients (21%) developed multiple food allergies. Mean age of six patients at OLT who developed food allergy was younger compared to the non-food allergy group (10.2 months vs. 68.9 months, $p < 0.05$). Food allergy has been developed within 1 yr in 5, and in 20 months in one patient after OLT. All six patients had cow's milk and egg allergy after OLT. Five children developed wheat, one children developed lentil and another one developed peach allergy in addition to cow's milk and egg allergy. Out of six food-allergic patients after OLT, four children developed Epstein-Barr virus (EBV) infection prior to food allergy. Before OLT, TECs and total IgE levels were not differed among food allergic and non-food allergic patients ($p > 0.05$). Mean of TECs were significantly higher in food allergic group compared to non-food allergic group at each time point after OLT ($p < 0.05$). Though statistically insignificant, mean of total IgE levels were also higher in the food allergic group ($p > 0.05$). These findings suggest that food allergy should be considered after OLT in patients who are younger than 1 yr of age, who developed hypereosinophilia, high total IgE levels or EBV viremia.

COMMENTS

Several reports have discussed the development of new-onset food allergy in posttransplant patients. There have been dramatic reports of the transfer of peanut allergy from a donor to a transplant recipient.^{1,2} This mechanism is thought to be related to the passive transfer of food-specific immunoglobulin E (IgE) antibodies from the donor to the recipient.³ However, most reports have involved the pediatric liver transplant population in which the donors were not food-allergic.^{4,5} In this particular population, the mechanism of the development of new-onset food allergy remains largely unknown, but evidence is evolving.

Levy et al.⁵ evaluated the association of new-onset food allergy in their solid organ transplant center. These authors reviewed 232 children [mean age, 10.8 years (range, 2-18 years)] at their transplant center who received kidney transplants from 1986 to 2005. A re-

view was also conducted of 65 children [mean age, 5.5 years (range, 0.5-17.5 years)] who received liver or combined liver-kidney transplants from 1995 to 2005. The diagnosis of food allergy was based on the clinical symptoms of an immediate hypersensitivity-type reaction and evidence of specific IgE antibodies against suspected foods. None of the 232 children who underwent kidney transplantation acquired a food allergy. Four of the 65 children (6%) who underwent liver ($n = 2$) or combined liver-kidney ($n = 2$) transplantation acquired a new-onset food allergy post-transplantation. All of these 4 patients had received tacrolimus. Three children were 1 to 1.5 years old, and the fourth child was 7 years old. Three of these patients developed multiple food allergies. The authors concluded that the pathogenesis of new-onset food allergy may involve the liver as the organ transplanted and tacrolimus as part of the immunosuppressive protocol.

Boyle et al.⁴ speculated that the liver as the organ transplanted, together with the maturity of the host immune regulatory mechanisms, plays a role in the development of new-onset food allergies. Other investigators have also speculated that tacrolimus may be a factor in the development of new-onset food allergies following transplantation.^{6,7}

This review by Ozbek et al. reports on a prospective longitudinal study investigating the prevalence of sensitization and food allergy in pediatric liver recipients. Ozbek et al. followed 28 children (14 male and 14 female) from September 2004 until February 2008. The patients were between 6 months and 16 years of age, and all received living related donor livers. Factors studied were the total eosinophil count, IgE, and specific IgEs before and 3, 6, and 12 months after liver transplantation. After 1 year, only those children with symptomatic food allergies were followed every 6 months with specific IgEs. Food allergy was diagnosed via a history of immediate type reactions, chronic diarrhea without an evident cause, detectable serum food-specific IgE antibodies, and/or resolution of symptoms after food avoidance. For all donors, a detailed history of atopic diseases was taken before donation. None of the donors had a history of food allergy, and all donors had negative results on food-specific IgE or skin prick tests.

Immunosuppressive therapy was based on tacrolimus in 24 patients, cyclosporine in 3 patients, and sirolimus in 1 patient. Mean follow-up was 25.4 months (range, 12-40 months). Six (21.4%) recipients developed food allergies, and all were on tacrolimus. All children with food allergies were sensitized to more than 1 food. All 6 had cow's milk and egg allergies. Other allergies were demonstrated to wheat, lentils, and peaches. All allergic symptoms resolved with appropriate elimination diets. The mean age of the children who developed a food allergy was significantly ($P < 0.05$) lower at 10.2 ± 3.2 months compared to 68.9 ± 10.1 months. The time periods between transplantation and the onset of food allergy were 2, 6, 6, 12, 12, and 20 months (mean, 9.7 months). The total eosinophil count was not different between those developing food allergies and those not developing allergies before trans-

plantation. At each time point following transplantation, the total eosinophil count was significantly higher in the food allergy patients compared with the non-food allergy patients. Interestingly, 9 patients developed Epstein-Barr virus (EBV) infection after liver transplantation. Four of the 6 patients with food allergies had EBV infection, and 5 of the 22 patients with no food allergy had EBV infection.

Ozbek et al. conclude that young age, liver transplantation, immunosuppressive drugs, gastrointestinal infections, and EBV infections may be the reasons for the development of food allergy. The mechanism speculated for the development of food allergy is breakdown of oral tolerance (immunological ignorance of antigenic food proteins by the systemic immune system). Ozbek et al. caution that a new-onset food allergy should be considered in symptomatic pediatric liver transplant patients younger than 1 year of age who develop hypereosinophilia, high total IgE levels, or EBV viremia.

REFERENCES

1. Phan TG, Strasser SI, Koorey D, McCaughan GW, Rimmer J, Dunckley H, et al. Passive transfer of nut allergy after liver transplantation. *Arch Intern Med* 2003;163:237-239.
2. Khalid I, Zoratti E, Stagner L, Betensley AD, Nemeh H, Allenspach L. Transfer of peanut allergy from the donor to a lung transplant recipient. *J Heart Lung Transplant* 2008;27:1162-1164.
3. Trotter JF, Everson GT, Bock SA, Wachs M, Bak T, Kam I. Transference of peanut allergy through liver transplantation. *Liver Transpl* 2001;7:1088-1089.
4. Boyle RJ, Hardikar W, Tang ML. The development of food allergy after liver transplantation. *Liver Transpl* 2005;11:326-330.
5. Levy Y, Davidovits M, Cleper R, Shapiro R. New-onset post-transplantation food allergy in children—is it attributable only to the immunosuppressive protocol? *Pediatr Transplant* 2009;13:63-69.
6. Lacaille F, Laurent J, Bousquet J. Life-threatening food allergy in a child treated with FK506. *J Pediatr Gastroenterol Nutr* 1997;25:228-229.
7. Hinds R, Dhawan A. Food allergy after liver transplantation—is it the result of T-cell imbalance? *Pediatr Transplant* 2006;10:647-649.

Institution of a Standard Procedure To Prevent Hepatic Artery Thrombosis

Feasibility and effectiveness of a new algorithm in preventing hepatic artery thrombosis after liver transplantation.

Müller SA, Schmied BM, Mehrabi A, Welsch T, Schemmer P, Hinz U, et al. *J Gastrointest Surg* 2009. doi://10.1007/s11605-008-0753-y. Available at: <http://www.springerlink.com>.

Abstract

Introduction: The incidence of hepatic artery thrombosis (HAT) after liver transplantation (LTx) is up to 9% in adult recipients. **Material and Methods:** To minimize HAT, we developed an algorithm that we have

routinely applied since 2001. The algorithm is a cascade of potentially necessary procedures to improve hepatic artery blood flow before proceeding with LTx when arterial blood flow is impaired. Incidence, outcome, and possible therapeutic approaches of HAT were analyzed in prospectively non-controlled collected data during a 5-year period. There were 335 LTx in 299 adults (199 male, 100 female) with a median age of 49.7 years. **Results:** HAT was defined as early and late HAT (diagnosis within or after 30 days following LTx). After a mean follow-up of 17 months, nine HAT were documented (2.7%; five early and four late HAT). Treatment consisted of thrombolysis ($n=1$), surgical thrombectomy ($n=4$), and re-transplantation ($n=4$). Five HAT patients died during follow-up. **Discussion:** Complex arterial reconstruction was associated with HAT compared to branch-patch anastomoses ($P=0.0193$). Median arterial intraoperative blood flow was no risk factor for HAT. One-year patient survival after HAT was 31%. Once HAT occurs, complication rates are high and long-term results are devastating. **Conclusion:** Therefore, we have implemented the presented algorithm, which showed an acceptable HAT rate.

COMMENTS

The focus on quality in healthcare became prominent in the United States following the publication of reports by the Institute of Medicine.^{1,2} Motivated by cutbacks in federal payments for certain complications, and in anticipation of pay-for-performance programs, hospitals are increasingly anxious to redesign healthcare to improve medical quality.³ No clinical service or program is immune to the increasing pressure from hospitals, and liver transplant programs are no exception. However, most transplant professionals would state that we have always tried to provide excellent patient care and have accomplished much to improve the quality of liver transplantation.

Quality programs have created a new language. For example, *lean* used to mean "lower body mass index"; now, it also means "system for quality management."⁴⁻⁶ Quality managers talk about having a toolbox that contains quality improvement methods for improving medical care. These days, it is necessary for the liver transplant community to use the language of quality in addressing our performance improvement efforts. For example, through the use of lean management principles, the healthcare provider is encouraged to standardize the process to eliminate unnecessary variation.

Standardizing the process is exactly what Coelho et al.⁷ was referring to in their discussion of continuous 7-0 sutures versus interrupted 7-0 sutures for hepatic artery anastomosis. These investigators found that hepatic artery thrombosis (HAT) occurred in 10% of recipients who received continuous sutures and in 2% of recipients who received interrupted sutures. Coelho et al. could have articulated their findings in lean terminology by stating that the use of 7-0 sutures in an interrupted manner is the standard process for hepatic artery anastomosis and eliminates unnecessary variation. Similarly, Zheng et al.⁸ concurred that using 7-0

sutures in an interrupted fashion is the best standard technique. Furthermore, to mitigate the complications of HAT, Zheng et al. suggested conducting routine post-transplant ultrasonography for early detection of HAT. However, diagnosing HAT as a defect at this stage might not prevent long-term complications.

In this review, Müller et al. report a new algorithm for detecting a mistake in a hepatic arterial anastomosis before the mistake becomes a defect. After finding a 6.8% incidence of HAT at their institution from 1996 to 2001, the authors designed an algorithm as a risk-reduction strategy. This algorithm attempted to minimize the incidence of HAT by standardizing the surgical procedure. Between December 2001 and December 2006, 335 consecutive whole liver transplants (mean recipient age, 49.7 years) were performed in which the authors strictly followed the algorithm. Hepatic arterial flow was measured intraoperatively, and the new algorithm was followed for flow rates < 150 mL/minute. The first step in the algorithm was intra-arterial injection of a vasodilative drug into the recipient hepatic artery. If the flow rate remained < 150 mL/minute, the portal vein was then clamped for 30 to 60 seconds. If the hepatic arterial flow increased by at least 50%, the splenic artery was then ligated. If the flow still remained < 150 mL/minute, the arcuate ligament was resected, and if the flow continued to be inadequate, an arterial conduit to the aorta was performed. Adherence to this algorithm decreased the authors' incidence of HAT to 2.7%. The interval between liver transplantation and detection of HAT was an average of 66.6 days (range, 2-318). This study suffers from a similar problem experienced by most quality improvement studies, in that these studies use a before/after design with no simultaneous control group. This could cause other confounding changes that resulted in general improvement in medical care over time to not be accounted for in this study design.

Liver transplant programs are engaged in several quality improvement projects using plan/do/study/act or similar tools. Acquiring a new language will help us communicate with our quality improvement colleagues and better highlight the quality efforts of the liver transplant community.

REFERENCES

1. Institute of Medicine Committee on Quality of Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy of Sciences; 2001.
2. Institute of Medicine Committee on Quality of Health Care in America. *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy of Sciences; 2000.
3. Wang MC, Hyun JK, Harrison M, Shortell SM, Fraser I. Redesigning health systems for quality: lessons from emerging practices. *Jt Comm J Qual Patient Saf* 2006;32:599-611.
4. 5S: a lean method to cut the clutter. *OR Manager* 2007; 23:15.
5. Womack JP, Jones DT. *Beyond Toyota: how to root out*

- waste and pursue perfection. *Harv Bus Rev* 1996;74:140-158.
6. Womack JP, Byrne AP, Fiume OJ, Kaplan GS, Toussaint J. *Going Lean in Health Care*. Cambridge, MA: Institute for Healthcare Improvement; 2005.
7. Coelho GR, Leitao AS Jr, Cavalcante FP, Brasil IR, Cesar-Borges G, Costa PE, et al. Continuous versus interrupted suture for hepatic artery anastomosis in liver transplantation: differences in the incidence of hepatic artery thrombosis. *Transplant Proc* 2008;40:3545-3547.
8. Zheng SS, Yu ZY, Liang TB, Wang WL, Shen Y, Zhang M, et al. Prevention and treatment of hepatic artery thrombosis after liver transplantation. *Hepatobiliary Pancreat Dis Int* 2004;3:21-25.

James D. Perkins, M.D., Special Editor
Liver Transplantation Worldwide
University of Washington Medical Center
Seattle, WA