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Transplant Surgery: Do the training wheels ever come off?

Becoming a transplant surgeon requires mastering both operative procedures and management of the patient before and after the operation. Along with the ability to make wise decisions under pressure, a solid foundation in all areas is necessary.

In this issue, Khan et al. analyzed their experience training 11 fellows focusing specifically on the liver transplant operation (1). To evaluate for evidence of a learning curve, they divided fellow experience into two cohorts: Transplants 1 to 45, and 45 to 90. The break point matches the current American Society of Transplant Surgery (ASTS) minimum requirement of 45 liver transplants for fellows completing training in liver transplantation. They report that Total Operative Time (TOT) and Warm Ischemic Time (WIT - the time it took to complete the vascular anastomoses prior to reperfusion) was shorter after the fellow had completed 45 transplants. The incidence of biliary complications (including bile leak) also decreased. The decrease in operative times, while statistically significant, was modest and did not have a clinical impact. Nonetheless, shorter operative time suggests familiarity with the procedure, comfort working with the attending, and potentially components of mastery. The decrease in biliary complications is interesting. While many factors can contribute to biliary complications, the technical aspects of this anastomosis are subtle and include gentle handling of tissue, trimming back the donor and recipient bile ducts, suture placement, and appropriately securing the sutures to achieve gentle tissues approximation without strangulation. It is also possible the variability in biliary complications reflects the impact of multiple comparisons, changes in fellow autonomy/attending

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oversight not captured, or other unappreciated factors. No difference was observed between the two cohorts with respect to other variables including blood loss, vascular complications, reoperation, length of stay and patient and graft survival. The authors subsequently assessed outcomes with greater granularity utilizing sequential 15 transplant increments. There was a consistent decrease in TOT and WIT over sequential cohorts, consistent with a dose-dependent response to experience. The dose dependent response for other outcomes was more variable, but the association with biliary complications remained significant. The observed variability with this more granular analysis suggests many of the outcomes may not be fully attributable to fellow experience.

Improvement with experience or a "learning curve" does not just apply to fellows. A learning curve has been reported for faculty surgeons early in their experience with living donor liver transplantation (2). The field also continues to mature. Indeed, the authors note that TOT, WIT, and biliary complications all decreased when they compared transplants performed with the first 6 fellows to the last 5 fellows suggesting it is not just the fellows who are on a learning curve. Association of outcomes with experience is also not unique to transplantation. Acute care general surgeons with more post training experience appear to have better patient outcomes in emergency general surgery and trauma compared to early career faculty (3). Faculty anesthesiologist experience is associated with fewer perioperative complications following complex gastrointestinal cancer surgery (4). In medicine and life – experience matters.

The subtle implications of this manuscript may not be intuitive, particularly for non-surgeons. Operating fast and operating well are not synonymous and the association of time with outcomes is not causal. In the literature cited by Khan et al, very prolonged warm ischemic time was associated with poor outcomes, but this generally reflects the difficulty of the procedure and technical challenges. As the authors point out, the operative times in this series are well below times that have clinical impact. Additionally, the literature cited reflects transplant experience from two decades ago.

When does the learning curve begin to plateau? As pointed out a variety of domains must be considered. Domains related to technical proficiency may be reached more quickly than those reflecting decision making in the face of uncertainty (wisdom) which may never plateau. While 45 transplants are a minimum requirement, fellows clearly continue to develop after achieving this threshold. Given all the potential nuances and technical variation unique to each patient, performing 60 to 90 transplants during a two-year fellowship is a reasonable goal. Even then, one will never have enough experience to be an independent expert. When is someone an expert? Defining an exact point is elusive but any potential transition to mastery occurs many years after becoming faculty. Importantly, no liver transplant surgeon

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functions as a one-person team and none of us should be above asking for help. We are all on a learning curve. There is growing recognition of the value of ongoing refinement of operative skills and coaching may benefit all surgeons (5).

Similar to our individual learning curves, the ASTS been on a journey to improve fellowship training, both in and out of the operating room. Aside from established program requirements, a formal curriculum has been codified that outlines the knowledge that all fellows should learn. A formal written examination has been implemented to assess if this knowledge has been obtained. In addition to minimum case volumes, program directors are required to attest their fellows have successfully completed their fellowship requirements. To improve assessment of technical skills, the ASTS has developed an evaluation tool based on operative milestones for specific components of each procedure (TABLE 1). The operative procedure is only one part of the training. There is a similar assessment for non-operative milestones. The program faculty review these assessments with fellows during their training to ensure appropriate progress. In effort to formally evaluate fellows, the ASTS will begin formal oral examination of graduates starting in 2022.

Both authors are hopeful that we are not at the end of our learning curves, but we are certain that it takes more than 45 liver transplants to become a fully independent transplant surgeon. We applaud the ASTS for establishing a curriculum and developing approaches to evaluate the nuances that lead to competence both in and outside the OR. We all acknowledge the need for continual self-evaluation, learning, and coaching. More work is needed to facilitate a safe and structured transition from training wheels to independence.

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Disclosure

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TABLE 1.

ASTS Operative Milestone Formative Assessment Specific for Liver Transplant Operative Procedure

Liver Back Table

Back table preparation of an adult whole liver, standard anatomy	_____
Back table preparation of adult whole liver, replaced left arterial anatomy	_____

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Back table preparation of adult whole liver, replaced right arterial anatomy _____

Liver Transplantation

Performs hepatectomy in straightforward case _____

Performs vascular implantation of liver in straightforward case _____

Performs biliary anastomosis _____

Performs implantation into pediatric patient (<25kg or 6 years old) _____

Performs implantation of partial/technical variant liver graft _____

Performs procedure in a technically complex case: portal vein thrombectomy _____

Performs procedure in a technically complex case: arterial conduit _____

Performs procedure in a technically complex case: redo transplant _____

Performs procedure in a technically complex case: veno venous bypass _____

Levels for Assessment Areas Above

1. can describe, but not perform the procedure _____
2. Can perform with senior assistance/significant guidance _____
3. Can perform with minimal oversight or assistance _____
4. Can perform independently _____
5. Can lead a junior trainee through the technique or procedure _____

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