Model for End-Stage Liver Disease–Sodium Score
The Evolution in the Prioritization of Liver Transplantation

Victor Ilich Machicao, MD

KEYWORDS

- Organ allocation • MELD score • MELD sodium score • Liver transplantation
- Waiting-list mortality • Hepatocellular carcinoma • Liver cirrhosis
- Mathematical model

KEY POINTS

- The model for end-stage liver disease (MELD) -based allocation system implemented in 2002 was the first step toward prioritizing liver transplantation for the patients with the highest risk of mortality.
- The incorporation of sodium to the MELD score has made the model stronger in predicting mortality among liver transplant candidates.
- The current allocation system for patients with hepatocellular carcinoma still allows outcome disparity compared with patients without hepatocellular carcinoma.

HISTORICAL PERSPECTIVE: STARTING TO REGULATE LIVER TRANSPLANTATION

It has been more than 50 years since Starzl and colleagues[1] performed the first successful human liver transplantation (LT) in the United States. In the following years, LT gradually established its role as definitive therapy for patients with acute liver failure and end-stage liver disease, and later on for selected patients with hepatocellular carcinoma (HCC). Afterward, the limited availability of cadaveric organs became the main limiting factor for the wider use of LT. At the same time, the increased mortality seen among patients awaiting transplantation became an issue. A system of prioritization was critical in order to reconcile the disparity between supply and demand of organs for transplantation.

The first step to regulate organ allocation for LT came only 3 decades ago. It started with the US Congress passing the National Organ Transplant Act in 1984, which created the Organ Procurement and Transplantation Network (OPTN), as a public-private national nonprofit organization with expertise in organ transplantation and procurement. The OPTN is composed by all organ procurement organizations (OPO) and transplant centers nationwide, voluntary health organizations, and the general public. The immediate task upon creation of the OPTN was to establish a national list of individuals who need organ transplantation and to institute a national system to match organs and individuals included on the list. The United Network for Organ Sharing (UNOS) was incorporated as an independent, nonprofit organization in March 1984. UNOS has served as the OPTN since 1986, after receiving the initial contract to develop the requirements for the operation of the OPTN.

Before 1997, patients with end-stage liver disease were listed for LT by UNOS in each local OPO and were categorized mainly by their inpatient status. Patients requiring hospitalization in an intensive care unit (ICU) were given top priority, followed by hospitalized non-ICU patients, and finally ambulatory patients. Each category was then composed of a large number of patients, which were ranked among them by the waiting time accrued since the day they were placed on the LT waiting list. Therefore, the waiting list time became the most important variable defining priority for LT. Timely referral became fundamental for a patient's chance to receive LT. However, waiting time was a variable completely unrelated to the severity of the underlying liver disease. Patients referred for listing early in their natural history of disease for LT, particularly those with well-compensated cirrhosis, had the advantage of lower mortality risk, which allow them to accrue time on the LT list, compared to sicker patients with decompensated cirrhosis, who carried a higher mortality risk, which did not allow them to survive until an organ could be available. Patients with advanced cirrhosis required staying in the ICU or inpatient hospital status in order to get a reasonable chance of undergoing LT, which was an issue of contention at that time. Accumulating time on the waiting list was the critical measure to receive higher priority for LT at that time.

THE FIRST IMPROVEMENT: CREATION OF THE UNOS STATUS CLASSIFICATION

Child and Turcotte[2] described in 1964 the first classification system for the prediction of survival among patients with cirrhosis complicated by variceal bleeding undergoing portosystemic shunt surgery, which was based on 3 clinical variables: ascites, hepatic encephalopathy, and nutritional status, plus 2 laboratory values: serum bilirubin and albumin. This classification divided patients with cirrhosis into 3 categories, based on their mortality risk for major surgery. In 1973, Pugh and colleagues[3] modified the original Child-Turcotte classification, assigning a score ranging from 1 to 3 to each of the 5 variables and replacing nutritional status by prothrombin time (PT). The modified score was renamed the Child-Turcotte-Pugh (CTP) score. The CTP score was calculated by UNOS based on the severity of ascites, hepatic encephalopathy, PT/international normalized ratio (INR), serum bilirubin, and albumin. Although the CTP score was never prospectively validated, several subsequent studies demonstrated that the CTP score is useful in the prediction of survival among patients with cirrhosis.[4,5]

OPTN/UNOS modified the organ allocation criteria for LT in 1997. Each LT candidate was assigned a status code, corresponding to the degree of medical urgency. For the first time in solid organ transplantation, a medical scoring system to assess disease severity, the CTP score, was incorporated in the definition of these categories.