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MELD 3.0 in Advanced Chronic Liver Disease

Nikhilesh R. Mazumder[1,2] and Robert J. Fontana[1]

[1]Division of Gastroenterology and Hepatology, University of Michigan, Ann Arbor, Michigan, USA; email: mazumde@med.umich.edu, rfontana@med.umich.edu

[2]Gastroenterology Section, Ann Arbor Veterans Affairs Healthcare System, Ann Arbor, Michigan, USA

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Abstract

The MELD (model for end-stage liver disease) 3.0 score was developed to replace the MELD-Na score that is currently used to prioritize liver allocation for cirrhotic patients awaiting liver transplantation in the United States. The MELD 3.0 calculator includes new inputs from patient sex and serum albumin levels and has new weights for serum sodium, bilirubin, international normalized ratio, and creatinine levels. It is expected that use of MELD 3.0 scores will reduce overall waitlist mortality modestly and improve access for female liver transplant candidates. The utility of MELD 3.0 and $PELD_{cre}$ (pediatric end-stage liver disease, creatinine) scores for risk stratification in cirrhotic patients undergoing major abdominal surgery, placement of a transjugular intrahepatic portosystemic shunt, and other interventions requires further study. This article reviews the background of the MELD score and the rationale to create MELD 3.0 as well as potential implications of using this newer risk stratification tool in clinical practice.

ORIGINS OF THE ORIGINAL MELD SCORE

OPTN: Organ Procurement and Transplantation Network

LT: liver transplant

CTP: Child-Turcotte-Pugh

INR: international normalized ratio

MELD: model for end-stage liver disease

TIPS: transjugular portosystemic shunt

AUROC: area under the receiver operating curve

In response to the 1998 Organ Procurement and Transplantation Network (OPTN) Final Rule, the medical community was charged with developing an objective, verifiable, and simple means to rank patients in the United States with decompensated cirrhosis on the liver transplant (LT) waiting list and reduce waitlist mortality (1). At that time, the primary means of risk stratification was the Child-Turcotte-Pugh (CTP) score, which comprised both subjective (severity of ascites and encephalopathy) and objective (albumin, bilirubin, and INR) parameters (2). Simultaneously, the model for end-stage liver disease (MELD) score was developed from a data set of 231 patients with cirrhosis undergoing transjugular intrahepatic portosystemic shunt (TIPS) placement for refractory ascites or variceal bleeding (1, 3) (**Figure 1**). The original score included total bilirubin, international normalized ratio (INR), and serum creatinine levels along with the etiology of liver disease as independent predictors of 90-day post-TIPS mortality and was superior to the CTP score (4). Subsequently, Kamath et al. reported on the original MELD score with two etiology groups for predicting 90-day mortality in LT candidates (5) (**Table 1**). The MELD score was further refined and simplified, and cirrhosis etiology was eliminated, when the model was tested in 3,437 US adult LT candidates (6). In that data set, the MELD score was again superior to the CTP score (AUROC of 0.83 versus 0.76) in predicting 90-day survival. In addition, the patients who died awaiting LT had a higher MELD score compared to those undergoing LT or still waiting at 90 days. Due to its superior performance, the MELD score was adopted by the OPTN on February 27, 2002 as the primary risk stratification tool used in national liver allocation policy to rank candidates over the age of 12. Furthermore, wait time was removed as a major determinant of organ allocation except as a tie breaker for patients with the same laboratory MELD score. MELD provides a continuous risk score that can vary from a value of 6 to 40, which was an advantage compared to the subjective, categorical CTP score (range 5 to 15). Patients who were on renal replacement therapy were assigned a maximum creatinine value of 4.0 mg/dL.

During its development, the MELD score was a more important determinant of 90-day survival than the presence of a portal hypertensive complication such as ascites, variceal bleeding, and hepatic encephalopathy. This was especially true at high scores. However, at lower scores MELD

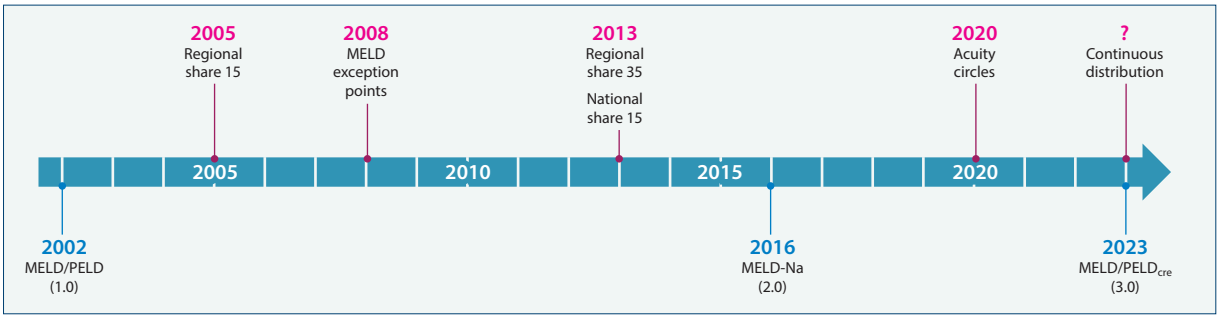

Figure 1

Evolution of the MELD scoring system and OPTN liver allocation policies in the United States. To minimize waitlist mortality, MELD/PELD scores were implemented in 2002 as an objective means to risk stratify LT candidates. MELD-Na scoring was adopted in 2016 to account for the impact of hyponatremia on waitlist mortality. The new MELD 3.0 incorporates serum albumin levels and gender for adults, while PELD$_{cre}$ includes serum creatinine and other coefficient updates for children. Refinements of the MELD/PELD scoring systems along with changes in OPTN policy governing the allocation of livers have led to increased sharing of donor organs and fewer waitlist deaths over the past 20 years while maintaining excellent post-LT outcomes. Abbreviations: LT, liver transplant; MELD, model for end-stage liver disease; OPTN, Organ Procurement and Transplantation Network; PELD, pediatric end-stage liver disease.

Table 1 Performance characteristics of MELD, MELD-Na, and MELD 3.0 prognostic scores derived from waitlisted American liver transplant candidates

Scoring model	MELD (2002)	MELD-Na (2016[a])	MELD 3.0 (2023)
Development cohort	Nov. 1999 to Dec. 2001	Jan. 2005 to Dec. 2009	Jan. 2016 to Dec. 2018
Sample size	3,437 LT candidates	34,685 LT candidates	29,410 LT candidates
Clinical characteristics	Med. age = 50.7 (r:18–79) 68% Male 70% Caucasian 36% Hepatitis C 28% Alcohol 11% Cryptogenic 6% Hepatitis B 5% Autoimmune	Med. age = NR[b] 64% Male 73% Caucasian 31% Hepatitis C 27% Alcohol 9% Cholestatic 34% Other	Med. age = 58.0 (r:51–64) 63% Male 70% Caucasian 29% Alcohol 20% Viral hepatitis 19% NASH 10% Cholestatic/Autoimmune 21% Other
Waitlist deaths	412 (12%)	1,850 (6.7%)	513 (5.8%)
Component variables	Ln INR Ln T. bilirubin Ln creatinine	Ln INR Ln T. bilirubin Ln creatine Sodium if 125 to 137 meq/L	Ln INR Ln T. bilirubin Ln creatinine Sodium if 125 to 137 meq/L Albumin if 1.5 to 3.5 g/dL T. bilirubin-sodium interaction Albumin-creatinine interaction Female gender
Score range	6 to 40	6 to 40	6 to 40
Model features	Creatinine cap 4.0 mg/dL T. bilirubin, creatinine, and INR lower bound 1.0	Creatinine cap 4.0 mg/dL T. bilirubin, creatinine, and INR lower bound 1.0 Na lower bound 125 meq/L Na upper bound 137 meq/L	Creatinine cap 3.0 mg/dL T. bilirubin, creatinine, and INR lower bound 1.0 Na lower bound 125 meq/L Na upper bound 137 meq/L Albumin lower bound 1.5 g/dL Albumin upper bound 3.5 mg/dL
Model performance (c-statistic)	0.83 versus 0.76 (CTP)	0.868 versus 0.858 (MELD)	0.869 versus 0.862 (MELD-Na)

[a]Data provided courtesy of Ray Kim, MD and the Scientific Registry of Transplant Recipients (SRTR Report on MELD Enhancement Subcommittee of the Liver Intestine Transplantation Committee October 2010).
[b]Not reported but 5% 18–34, 25% 35–49, 61% 50–64, 10% ≥ 65.
Abbreviations: CTP, Child-Turcotte-Pugh; INR, international normalized ratio; Ln, natural logarithm; LT, liver transplant; Med, median; MELD, model for end-stage liver disease; NASH, nonalcoholic steatohepatitis; NR, not reported; T, total.

was worse at predicting mortality than hyponatremia and ascites alone (7, 8). Since some LT candidates with a low MELD score still had a substantial risk of pre-LT mortality, such as those with hepatocellular carcinoma, metabolic liver disease, or hepatopulmonary syndrome, the OPTN allowed for the assignment of an arbitrary MELD exception score based upon standardized criteria. Subsequent studies demonstrated that this shift to a MELD-based liver allocation system reduced waitlist mortality by 3.5% with improved distribution of livers across epidemiological and demographic strata. There was no associated decrease in post-LT survival with "taking the sickest patients first" as mandated by the Final Rule (9, 10). In 2002, a separate model termed the pediatric end-stage liver disease (PELD) score was also adopted to minimize pediatric waitlist mortality (9). The PELD score includes the variables of age, serum bilirubin, serum albumin, INR, and growth status for LT candidates under the age of 12 and was also superior to the CTP score.

PELD: pediatric end-stage liver disease

MODEL REFINEMENTS AND THE MELD-NA SCORE

eGFR: estimated glomerular filtration rate

Over time it became apparent that, while MELD and PELD scores represented an average improvement in risk prediction for LT candidates, they were less reliable in patients with lower scores. For instance, MELD scores were not as effective in predicting poor outcomes among LT candidates with lower scores and concomitant hyponatremia and ascites (7, 8). Additionally, the MELD score underestimates mortality in patients with biliary diseases such as primary sclerosing cholangitis and primary biliary cholangitis (5). While there was initial enthusiasm about using a low MELD score (<15) to rule out the need for transplant, this too fell by the wayside as it was recognized that certain patients would benefit from LT (11, 12). Last, geographic disparities were being recognized: In some areas, even patients with very high MELD scores were succumbing to death on the waitlist due to long wait times (13, 14).

Due to observed continued inequities in access to transplantation, several refinements to OPTN organ allocation policy were implemented to better prognosticate an individual patient's risk of death (**Figure 1**). In 2013, mandatory regional sharing of organs for patients with a MELD score of 35 or higher was implemented and led to substantial reduction (>30%) in high-risk patient waitlist mortality (15). In 2016, a criterion of serum sodium levels was introduced by adoption of the MELD-Na score for allocating livers; this revised model was superior to MELD score in predicting waitlist mortality (8, 16) (**Table 1**). Subsequent follow-up studies demonstrated that use of the MELD-Na helped to further reduce waitlist mortality (17). Other changes to lessen geographic variation included further mandated regional sharing of organs based on MELD scores ≥15 and creation of a national liver review board to further standardize MELD exception scores.

Despite this, continued regional discrepancies in the median MELD-Na score at the time of LT and waitlist mortality were reported (18). For example, in 2017 the median MELD-Na score at LT varied from 19 to 36 in differing parts of the country (18). As a result, "acuity circles" were introduced in February 2020 that overcame historical, state-based Organ Procurement Organization boundaries (**Figure 1**). This new system uses concentric circles of 50 to 500 miles for organ offers based upon the MELD-Na score of the potential recipient. Recent reports from the OPTN have demonstrated increased LT rates for patients with high MELD-Na scores and decreased geographic variability in median scores at LT using acuity circle–based liver allocation (19, 20).

THE NEED FOR AN UPDATE TO THE MELD-NA SCORE

Despite the utility of the MELD-Na score, its accuracy has been declining, and it fails to accurately predict outcomes for several subgroups of patients (21, 22). This loss of accuracy may, in part, be due to the changing waitlist composition, which now includes a higher proportion of patients with alcoholic liver disease and nonalcoholic steatohepatitis as compared to hepatitis B and C (**Figure 2**) than when the original MELD score was developed (**Table 1**). Furthermore, waitlisted patients are older and have more nonliver comorbidities, which may confound the ability of MELD-Na to predict mortality. In addition, compared to male LT candidates, female candidates appear to have a disproportionally higher risk of waitlist mortality in studies that control for MELD-Na score (23, 24). This may be due to the lower serum creatinine levels observed in women with a smaller muscle mass, and their generally smaller size reducing their access to appropriately sized deceased donor organs. At the same time, the presence of sarcopenia and frailty were increasingly recognized as MELD-independent predictors of waitlist mortality, but these factors are difficult to quantify and measure (25). To remove sex- and sarcopenia-related impacts on creatinine, estimated glomerular filtration rate (eGFR) was suggested to replace creatinine, but this change introduces problems with racial differences (21).

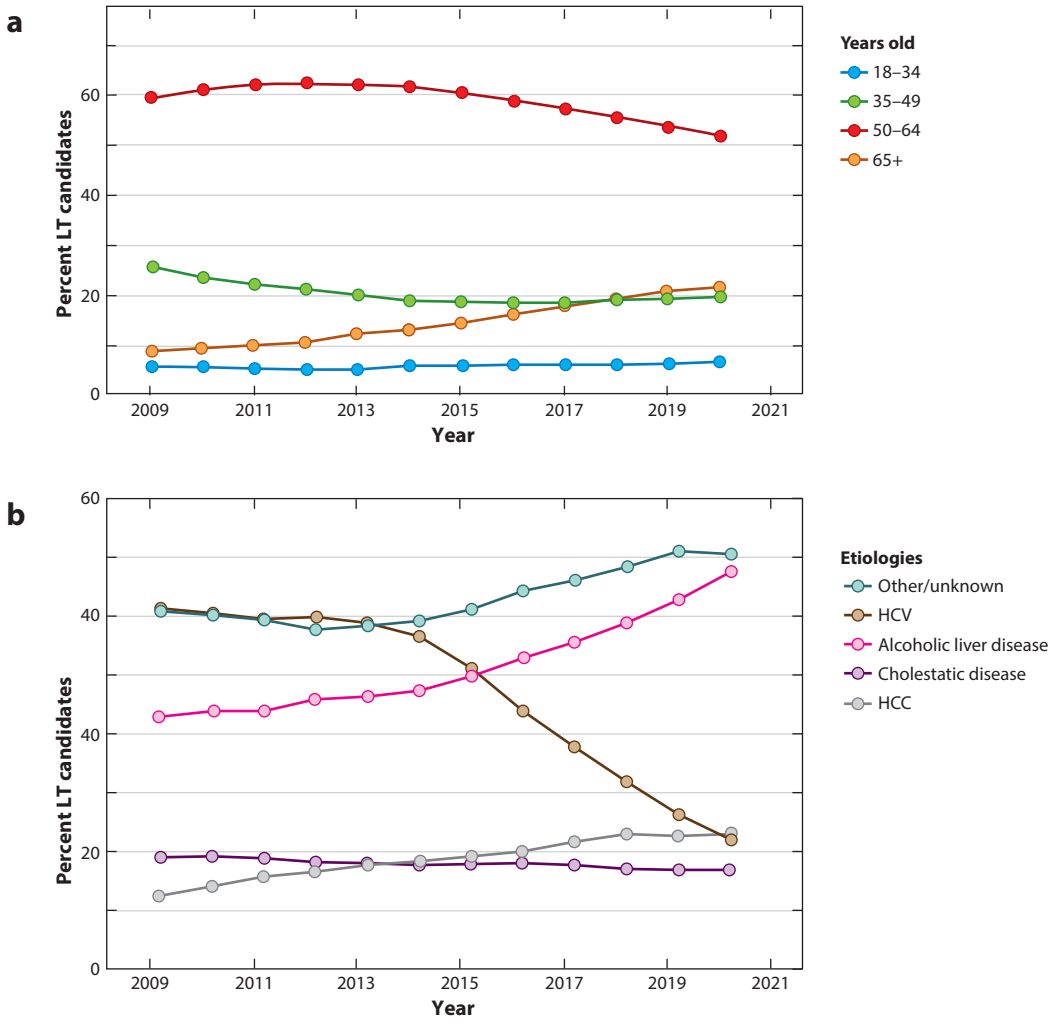

Figure 2

Age and etiologies of liver failure among American LT candidates over time. (*a*) Since 2019, the median age of LT candidates has continued to increase, with a decline in the proportion of younger patients (18 to 34 years) and a significant increase in the proportion over the age of 65. (*b*) The etiologies of liver failure have also evolved over time, with a marked increase in the proportion of patients with alcoholic cirrhosis and NASH and a simultaneous decline in the proportion with HCV cirrhosis due to the widespread uptake of safe and effective antiviral agents. Abbreviations: HCC, hepatocellular carcinoma; HCV, hepatitis C virus; LT, liver transplant; NASH, nonalcoholic steatohepatitis. Data adapted from Reference 46 with permission.

With this background, the OPTN set out to determine if the MELD-Na scoring system could be further improved in a more modern cohort of LT candidates to minimize waitlist mortality (26). The resulting MELD 3.0 model was designed to better predict 90-day waitlist survival and to improve disparities among candidates.

DEVELOPMENT OF THE MELD 3.0 SCORE

To address the limitations of the MELD-Na score, Kim et al. proposed the MELD 3.0 score in 2021 (26). They utilized data from the publicly available OPTN database that included adult

LT candidates waitlisted in the United States between January 15, 2016 and December 31, 2018. They excluded patients who had previously undergone transplant, were under the age of 18, or were listed for multi-organ transplant. They internally validated their model using a 70:30 split of development:validation, resulting in a validation set of 8,823 patients. The primary outcome was waitlist mortality, including delisting due to being too sick. They utilized a Cox regression model which models time-to-event and patients were censored at the end of 90 days, at transplantation, or if they acquired exception points. The study was designed to cast a wide net for possible predictors and included age, sex, race, serum sodium, creatinine, eGFR, INR, bilirubin, albumin, and height. Kim et al. (26) had two main goals: (*a*) to create an enhanced model of waitlist mortality and (*b*) to rescale this to MELD-Na (minimum of 6) and determine if significant reclassification was achieved. Finally, they compared the simulated effect on nationwide waitlist mortality using the liver simulated allocation model, a standard model provided by the Scientific Registry of Transplant Recipients.

In the process of creating MELD 3.0, several important findings were noted during variable selection. First, eGFR was removed from consideration as a substitute for creatinine since eGFR is typically calculated using race and sex, which were already included and may cause colinearity concerns. More significantly, conventional methods for determining eGFR such as MDRD-4 (Modification of Diet in Renal Disease-4) and CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) yield higher eGFR rates for black patients at the same creatinine (27, 28). This would likely magnify known disparities for black patients in access to liver transplantation, which has been a persistent issue (29, 30). Additionally, newer iterations of eGFR are planned that are race-independent using serum cystatin C levels, but this method is not yet widely used in transplant listing (31). Ultimately, Kim et al. (26) decided to exclude race altogether.

Next, they considered height and sex. Women were found to have a higher rate of waitlist mortality, which has been previously described and attributed to liver-related mortality (23, 32–34). This was especially true in that risk for women, but not men, varied with height. Ultimately, the authors determined that sex, not height, was a useful variable to include for the final model. Last, the implications of including serum albumin levels were addressed. While traditionally thought of as a marker of nutrition and sarcopenia, albumin is now well known to be an important marker of inflammation and liver synthetic function, and its infusion is critical in many situations (35–37). Serum albumin has been considered for inclusion in the MELD score since its inception, given its power to predict outcomes among patients with cirrhosis (5, 38, 39). However, albumin infusion is a first-line treatment for patients with cirrhosis and acute kidney injury or spontaneous bacterial peritonitis (36, 37). Thus, Kim et al. (26) performed a sensitivity analysis to determine the contribution of albumin to the MELD 3.0 score in anticipation of the conflict between administering albumin for an acute indication and lowering allocation score.

Kim et al. (26) then proceeded to create the MELD 3.0 model and found a small but significant improvement in waitlist mortality compared to MELD-Na. Their optimal model includes sex, bilirubin, sodium, INR, creatinine, and albumin as well as sodium–bilirubin and albumin–creatinine interaction terms. After scaling to match the distribution of MELD-Na score for comparison, they noted a significant but incremental improvement in the overall c-statistic from 0.862 to 0.869 (**Table 1**). This small improvement was similar in magnitude among the subgroups of patients by different etiologies of liver disease. When applied to a more recent group of 10,459 listed patients in 2019, MELD 3.0 continued to show a small but significant improvement in predicting 90-day waitlist mortality (0.8682 versus 0.8641, $p = 0.02$). Similarly, when application of the MELD 3.0 algorithm was simulated nationally via the Liver Simulated Allocation Model, MELD 3.0 reduced the estimated number of anticipated waitlist deaths from 7,850 to 7,778 (0.7% reduction). This benefit over MELD-Na was lost when albumin was removed from MELD 3.0.

The effect of MELD 3.0 was best seen among patients who died on the list, but inference is somewhat limited by small numbers. Among the validation set of 8,823, only 514 (5.8%) patients died within 90 days. MELD 3.0 up-categorized 62 of these patients and down-categorized 17 patients with a net improvement of 45/514 (8.8%) deaths. Notably, MELD 3.0 had a more profound effect on reclassifying women, with a net improvement in 33/221 (14.9%) deaths compared to 12 (4.1%) in men. Extending this to national waitlist mortality, an improvement of 8.8% would be expected to avert approximately 20 deaths per year. For comparison, the 2016 implementation of the sodium addition to the original MELD score was projected to avert approximately 66 deaths per year (40).

The MELD 3.0 score has several interaction terms that add complexity to its interpretation but may contribute to its improved prognostic accuracy compared to the MELD-Na score. Statistically, an interaction term signifies that the effect of one predictor variable on waitlist mortality is not independent of other predictors. Interaction terms are not a new feature of the MELD system; in fact, serum sodium acts as a de facto interaction term with the original MELD score to calculate MELD-Na (41). Specifically, patients with MELD scores less than 11 are not allowed to receive hyponatremia points. MELD 3.0 contains an albumin–creatinine interaction term that, in this case, tempers the effect of hypoalbuminemia at higher creatinine values. The authors comment that this effect may help avert unintended consequences for high MELD patients who require albumin for acute situations such as spontaneous bacterial peritonitis or acute kidney injury (37).

ANTICIPATED IMPACT OF MELD 3.0 ON THE PRACTICE OF LIVER TRANSPLANTATION

Despite the issues mentioned above, the MELD 3.0 score was ultimately accepted and implemented for transplant allocation in 2023. The MELD 3.0 score provides an overall improvement in up-classification of decedents over the MELD-Na score. Although this improvement is about one-third the benefit that was attained after the 2016 transition to MELD-Na score, the benefit of MELD 3.0 over MELD-Na is statistically significant and comes at no additional cost, only requiring the collection and recording of patient sex and albumin level. Second, this benefit is experienced by all patients, but more so by female patients (14.9% up-classified), who have been identified as having inferior waitlist outcomes (23, 32–34). This benefit may also extend more generally to other settings in which there is a different mix of cirrhosis etiologies, such as in Asia (42). Last, uncapping the MELD 3.0 score, so that a score above 40 is possible, may further expand its predictive power (43).

However, caution should be exercised, as interactions may be two-sided and issues remain with regard to sodium and albumin. The MELD 3.0 equation directly incorporates sodium as a predictor, in contrast to the MELD-Na calculation, which is post hoc adjustment of the MELD score. For instance, a female patient with a bilirubin level of 4 mg/dL, INR of 1.2, creatinine of 1.0 mg/dL, albumin of 1.5 mg/dL, and serum sodium of 135 meq/L would have a MELD-Na score of 15 and a MELD 3.0 score of 20. Albumin infusion can increase serum albumin by as much as 1.5 mg/dL with once-weekly administration and can feasibly be raised even higher than the allowed maximum of 3.5 mg/dL in the MELD 3.0 equation (26, 44, 45). Assuming that iatrogenic infusion increases albumin to 3.0, a MELD 3.0 score would drop from 20 to 17 (**Table 2**). This may seem like a small drop, but considering that the waitlist is skewed toward lower–MELD score patients, this may pose a significant disadvantage for the listed patient with a low MELD score receiving albumin (46). Examples of MELD 3.0 changes after albumin infusion can be found in **Table 2**. Indeed, prior studies in the MELD-Na era have suggested that more than three-quarters of patients on the list have a MELD score below 20, and the most recent data

Table 2 Examples of MELD 3.0 score change after albumin infusion among female patients with a simulated increase in albumin of 0.7 and 1.5 g/dL

		Low risk	Intermediate risk		High risk
Laboratory values	Bilirubin, mg/dL	2.5	4	6.0	12.0
	Na, mmol/L	136	135	131	128
	INR	1.0	1.2	1.5	2.2
	Creatinine, mg/dL	1.2	1.0	1.5	2.8
	Albumin, g/dL	2.6	1.5	2.2	2.0
Scores	MELD	12	14	22	35
	MELD-Na	13	16	26	36
	MELD 3.0	16	20	27	39
MELD 3.0 after treatment	Albumin increase +0.7 g/dL	14	19	27	39
	Albumin increase +1.5 g/dL	14	17	26	39

from 2020 show that 99% of listed patients have a MELD-Na score below 30, the majority below 20 (46–48).

The impact of albumin infusions is not as prominent at higher MELD 3.0 scores by design. For instance, a female patient with a bilirubin measurement of 6 mg/dL, INR of 1.5, creatinine of 2 mg/dL, albumin of 1.5 g/dL, and serum sodium of 130 meq/L would have a MELD-Na score of 28 and a MELD 3.0 score of 31. The latter would only decrease to 30 with an increase in serum albumin to 3.5 mg/dL, a trivial change. As the MELD 3.0 score is implemented, an important issue will be how to handle the relative loss in standing on the transplant list with albumin infusion. Mitigating this issue is the less frequent need for recertification among patients with lower MELD scores who are listed for transplant. For now, albumin remains a lifesaving medication in the context of decompensated cirrhosis and should not be withheld if clinically indicated (36, 37).

The new MELD 3.0 score also has implications for pediatric transplant. For instance, the MELD 3.0 score is proposed for organ allocation among 12–17-year-olds and is superior to MELD-Na in this age group as well (49).

MELD 3.0 IN OTHER CHRONIC LIVER DISEASE SCENARIOS

Numerous studies have explored the utility of MELD and MELD-Na scores in predicting outcomes in non–transplant candidates with varying causes of liver disease, but it remains to be seen if MELD 3.0 will add benefit (50–53). For example, the prognostic ability of the MELD score in cases of alcohol-related hepatitis and liver injury are well known (52, 53). Several studies have used MELD scores as a prognostic marker for patients with acutely decompensated hepatitis B prior to initiating rescue oral antiviral therapy. Similarly, MELD and MELD-Na scores have shown benefit in identifying cirrhotic patients with hepatocellular carcinoma at risk for further liver disease worsening with various locoregional therapies (54–56). MELD scores have also been tested as a convenient model to prognosticate short-term outcomes in patients with acute liver failure and drug-induced liver injury. These studies demonstrate moderate discriminatory ability compared to other bedside clinical and laboratory indices (57–59).

In addition to the MELD 3.0 score, other modifications of the MELD score have been proposed. The MELD-Lactate score has been shown to improve inpatient mortality risk prediction over MELD scores, but this has not been validated in ambulatory outpatients (60, 61). Other iterations have attempted to improve the accuracy of MELD and MELD-Na by incorporating sarcopenia, measures of liver function, or trajectory over time (62–65).

In regard to TIPS placement, MELD-Na cut-off scores of 18 to 22 are frequently used to identify patients at high risk of post-TIPS worsening hepatic decompensation or death (66, 67). However, more recent studies have begun to also recognize the importance of medical comorbidities in TIPS candidates and the importance of subject age and serum albumin levels prior to TIPS placement (67–69). To date, only one study of 885 patients undergoing TIPS for gastrointestinal bleeding demonstrated a better AUROC for MELD 3.0 compared to MELD and MELD-Na scores in predicting mortality (70). This non–peer-reviewed study suggested that MELD 3.0 may have better discriminatory ability, but further studies are needed.

The MELD score has also been tested as a predictor for short-term mortality and clinical decompensation in cirrhotic patients undergoing urgent abdominal surgery. Although high MELD score is a sign of poor prognosis, at low scores the MELD is a poor prognostic marker, and this may be the reason why, for presurgical risk stratification, the CTP score typically outperforms it (71). Newer models such as the VOCAL-Penn score that account for the type of surgery, its urgency, and medical comorbidities appear to perform better than the MELD score (69).

Going forward, prospective studies that capture preinterventional laboratory components of MELD 3.0 as well as clinical variables (e.g., age, gender, comorbidity index) will be needed to develop better models. In addition, artificial intelligence– and machine learning–based approaches to predicting clinical outcomes in patients with advanced chronic liver disease hold promise as being potentially superior or complementary to MELD scores (72–74). Further research is needed to delineate the potential boost in prediction compared to the MELD 3.0 score.

SUMMARY POINTS

1. The MELD score was developed in 2002 to provide a unified, objective, verifiable, and simple means to allocate livers to waitlisted patients.
2. The MELD-Na score, which incorporates serum sodium levels along with total bilirubin, INR, and creatinine levels, led to improved 90-day waitlist mortality following implementation in 2016.
3. Due to the evolving demographics and etiologies of cirrhosis in LT candidates (**Figure 2**), the MELD-Na score no longer adequately reflects 90-day mortality and has perpetuated disparities in waitlist mortality, particularly among smaller female LT candidates.
4. The MELD 3.0 score includes total bilirubin, INR, creatinine, and sodium levels as well as new inputs of patient gender and serum albumin levels that should lead to a further reduction in 90-day waitlist mortality among US LT candidates.
5. The utility of MELD 3.0 and $PELD_{cre}$ scores for risk stratification in cirrhotic patients undergoing major abdominal surgery, TIPS placement, and in other natural history cohorts requires further study.

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