MELD 3.0 Score For Predicting Survival in Patients With Cirrhosis After Transjugular Intrahepatic Portosystemic Shunt Creation

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Research Article

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Abstract

Background/purpose: Evaluate the efficacy of transjugular intrahepatic portosystemic shunt (TIPS) in patients with cirrhosis is important and challenging. To validate the Model for End-Stage Liver Disease (MELD) 3.0 score in predicting mortality in patients with cirrhosis after TIPS creation.

Methods: A total of 885 consecutive patients with cirrhosis from December 2011 to October 2019 who underwent TIPS placement were retrospectively reviewed. The prognostic value of the MELD 3.0 score, MELD score, MELD-Na score and Child-Pugh score was calculated and compared with Receiver operating characteristic (ROC) curve and DeLong et al. test.

Results: The AUROC of the MELD 3.0 score in predicting 3-month mortality was 0.732 (0.702-0.761), which were significantly superior to the MELD score (0.671 [0.639-0.702]; $P = 0.019$) and MELD-Na score (0.678 [0.647-0.709]; $P = 0.009$). A MELD 3.0 score of 10 could be used as a cut-off point for discriminating high- and low-risk patients. The MELD 3.0 score could stratify patients with Child-Pugh grade A (log-rank $P = 0.005$) and B (log-rank $P < 0.001$). Child-Pugh score could stratify patients defined as low risk by MELD 3.0 score (log-rank $P = 0.010$).

Conclusions: The MELD 3.0 score was significantly superior to the MELD and MELD-Na scores in predicting mortality in patients with cirrhosis after TIPS creation.

Introduction

Transjugular intrahepatic portosystemic shunt (TIPS) is widely used to treat portal hypertension related complications, including variceal hemorrhage and refractory ascites[1, 2]. Studies have shown that the 3-month mortality after TIPS is up to 27.0%, which is significantly associated with poor liver function reserve in this group of patients[3, 4]. Currently, many scores are used to evaluate and screen patients receiving TIPS[5–7]. As demographics change and medical technology advances, it is necessary to adjust the scoring system accordingly. Recently, in order to further improve the screening ability of the Model for End-Stage Liver Disease (MELD) score in liver allocation, Kim and colleagues established a new MELD 3.0 score system with more accurate predictive prognostic ability[8]. Sex and albumin levels were added to this new scoring system. This system still ensures that every data element is objective, verifiable and auditable for policy implementation[9]. The new score is more predictive, reclassifying approximately 9% of patients on the liver transplant waiting list to have a greater chance of receiving a liver transplant and reducing waiting list deaths by at least 20 per year. Given that the MELD 3.0 score is such an excellent prognostic tool, the purpose of this study is to explore MELD 3.0 score for predicting survival in patients with cirrhosis after TIPS creation.

Patients And Methods

Patients

An electronic inpatient case database was searched and a total of 965 patients who received de novo TIPS implantation between December 2011 and October 2019 were screened. Patients with technical failure (n = 25) and lost to follow-up (n = 55) were excluded. Eventually, 885 patients were enrolled in the study. Pre-procedure laboratory parameters, image information and operation notes were systematically sorted through the medical record system, while the date of death, liver transplantation, or the last follow-up was determined. The primary outcome was 3-month mortality after TIPS creation. The second outcomes were 1-year and 2-year mortality after TIPS implantation.

This single institution retrospective study was approved by the institutional review committee. Informed consent was obtained from all individual participants included in the study. The study conforms to the 1975 Declaration of Helsinki (6th revision, 2008).

TIPS Procedures

TIPS procedures were performed under two experienced interventional radiologist using conventional technique by general anesthesia. From the right jugular vein approach, the liver set (RUPS-100, Cook, Bloomington, USA) was introduced into the right hepatic vein. Once the portal vein access was established, portography was performed to show the entire portal system. An 8×60 mm balloon catheter (Cordis, Roden, the Netherlands) was used to dilate the intrahepatic tract. Eight-millimeter polytetrafluoroethylene (PTFE) coated stents (Fluency Plus, Bard&BD, Murray Hill, USA) were placed with or without the use of an 8-mm bare stent (Cordis, Roden, the Netherlands). After June 2019, we adopted GORE VIATORR TIPS Endoprosthesis covered stent graft (W.L. Gore, Flagstaff, AZ, USA). The portosystemic pressure gradient (PSG) pre- and post-procedure was measured.

Scores and Statistical Analyses

The MELD score was calculated as $6.43 + 9.57 \cdot \log_e \text{creatinine (mg/dL)} + 3.78 \cdot \log_e \text{bilirubin (mg/dL)} + 11.2 \cdot \log_e \text{INR}$. Values of creatinine, bilirubin, or INR less than 1 were set to 1 [10]. The MELD-Na score was given by $\text{MELD} + 1.32 \cdot (137 - \text{Na}) - [0.033 \cdot \text{MELD} \cdot (137 - \text{Na})]$. The upper and lower limits of Na are 137 and 125 mmol/L, respectively [11]. The MELD 3.0 was defined as $1.33 \text{ (if female)} + 4.56 \cdot \log_e \text{ (bilirubin)} + 0.82 \cdot (137 - \text{Na}) - 0.24 \cdot (137 - \text{Na}) \cdot \log_e \text{ (bilirubin)} + 9.09 \cdot \log_e \text{ (INR)} + 11.14 \cdot \log_e \text{ (creatinine)} + 1.85 \cdot (3.5 - \text{albumin}) - 1.83 \cdot (3.5 - \text{albumin}) \cdot \log_e \text{ (creatinine)} + 6$, which is rounded to the nearest integer. Consistent with prior versions of MELD, bilirubin, INR and creatinine values below 1.0 were set to 1.0. The lower and upper bounds of Na value were the same to MELD-Na. For serum albumin, lower and upper bounds of 1.5 g/dL and 3.5 g/dL, respectively, were selected. [8]

Continuous variables are expressed as mean with SD. Categorical variables were expressed as frequencies and percentages. Differences in continuous variables were determined using ANOVA; otherwise, Wilcoxon Mann-Whitney tests were used. Chi-square tests and Fisher's exact tests were used to analyze categorical variables. Receiver operating characteristic (ROC) curve analyses were performed to investigate the discriminative ability of the prognostic models, and the DeLong et al. test was used for pairwise comparison. According to the area under the receiver operating characteristic curve (AUROC) of MELD 3.0

to find the optimal cut-off value. Kaplan-Meier survival curves were then created. In the subgroup analysis, the AUROC of each prognostic score was compared in patients with viral, nonviral cirrhosis and nonhepatocellular carcinoma, and in patients whose TIPS were created for variceal bleeding. Statistical calculations were performed using SPSS (Version 25.0; IBM, New York, NY), MedCalc Statistical Software (Version 20.0.3; MedCalc Software Ltd, Ostend, Belgium) and GraphPad Prism (Version 8; GraphPad Software, San Diego, CA). *P* values less than 0.05 were considered statistically significant.

Results

Baseline Characteristics

A total of 885 patients with cirrhosis who received TIPS in our hospital from December 2011 to October 2019 were included. The main causes of chronic liver disease were hepatitis B virus (HBV) infection (549 cases, 62.0%), alcoholic liver disease (111 cases, 12.5%), autoimmune liver disease (95 cases, 10.7%) and hepatitis C virus (HCV) infection (38 cases, 4.3%). The indications for TIPS treatment were secondary prevention of variceal hemorrhage in 807 cases (91.2%) and refractory ascites in 57 cases (6.4%), and others such as hepatic pleural effusion, portal venous thrombosis and hepatorenal syndrome in 21 cases (2.4%). Hepatocellular carcinoma was found in 36 of 885 patients (4.1%). The mean MELD score was 10.6 ± 2.9 , and 676 patients (76.4%) had MELD scores ≤ 12 . The mean MELD-Na and MELD 3.0 scores were 11.0 ± 3.4 and 11.0 ± 3.8 , respectively. The mean Child-Pugh score was 7.3 ± 1.6 , 312 (35.3%), 506 (57.2%), and 67 (7.6%) patients were graded as Child-Pugh A, B, and C, respectively. The pre-TIPS PSG decreased from 18.1 ± 6.1 mm Hg to 7.2 ± 3.0 mm Hg after TIPS placement ($P < 0.001$). The overall mortality at 3-month, 1-year and 2-year was 3.7%, 5.2%, 7.9% and 14.4%, respectively. Baseline features of the study cohort are summarized in Table 1.

Table 1

Patient demographics and transjugular intrahepatic portosystemic shunt (TIPS) procedure details

Characteristic	Value
Age	51.5±11.5
Gender (%)	
Male	601(67.9%)
Female	284(32.1%)
Cause of liver disease (%)	
HBV	549(62.0%)
HCV	38(4.3%)
Alcoholic	111(12.5%)
PBC/AIH	95(10.7%)
Other	92(10.4%)
Ascites	603(68.1%)
Hepatic encephalopathy before TIPS	12(1.4%)
Hepatocellular carcinoma	36(4.1%)
Laboratory	
Bilirubin (mg/dL)	1.3±0.8
Albumin (g/L)	33.4±5.8
Creatinine (mg/dL)	0.8±0.5
International normalized ratio (INR)	1.3±0.2
Sodium (mmol/L)	139.7±5.6
Indication for TIPS (%)	
Varices	807(91.2%)
Ascites	57(6.4%)
Others	21(2.4%)
PSG before TIPS (mmHg)	17.9±9.8
PSG after TIPS (mmHg)	7.4±5.1

Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus; PBC, primary biliary cholangitis; AIH, autoimmune hepatitis; PSG, portosystemic gradient.

Characteristic	Value
Child-Pugh score	7.3±1.6
A	312(35.3%)
B	506(57.2%)
C	67(7.6%)
MELD score	10.6±2.9
MELD-Na score	11.0±3.4
MELD 3.0	11.0±3.8
Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus; PBC, primary biliary cholangitis; AIH, autoimmune hepatitis; PSG, portosystemic gradient.	

Prognostic Discrimination

The AUROC of the MELD 3.0 score in predicting 3-month, 1-year and 2-year mortality were 0.732 (0.702-0.761), 0.715 (0.684-0.745) and 0.666 (0.634-0.697), respectively, which were significantly superior to the MELD score (0.671 [0.639-0.702]; $P = 0.019$), (0.672 [0.640-0.703]; $P = 0.012$) and (0.620 [0.587-0.652]; $P = 0.003$) and MELD-Na score (0.678 [0.647-0.709]; $P = 0.009$), (0.672 [0.640-0.703]; $P = 0.003$) and (0.617 [0.584-0.650]; $P < 0.001$). The AUROC of the Child-Pugh score in predicting 3-month, 1-year and 2-year mortality were 0.753 (0.724-0.782), 0.706 (0.675-0.736) and 0.665 (0.633-0.696), respectively, which seems comparable to MELD 3.0. However, there was no significant difference compared with MELD 3.0, MELD and MELD-Na scores (Table 2; Fig. 1).

Table 2
AUROC of scores for prediction of different survival endpoints

	MELD 3.0	MELD	MELD-Na	Child-Pugh
3-month mortality	0.732(0.702-0.761)	0.671(0.639-0.702)	0.678(0.647-0.709)	0.753(0.724-0.782)
		0.019*	0.009	0.618
1-year mortality	0.715(0.684-0.745)	0.672(0.640-0.703)	0.672(0.640-0.703)	0.706(0.675-0.736)
		0.012	0.003	0.752
2-year mortality	0.666(0.634-0.697)	0.620(0.587-0.652)	0.617(0.584-0.650)	0.665(0.633-0.696)
		0.003	0.000	0.971
*AUROC (95% CI) P Value, P value against MELD 3.0 score.				

Sub-analyses revealed that MELD 3.0 score yielded higher AUROC in predicting 3-month, 1-year and 2-year mortality (0.720, 0.734 and 0.683) in patients with HBV-related cirrhosis than either MELD score (0.682, 0.688 and 0.644) or MELD-Na score (0.682, 0.685 and 0.638) (Table S1). The same trend was observed in patients with nonviral cirrhosis (Table S2). MELD 3.0 score also yielded higher AUROC in patients with nonhepatocellular carcinoma (0.760, 0.725 and 0.666) than either MELD score (0.703, 0.686 and 0.621) or MELD-Na (0.715, 0.688 and 0.620) (Table S3). MELD 3.0 score had better AUROC in patients whose TIPS were created for variceal bleeding (0.721, 0.703 and 0.662) than either MELD score (0.672, 0.672 and 0.625) or MELD-Na score (0.663, 0.658 and 0.617) (Table S4). However, Child-Pugh showed similar efficacy to MELD 3.0 in all subgroups.

Optimal Cut-off Value for Risk Stratification

The area under the receiver operating characteristic curve analysis showed that a MELD 3.0 score of 10 best predicted 3-month, 1-year and 2-year mortality after TIPS placement. Therefore, we stratified the risk of patients undergoing TIPS with a MELD 3.0 score of 10 as a cut-off value. There was a significant difference in survival between high-risk (>10) and other patients in our cohort ($P < 0.001$ for log-rank test of Kaplan-Meier's survival curve; Fig. 2A). Similarly, Child-Pugh score could also achieve effective risk stratification through its grading system (log-rank $P < 0.001$; Fig. 2B). Since all patients with Child-Pugh grade C had MELD 3.0 score > 10 , we attempted to explore the risk stratification effect of MELD 3.0 in patients with low Child-Pugh score. The MELD 3.0 score could significantly discriminate patients with high and low risk in Child-Pugh grade A (log-rank $P = 0.005$; Fig. S1A) and B (log-rank $P < 0.001$; Fig. S1B) subgroups. Conversely, Child-Pugh score could also stratify the risk of patients defined as low risk by MELD 3.0 score (log-rank $P = 0.010$; Fig. S1C).

Discussion

To the best of our knowledge our study is the first to investigate the prognostic value of the MELD 3.0 score in patients with TIPS creation. In our cohort, MELD 3.0 score showed robust effects not only in predicting short-term mortality, but also in predicting medium- and long-term mortality, and was significantly superior to MELD and MELD-Na scores.

It is well known that patients treated with TIPS often have decompensated cirrhosis, and these patients always have very poor liver function and high mortality[12]. Diverting blood from the liver through TIPS creation may further exacerbate liver damage and increase mortality[1]. Careful pre-procedure assessment and risk stratification could tell clinicians which patients need more careful care post-procedure. In 2000, the MELD score was first established to predict 3-month mortality in patients with TIPS creation and to assess liver function reserve[10]. MELD has also shown robust efficacy in cirrhotic patients who have not received TIPS placement and was used in liver allocation in 2002 to ensure objectivity and fairness[13]. Data show that serum sodium level is an independent predictor of mortality

in cirrhotic patients awaiting transplantation[14]. Therefore, the MELD-Na scoring system was established and used for liver allocation[11].

However, changes in epidemiology of liver disease and advances in medical technology require us to re-examine the clinical usefulness of the current score. In addition, women are at a disadvantage in the current system. It has been reported that women with the same MELD score were significantly less likely to receive a transplant than men[15]. This was associated with an overestimation of glomerular filtration rate (GFR) in serum creatinine, thus underestimating the risk of mortality in women compared to men with the same creatinine[16]. Based on the above reasons, MELD 3.0 was established by Kim et al. to predict 3-month survival. In the new model, sex and albumin levels were taken into account. Impaired liver function is known to lead to reduced albumin synthesis, and hypoproteinemia has been shown to be associated with prognosis. Renal impairment occurs in 20% of patients with decompensated cirrhosis, and previous studies have shown to be significantly associated with survival. However, in patients with reduced renal function, the MELD score may overestimate the risk of death[17]. In the MELD 3.0 model, the overestimation of mortality was partially offset by the addition of creatinine and albumin level interaction terms and the reduction of the upper limit of creatinine levels from 4.0 mg/dL to 3.0 mg/dL. These factors all improved the predictive accuracy of MELD 3.0. In our cohort, the MELD 3.0 was significantly superior to the MELD and MELD-Na scores in predicting 3-month survival, and it was also found to be significantly superior in predicting middle- and long-term survival. Furthermore, subgroup analyzes demonstrated that the discriminant ability of MELD 3.0 score was better than that of MELD and MELD-Na scores.

Although previous studies have shown that MELD score was superior to Child-Pugh score in this setting[10, 18]. However, in our cohort, MELD 3.0 and Child-Pugh scores showed similar discrimination. On the contrary, recent studies by Wang et al. and Kraglund et al. concluded that Child-Pugh score was superior to MELD score[19, 20]. The reasons of that may be due to the limitation of MELD score. Differences in the International standardized ratio (INR) between laboratories can lead to differences of up to 12 points in MELD scores[21]. Almost 10% of patients with MELD scores less than 12 may still develop early hepatic failure after TIPS creation[22].

Considering that our cohort was Chinese patients, our cohort had better liver function reserve compared with Kim's cohort, which can be seen from MELD score (median 10 vs. 16) and Child-Pugh score (median 7 vs. 9). So based on our cohort, we found that a MELD 3.0 score of 10 can be used as a cut-off point for discriminating high- and low-risk patients. Another interesting finding was that using this cut-off value, MELD 3.0 score was able to stratify patients with Child-Pugh grades A and B. Conversely, Child-Pugh score could also stratify the risk of patients with MELD 3.0 score < 10. These results suggest that MELD 3.0 score and Child-Pugh score are complementary in identifying high-risk patients.

Our study inevitably has some limitations that need to be discussed. First, it was a single center retrospective analysis which included 885 patients. Previous studies have assessed prognostic scores in patients with TIPS creation in a relatively small number of patients. However, we are a large tertiary center

and receive the vast majority of patients from Western China. Results derived from these data are more reliable. In addition, it should be noted that patients with HBV-related cirrhosis accounted for the vast majority of our cohort. In subgroup analysis of patients with HBV-related cirrhosis, MELD 3.0 score still maintained significant superiority. However, this superior performance was reduced in the nonviral cirrhosis subgroup. This may also suggest that these results appear to be more applicable to patients with HBV-related cirrhosis.

In conclusion, our cohort showed that the MELD 3.0 score was significant superior to the MELD and MELD-Na scores not only in predicting short-term mortality but also medium- and long-term mortality in patients with TIPS creation. This study also confirms that the scoring system is worthy of clinical application. This supports the MELD 3.0 score as a useful tool to determine whether patients should be considered for TIPS implantation. However, since the vast majority of patients treated with TIPS in our cohort were patients with HBV-related cirrhosis, the predictive power of this new score for post-TIPS mortality in patients with other etiology needs further exploring.

Declarations

Compliance with Ethical Requirements

Conflict of interest

The authors declare that they have no conflict of interest

Ethical Approval

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent for publication

For this type of study, consent for publication is not required.

Availability of data and material

The data generated during the current study are available from the corresponding author on reasonable request.

Code availability

Not applicable.

Author contributions

The idea of the article was designed by Xuefeng Luo. Material preparation, data collection and analysis were performed by Jinlei Song, Xiaoze Wang, Yuling Yan and Tong Xiang. The first draft of the manuscript was written by Jinlei Song. All authors read and approved the final manuscript.

References

1. Rössle M. **TIPS: 25 years later.** *J Hepatol*, 2013, **59**:1081–1093.
2. de Franchis R, Baveno VIF. **Expanding consensus in portal hypertension: Report of the Baveno VI Consensus Workshop: Stratifying risk and individualizing care for portal hypertension.** *J Hepatol*, 2015, **63**:743–752.
3. Bettinger D, Schultheiss M, Boettler T, Muljono M, Thimme R, Rössle M. **Procedural and shunt-related complications and mortality of the transjugular intrahepatic portosystemic shunt (TIPSS).** *Aliment Pharmacol Ther*, 2016, **44**:1051–1061.
4. Sarwar A, Zhou L, Novack V, Tapper EB, Curry M, Malik R, Ahmed M. **Hospital volume and mortality after transjugular intrahepatic portosystemic shunt creation in the United States.** *Hepatology*, 2018, **67**:690–699.
5. Ronald J, Wang Q, Choi SS, Suhocki PV, Hall MD, Smith TP, Kim CY. **Albumin-bilirubin grade versus MELD score for predicting survival after transjugular intrahepatic portosystemic shunt (TIPS) creation.** *Diagnostic and Interventional Imaging*, 2018, **99**:163–168.
6. Sturm L, Praktiknjo M, Bettinger D, Huber JP, Volkwein L, Schmidt A, Kaeser R *et al.* **Prognostic Value of the CLIF-C AD Score in Patients With Implantation of Transjugular Intrahepatic Portosystemic Shunt.** *Hepatol Commun*, 2021, **5**:650–660.
7. Young S, Rostambeigi N, Golzarian J, Lim N. **MELD or Sodium MELD: A Comparison of the Ability of Two Scoring Systems to Predict Outcomes After Transjugular Intrahepatic Portosystemic Shunt Placement.** *AJR Am J Roentgenol*, 2020, **215**:215–222.

8. Kim WR, Mannalithara A, Heimbach JK, Kamath PS, Asrani SK, Biggins SW, Wood NL *et al.* **MELD 3.0: The Model for End-stage Liver Disease Updated for the Modern Era.** *Gastroenterology*, 2021.
9. Wiesner R, Edwards E, Freeman R, Harper A, Kim R, Kamath P, Kremers W *et al.* **Model for end-stage liver disease (MELD) and allocation of donor livers.** *Gastroenterology*, 2003, **124**:91–96.
10. Malinchoc M, Kamath PS, Gordon FD, Peine CJ, Rank J, ter Borg PC. **A model to predict poor survival in patients undergoing transjugular intrahepatic portosystemic shunts.** *Hepatology*, 2000, **31**:864–871.
11. Leise MD, Kim WR, Kremers WK, Larson JJ, Benson JT, Therneau TM. **A revised model for end-stage liver disease optimizes prediction of mortality among patients awaiting liver transplantation.** *Gastroenterology*, 2011, **140**:1952–1960.
12. D'Amico G, Garcia-Tsao G, Pagliaro L. **Natural history and prognostic indicators of survival in cirrhosis: a systematic review of 118 studies.** *J Hepatol*, 2006, **44**:217–231.
13. Kamath PS, Wiesner RH, Malinchoc M, Kremers W, Therneau TM, Kosberg CL, D'Amico G *et al.* **A model to predict survival in patients with end-stage liver disease.** *Hepatology*, 2001, **33**:464–470.
14. Biggins SW, Kim WR, Terrault NA, Saab S, Balan V, Schiano T, Benson J *et al.* **Evidence-based incorporation of serum sodium concentration into MELD.** *Gastroenterology*, 2006, **130**:1652–1660.
15. Locke JE, Shelton BA, Olthoff KM, Pomfret EA, Forde KA, Sawinski D, Gray M *et al.* **Quantifying Sex-Based Disparities in Liver Allocation.** *JAMA Surg*, 2020, **155**:e201129.
16. Allen AM, Heimbach JK, Larson JJ, Mara KC, Kim WR, Kamath PS, Therneau TM. **Reduced Access to Liver Transplantation in Women: Role of Height, MELD Exception Scores, and Renal Function Underestimation.** *Transplantation*, 2018, **102**:1710–1716.
17. Alessandria C, Gaia S, Marzano A, Venon WD, Fadda M, Rizzetto M. **Application of the model for end-stage liver disease score for transjugular intrahepatic portosystemic shunt in cirrhotic patients with refractory ascites and renal impairment.** *Eur J Gastroenterol Hepatol*, 2004, **16**:607–612.
18. Angermayr B, Cejna M, Karnel F, Gschwantler M, Koenig F, Pidlich J, Mendel H *et al.* **Child-Pugh versus MELD score in predicting survival in patients undergoing transjugular intrahepatic portosystemic shunt.** *Gut*, 2003, **52**:879–885.
19. Wang Q, Bai W, Han G. **Freiburg index of post-TIPS survival: the first score for individual prediction and a complementary tool for risk stratification.** *J Hepatol*, 2021.
20. Kraglund F, Gantzel RH, Jepsen P, Aagaard NK. **External validation of the Freiburg index of post-TIPS survival.** *J Hepatol*, 2021.
21. Tripodi A, Chantarangkul V, Primignani M, Fabris F, Dell'Era A, Sei C, Mannucci PM. **The international normalized ratio calibrated for cirrhosis (INR(liver)) normalizes prothrombin time results for model for end-stage liver disease calculation.** *Hepatology*, 2007, **46**:520–527.
22. Luca A, Miraglia R, Maruzzelli L, D'Amico M, Tuzzolino F. **Early Liver Failure after Transjugular Intrahepatic Portosystemic Shunt in Patients with Cirrhosis with Model for End-Stage Liver Disease Score of 12 or Less: Incidence, Outcome, and Prognostic Factors.** *Radiology*, 2016, **280**:622–629.

Figures

Figure 1

ROC AUC curve analysis of MELD 3.0, MELD, MELD-Na and Child-Pugh scores in predicting mortality at 3-month(A), 1-year(B) and 2-year(C).

Figure 2

Freedom from death after TIPS creation stratified by MELD 3.0 score (A) and Child-Pugh grade (B).

Supplementary Files

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