



Nomogram for predicting pathologic complete response after transarterial chemoembolization in patients with hepatocellular carcinoma

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Background: The pathologic responses to transarterial chemoembolization (TACE) in patients with hepatocellular carcinoma (HCC) are heterogeneous and result in disparate outcomes. The study aimed to establish and validate an effective nomogram for predicting pathologic complete response (PCR) after TACE.

Methods: We analyzed the clinicopathologic characteristics of HCC patients undergoing hepatectomy following TACE. Variables with statistical significance in a multivariate logistic regression analysis were incorporated in the nomogram.

Results: We detected PCR in 64 (50.4%) patients in the training cohort and 18 (37.5%) patients in the validation cohort. Univariable and multivariable logistic regression revealed that hepatitis B virus (HBV) DNA load ($P=0.031$), α -fetoprotein (AFP, $P=0.040$), maximum tumor diameter ($P=0.003$), preoperative TACE session ($P=0.026$), and modified Response Evaluation Criteria in Solid Tumors (mRECIST) complete response ($P=0.030$) were identified as significant predictors of PCR. Incorporating these 5 factors, a nomogram was developed which attained concordance indexes of 0.80 [95% confidence interval (CI): 0.72–0.87] and 0.82 (95% CI: 0.68–0.95) for predicting PCR in the training and validation cohorts, respectively.

Conclusions: The easy-to-use nomogram achieved a good post-TACE prediction of PCR in HCC patients. Using the model, patients who would benefit most from TACE could be identified, and the subsequent appropriate procedures could be guided accordingly.

Keywords: Nomogram; hepatocellular carcinoma (HCC); pathologic complete response (PCR); transarterial chemoembolization (TACE)

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Introduction

Hepatocellular carcinoma (HCC) is a common malignancy and the second most frequent cause of cancer-related death worldwide (1). The European Association for the Study of the Liver (EASL) and American Association for the Study of Liver Diseases (AASLD) clinical guidelines recommend that liver resection, liver transplantation and, radiofrequency ablation should be considered in patients at Barcelona Clinic Liver Cancer (BCLC) stage A. Transarterial chemoembolization (TACE) is recommended as the first-line treatment for unresectable HCC, the bridge strategy for liver transplantation and downstaging therapy for curative hepatectomy with Child-Pugh class A or B and good performance (1-3). It can also be performed in HCC patients at BCLC stage A who are not feasible for surgery or ablation for reasons such as old age, tumor location, personal willingness, and so on (4).

A recent study reported that the local HCC response to the initial TACE correlates well with the efficacy of subsequent treatments, even the prognosis of the patients (5). Therefore, the accurate estimation of HCC response to TACE may be of great clinical significance, because it can evaluate the therapeutic efficacy and help surgeons choose appropriate subsequent procedures. Although TACE has been widely performed in clinical practice, the responses to TACE are heterogeneous and it is still unclear and controversial which group of patients has optimal HCC responses and benefit most from TACE (6). Histopathological examination is considered a gold standard for the evaluation of HCC response. Unfortunately, histopathological examination depends on surgical specimens that can only be obtained after liver resection or transplantation. Many clinical standards on the assessment of HCC response to TACE have been made over the past decade, including the World Health Organization (WHO) criteria (7) and modified Response Evaluation Criteria in Solid Tumors (mRECIST) guideline (8). However, such evaluation criteria mainly depend on imaging examination, sometimes leading to discrepancies when compared to pathological examination results. The accuracy of radiological examination may be significantly decreased by the dense lipiodol accumulation in HCC lesions after TACE, which may mask tumoral enhancement and make the detection of viable tumors difficult on contrast-enhanced computed tomography (CT) (9). In addition, peritumoral inflammation resulting from TACE can also lead to false-positive diagnoses of tumoral necrosis on

contrast-enhanced magnetic resonance imaging (MRI) (10). In previous studies, the sensitivity of contrast-enhanced CT was 36–72% and that of contrast-enhanced MRI was 43–85%, in detecting residual viable HCC compared with the histopathologic examination (11,12). Inaccurate evaluation of HCC response may contribute to detrimental consequences, especially misleading the clinician to select the wrong subsequent procedures.

Due to the lack of a reliable and convenient predictive method, developing a model for predicting pathologic complete response (PCR) after TACE in patients with HCC based on preoperative clinicopathologic data becomes desirable. Compared with other predictive models, a nomogram can provide an individualized, intuitive, easy-to-use, and highly accurate estimation based on a combination of variables. The purpose of this study was to identify predictive factors associated with PCR after TACE in HCC patients. Furthermore, we aimed to establish and externally validate a nomogram by using readily available clinical variables to predict the possibility of PCR after TACE. We present the following article in accordance with the TRIPOD reporting checklist (available at <https://dx.doi.org/10.21037/atm-21-1120>).

Methods

Patients

In this study, we enrolled 2 independent cohorts of HCC patients who were treated with liver resection following TACE. The training and validation cohorts were composed of consecutive patients, and their data were retrospectively reviewed at the Eastern Hepatobiliary Surgery Hospital from October 2014 to December 2019 and at Mengchao Hepatobiliary Hospital of Fujian Medical University from June 2014 to April 2020, respectively. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the institutional ethics board of Eastern Hepatobiliary Surgery Hospital (No.: EHBHKY2020-K-028) and by the ethical review board of Mengchao Hepatobiliary Hospital of Fujian Medical University (No.: 2019-063-01). All patients gave written informed consent for their data to be used for research purpose.

The inclusion criteria were as follows: (I) HCC was preoperatively diagnosed using radiological tests (contrast-enhanced CT or MRI of the abdomen) and postoperatively confirmed by pathological examinations; (II) BCLC stage

A or B; (III) Child-Pugh A liver function; (IV) complete clinicopathologic data. Patients who received any preoperative anticancer treatments other than TACE were excluded.

Preoperative examinations

Demographics and preoperative examinations of patients included age, gender, routine blood test, liver function test, hepatitis B surface antigen (HBsAg), hepatitis B virus (HBV) DNA load, serum α -fetoprotein (AFP) level, preoperative TACE session, presence of cirrhosis, maximum tumor size, tumor number and BCLC stage. The preoperative S index was calculated using gamma-glutamyl transferase (GGT), platelet (PLT) and albumin (ALB) [S-index: $1,000 \times \text{GGT}/(\text{PLT} \times \text{ALB}^2)$]. Measurement of maximum tumor diameter and tumor number were based on the preoperative contrast-enhanced CT or MRI scan.

Preoperative and postoperative response-evaluation

Due to conventional TACE and drug-eluting bead TACE (DEB-TACE) having been reported to have equal effects in some large multicenter randomized controlled trials, all transarterial therapies in our study were categorized as TACE for analysis (13,14). All preoperative imaging examinations were reviewed independently by 2 experienced radiologists who were blinded to patients' clinical data.

Dense compact lipiodolization with complete disappearance of any intratumoral enhancement on CT scan, or no enhancement of all target lesions on MRI was defined as the complete response of mRECIST (8). When the categorization of radiologic response was not definite, a final judgement was made via consensus of the 2 radiologists. Liver resection was performed at least 1 month after the most recent TACE. The indications and contraindications of hepatectomy were similar to the previous study (15). Two experienced hepatic pathologists, blinded to the preoperative clinical and radiologic data, independently measured the percentage necrosis of each target lesion, using the slice of the maximum diameter at 20 \times magnification on slides stained with hematoxylin and eosin (16). Any disagreements regarding the necrotic extent evaluation between the pathologists were settled by discussion, and a final standard pathologic report was generated. PCR was defined as 100% necrosis of each target lesion. Cirrhosis was confirmed by histopathological examination of the noncancerous part of the resected specimens according to the Meta-analysis of Histological

Data in Viral Hepatitis (METAVIR) classification (17). Microvascular invasion and its pathological grading were not available because they could not be evaluated in PCR.

Statistical analysis

Statistical analysis was conducted using SPSS software (version 25.0; IBM Corp., Armonk, NY, USA) and R project (version 4.0.2; R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were expressed as mean (SD) and compared using two-tailed independent *t*-test. Categorical variables were presented as frequencies (percentages), and compared using the chi-square (χ^2) test or Fisher's exact test. Data in the training cohort were assessed by univariate logistic regression analysis for identifying variables associated with PCR. Multivariable logistic regression analyses were carried out on variables that reached $P < 0.05$ at univariate analysis. A *P* value < 0.05 (two-tailed) was considered to indicate statistical significance for each analysis.

A nomogram was constructed based on the results of multivariable logistic regression analysis, using the rms package of R. The nomogram has a reference line on the peak for scoring of each predictor from a 0- to 100-point scale. The variables were displayed with a scale that visually revealed the relative weight and predicted probabilities of PCR. To quantify the predictive performance of the nomogram, concordance index (C-index) and calibration with 1,000 bootstrap samples were calculated to reduce the overfit bias (18). Generally, a C-index value higher than 0.75 represents relatively good discrimination.

Validation of the nomogram

The prediction model formed in the training cohort was applied to the validation cohort to validate and evaluate the predictive power of the nomogram. Based on the nomogram, the total scores of each patient were calculated. Then, receiver operating characteristic (ROC) curve analysis was performed to calculate the optimal cutoff value of the total scores, determined by the maximum value of the Youden index (i.e., sensitivity + specificity - 1).

Results

Clinicopathologic characteristics

127 and 48 HCC patients undergoing liver resection after

TACE were consecutively enrolled into the training and validation cohorts during the study period, respectively. The baseline clinicopathologic characteristics of the training and validation cohorts are listed in *Table 1*. The majority of the baseline clinicopathologic data were similar between the 2 cohorts. The validation cohort had significantly larger tumor size and more tumor numbers. More advanced BCLC stage was more frequently observed in the validation cohort. PCR after TACE was found in 64 (50.4%) and 18 (37.5%) patients in the training and validation cohorts, respectively.

Identification of prognostic factors of predicting PCR after TACE in HCC patients

Univariate analysis revealed that low HBV-DNA ($P=0.002$), low AFP ($P=0.004$), small tumor diameter ($P<0.001$), multiple preoperative TACE sessions ($P=0.041$) and mRECIST complete response ($P=0.007$) were identified as significant predictive factors of PCR. In multivariate analysis, HBV-DNA load $\leq 1 \times 10^2$ IU/mL [odds ratio (OR), 3.42; 95% CI: 1.58–7.40; $P=0.002$], AFP ≤ 20 ng/mL (OR, 3.06; 95% CI: 1.44–6.50; $P=0.004$), maximum tumor diameter ≤ 5 cm (OR, 4.48; 95% CI: 1.52–7.96; $P<0.001$), multiple preoperative TACE sessions (OR, 2.37; 95% CI: 1.04–5.44; $P=0.041$), and mRECIST complete response (OR, 2.79; 95% CI: 1.32–5.89; $P=0.007$) were independently associated with PCR (*Table 2*).

Development and validation of a PCR-predicting nomogram

The predicting nomogram that contained all the independent predictive factors for PCR is shown in *Figure 1*. The C-index for PCR prediction in the training cohort was 0.80 (95% CI: 0.72–0.87). In addition, the calibration plot showed good agreement on PCR between the prediction by nomogram and the actual observation by histopathologic examination (*Figure 2*).

The nomogram also displayed a C-index of 0.82 (95% CI, 0.68–0.95) for the estimation of PCR, and the calibration curve showed good consistency between prediction and observation in the probability of PCR in the validation cohort (*Figure 3*).

Predictive accuracy of the PCR-predicting nomogram

The optimal cut-off values of the total nomogram scores

in training and validation cohorts were 169 and 149, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio and negative likelihood ratio for predicting PCR were 85.9%, 60.3%, 68.4%, 81.0%, 2.2 and 0.2 in the training cohort, and 83.3%, 76.7%, 78.1%, 82.1%, 3.6 and 0.2 in the validation cohort, respectively.

Discussion

Current advice states that TACE is used as the first-line treatment for some HCC patients at BCLC stage A or B and can improve selected patients' prognosis (19,20). It has already been found that PCR of HCC patients who underwent TACE strongly predict tumor-free survival after liver transplantation (21). However, the pathologic responses of HCC to TACE are substantially different, even at the same BCLC stage, which would render distinct survival outcomes (5,6). Thus, there is an urgent need to develop precise predicting tools to evaluate pathologic response after TACE. Our study revealed that post-TACE factors, including HBV-DNA load $\leq 1 \times 10^2$ IU/mL, AFP ≤ 20 ng/mL, maximum tumor diameter ≤ 5 cm, multiple TACE sessions and mRECIST complete response, are significantly associated with PCR.

Previously, a series of studies were carried out to predict the PCR by using preoperative clinical, laboratory and radiological data. The mRECIST, which was established a decade ago, is still extensively used to evaluate the therapeutic effect of solid tumors through radiological examination (8). However, in assessing HCC responses to TACE treatment, arterio-portal shunts, adjacent hepatic inflammation, coagulative hemorrhage, and the masking effect of lipiodol accumulation can influence arterial enhancement and make it difficult to diagnose the residual viable tumor (12,22,23). Recently, a small sample-size study attempted to detect residual viable HCC based on measuring the density of iodine depositions after TACE (24). Unfortunately, lipiodol accumulation is affected by tumor vascularity and lipiodol uptake, which may limit its utility in clinical practice (25). In addition, response evaluation that depends merely on radiological examination may be influenced by the radiologists' subjective judgment, leading to misdiagnosis (26). Recently, Peng *et al.* (27) used residual convolutional neural network to develop a model for predicting response to TACE. Although the deep learning model had high accuracy, the study focused only on intermediate-stage HCC, and this model required specific

Table 1 Baseline clinicopathologic characteristics in the training and validation cohorts

Variables	Cohort, No. (%)		P value
	Training (n=127)	Validation (n=48)	
Age, mean (SD), years	50.9 (10.3)	52.6 (12.5)	0.398
Sex			
Male	110 (86.6)	38 (79.2)	0.224
Female	17 (13.4)	10 (20.8)	
HBsAg			
Positive	110 (86.6)	37 (77.1)	0.125
Negative	17 (13.4)	11 (22.9)	
HBV-DNA, IU/mL			
$\leq 1 \times 10^2$	83 (65.4)	30 (62.5)	0.725
$> 1 \times 10^2$	44 (34.6)	18 (37.5)	
AFP, ng/mL			
≤ 20	81 (63.8)	24 (50.0)	0.097
> 20	46 (36.2)	24 (50.0)	
PLT, $\times 10^3/\mu\text{L}$			
< 100	24 (18.9)	4 (8.3)	0.089
≥ 100	103 (81.1)	44 (91.7)	
TBIL, $\mu\text{mol/L}$			0.133
≤ 17	101 (79.5)	33 (68.8)	
> 17	26 (20.5)	15 (31.2)	
ALB, g/L			0.581
< 35	12 (9.4)	6 (12.5)	
≥ 35	115 (90.6)	42 (87.5)	
ALT, U/L			0.485
≤ 40	89 (70.1)	31 (64.6)	
> 40	38 (29.9)	17 (35.4)	
GGT, U/L			0.194
≤ 45	33 (26.0)	8 (16.7)	
> 45	94 (74.0)	40 (83.3)	
Preoperative S-index			
≤ 0.28	64 (50.4)	21 (43.8)	0.433
> 0.28	63 (49.6)	27 (56.2)	
Cirrhosis			
Positive	85 (66.9)	29 (60.4)	0.420
Negative	42 (33.1)	19 (39.6)	

Table 1 (continued)

Table 1 (continued)

Variables	Cohort, No. (%)		P value
	Training (n=127)	Validation (n=48)	
Maximum tumor diameter, cm			
≤5	61 (48.0)	11 (22.9)	0.003
>5	66 (52.0)	37 (77.1)	
Tumor number			
Solitary	108 (85.0)	30 (62.5)	0.001
Multiple	19 (15.0)	18 (37.5)	
Preoperative TACE session			
Single	95 (74.8)	31 (64.6)	0.179
Multiple	32 (25.2)	17 (35.4)	
Pathologic complete response			
Yes	64 (50.4)	18 (37.5)	0.127
No	63 (49.6)	30 (62.5)	
mRECIST complete response			
Yes	48 (37.8)	20 (41.7)	0.639
No	79 (62.2)	28 (58.3)	
BCLC Stage, n (%)			
A	112 (88.2)	30 (62.5)	0.000
B	15 (11.8)	18 (37.5)	

SD, standard deviation; HBsAg, hepatitis B surface antigen; HBV, hepatitis B virus; AFP, α -Fetoprotein; PLT, platelet; TBIL, total bilirubin; ALB, albumin; ALT, alanine aminotransferase; GGT, γ -glutamyltransferase; TACE, transarterial chemoembolization; mRECIST, modified Response Evaluation Criteria in Solid Tumors; BCLC, Barcelona Clinic Liver Cancer.

computer software which would limit its use in clinical practice. The nomogram developed in the present study consists of 5 easily available preoperative variables from laboratory and imaging examinations, and medical history of treatment. The present nomogram performed well with a C-index of 0.80 in the training and 0.82 in the validation cohort. The calibration curves for the likelihood of PCR demonstrated optimal agreement between nomogram prediction and actual observation. The nomogram's predictive performance was also confirmed as remarkable in the external validation cohort.

Besides the classical mRECIST, HBV-DNA load, AFP, maximum tumor diameter, and TACE session were incorporated into the nomogram. AFP has been reported to be significantly correlated with PCR in HCC patients with cirrhosis after TACE (28). Another study showed that AFP

response following TACE correlated well with radiological response in intermediate-stage HCC (29). Golfieri *et al.* (30) investigated the relationship between tumor size and the extent of tumor necrosis induced by TACE and observed an increase percentage of necrosis in larger lesions, which we hypothesize was associated with more developed arterial neoangiogenesis in such tumors. The present study also demonstrated a close association between tumor diameter and PCR, which was similar to the findings of some recent studies (28,31,32). In previous clinical studies (33,34), multiple TACE sessions were often needed, as the best response cannot always be attained after a single TACE session, particularly in large tumors. Such findings were consistent with those of the current study.

Although there was no report on the association between HBV DNA load and PCR, a few studies have suggested a

Table 2 Univariable and multivariable analyses of variables associated with pathologic complete response in the training cohort

Variables	Univariable OR (95% CI)	P	Multivariable OR (95% CI)	P
Age, years	0.97 (0.93–1.00)	0.074		
Gender (male vs. female)	1.42 (0.51–4.02)	0.500		
HBsAg (negative vs. positive)	2.12 (0.73–6.14)	0.166		
HBV-DNA, IU/mL ($>1 \times 10^2$ vs. $\leq 1 \times 10^2$)	3.42 (1.58–7.40)	0.002	2.61 (1.09–6.26)	0.031
AFP, ng/mL (>20 vs. ≤ 20)	3.06 (1.44–6.50)	0.004	2.50 (1.04–5.98)	0.040
PLT, $\times 10^3/\mu\text{L}$ (<100 vs. ≥ 100)	0.57 (0.23–1.41)	0.221		
TBIL, $\mu\text{mol/L}$ (≤ 17 vs. >17)	1.92 (0.78–4.75)	0.156		
ALB, g/L (<35 vs. ≥ 35)	1.05 (0.32–3.46)	0.931		
ALT, U/L (≤ 40 vs. >35)	0.59 (0.28–1.28)	0.183		
GGT, U/L (≤ 45 vs. >45)	0.84 (0.42–1.70)	0.632		
Preoperative S-index (≤ 0.28 vs. >0.28)	0.51 (0.25–1.04)	0.064		
Cirrhosis (negative vs. positive)	1.24 (0.59–2.60)	0.573		
Maximum tumor diameter, cm (>5 vs. ≤ 5)	4.48 (1.52–7.96)	0.000	3.52 (1.54–8.04)	0.003
Tumor number (solitary vs. multiple)	0.50 (0.18–1.38)	0.180		
Preoperative TACE session (single vs. multiple)	2.37 (1.04–5.44)	0.041	2.98 (1.14–7.81)	0.026
mRECIST complete response (no vs. yes)	2.79 (1.32–5.89)	0.007	2.56 (1.09–6.01)	0.030
BCLC stage (A vs. B)	0.60 (0.20–1.80)	0.360		

OR, odds ratio; CI, confidence interval; HBsAg, hepatitis B surface antigen; HBV, hepatitis B virus; AFP, α -Fetoprotein; PLT, platelet; TBIL, total bilirubin; ALB, albumin; ALT, alanine aminotransferase; GGT, γ -glutamyltransferase; TACE, transarterial chemoembolization; mRECIST, modified Response Evaluation Criteria in Solid Tumors; BCLC, Barcelona Clinic Liver Cancer.

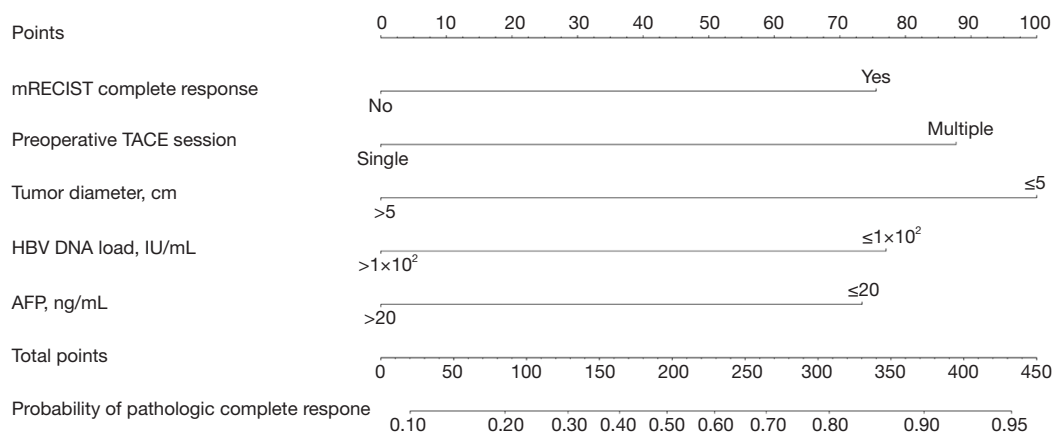


Figure 1 Nomogram to preoperatively estimate the probability of pathologic complete response after transarterial chemoembolization in patients with hepatocellular carcinoma. To use this nomogram, find the position of individual variable of each patient on the corresponding axis, draw a line upward to the points axis for the number of points of relevant variable, then accumulate all the points of an individual patient, and draw a line downward from the total points to the lowest line to determine the probability of pathologic complete response.

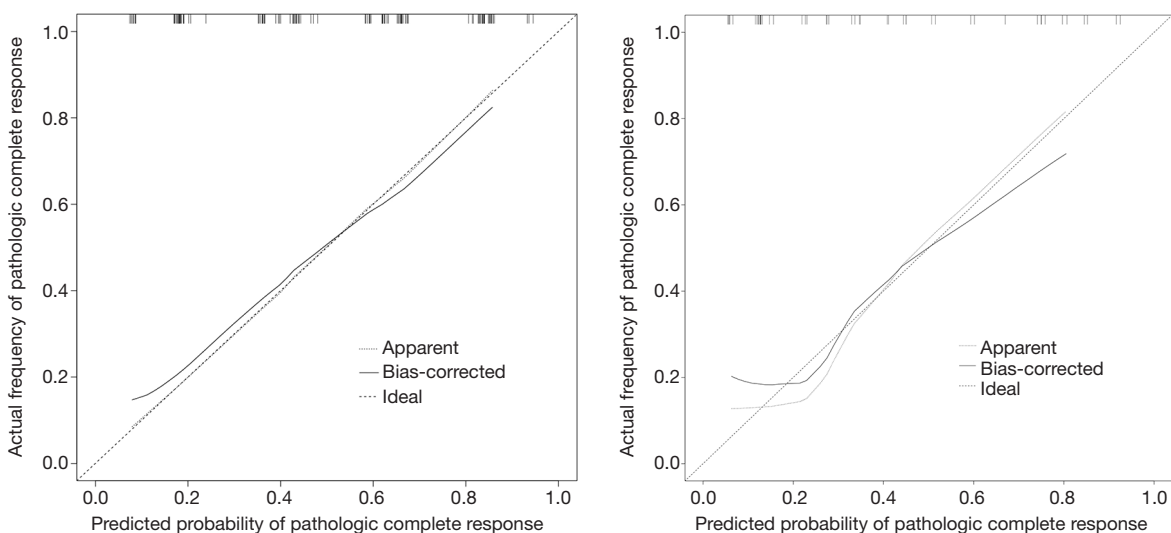


Figure 2 Calibration curves of the nomogram in the training and validation cohorts. The X-axis is the probability of pathologic complete response predicted by the nomogram, and the Y-axis represents the actual probability. The long-dashed diagonal line shows an ideal nomogram with a perfect match with the actual observation. The bias-corrected performance of our nomogram is represented by the solid line, and the apparent accuracy of the present nomogram is shown by the short-dashed line.

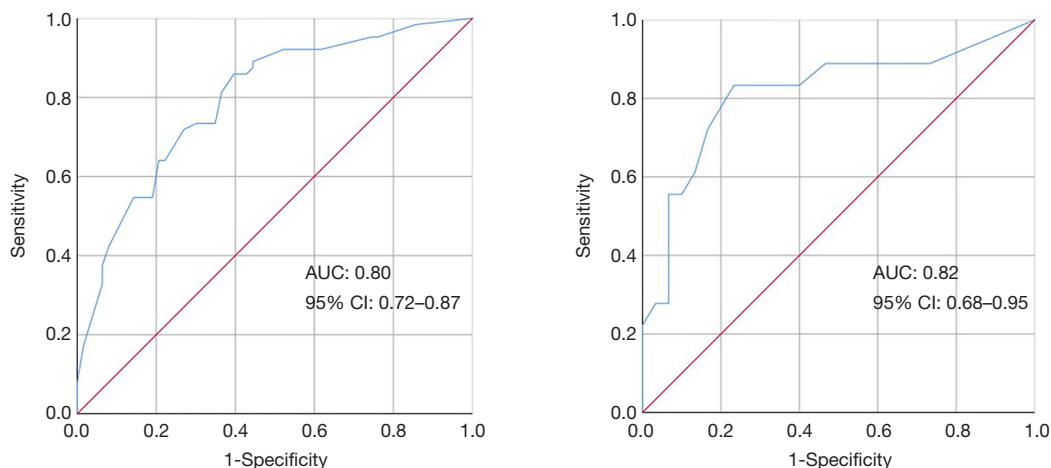


Figure 3 Receiver operating characteristic (ROC) curves of the nomogram in the training and validation cohorts. The ROC curves for the prediction of pathologic complete response depends on the logistic regression model. The area under the curve (AUC) in the training and validation cohorts are 0.80 (95% CI, 0.72–0.87) and 0.82 (95% CI, 0.68–0.95), respectively.

relationship between these 2 factors. Su *et al.* (35) found that elevated HBV DNA correlated well with lipiodol retention after TACE, and incomplete lipiodol deposition was considered to be an indication of substantial viable tumor remnant (36). Given the association above, we speculated that HBV DNA load might impact HCC response to TACE by influencing lipiodol deposition. However, further

research is required to explore the underlying mechanism and validate our speculation.

The clinical decision-making, such as repeated TACE, liver transplantation, hepatectomy or follow-up observation, mainly depended on the response to initial TACE treatment. Our intuitive and easy-to-use nomogram can serve as a tool to accurately evaluate the pathologic response and

thus carries significant clinical implications. As described in recent studies (37,38), researchers have reported that repeated TACE cannot provide a markedly higher survival benefit in some patients, and ineffective TACE may even lead to detrimental effects. The serum concentration of vascular endothelial growth factor (VEGF) increases substantially after TACE and remains at a high level for at least 4 weeks (39). It promotes vasodilation and splanchnic vascularization, aggravates hyperdynamic splanchnic circulation, eventually increases portal pressure, and even leads to liver fibrosis progression (40). Additionally, TACE also induces ischemic injury in surrounding normal liver tissue (41). These unfavorable factors affect hepatocyte regeneration, suppress tumor immunity and deteriorate liver function (42). Elevated VEGF also contributes to the angiogenesis of HCC, which is responsible for tumor progression (43). Our nomogram can identify candidate patients who are more likely to achieve PCR, avoiding futile and potentially harmful repeated TACE. PCR has also been associated with excellent outcomes in HCC patients who received preoperative TACE and liver transplantation (28). Optimal candidates for liver transplantation can be selected by using the nomogram, and a good prognosis may be expected.

Although traditionally regarded as a non-curative treatment, TACE remains a promising procedure. Luo *et al.* (44) found no significant difference in prognosis between patients who underwent subsequent hepatic resection and those who did not, when those patients had responded well to initial TACE. Another study compared the patients' outcomes of superselective TACE and hepatic resection for resectable early-stage HCC, and observed that they had similar overall survival rates (45). A propensity score matching analysis reported that hepatectomy and TACE appeared to be equivalently effective for patients with solitary HCC ≤ 5 cm (46). A previous clinical trial also showed that of 126 patients with PCR, only 3 developed recurrences and there was only 1 cancer-related death after liver transplantation; therefore, the authors concluded that PCR was tantamount to curative treatment (21). The PCR rates in the present study were 50.4% in the training cohort and 37.5% in the validation cohort, which was consistent with those of several previous studies (30). Depending on these findings, we speculate that some patients could obtain PCR after TACE, for whom close follow-up without immediately sequential TACE or operation is enough. It is of great clinical significance to identify these patients and avoid overtreatment. Further multi-center and randomized

controlled trials are needed to confirm this hypothesis.

Some limitations in this study should be considered. First, the limited sample size may weaken the statistical power of this analysis. However, to our knowledge, there is just a very small proportion of BCLC stage A patients that have received preoperative TACE. Second, the patients in our study were from different centers, which made it difficult to collect the pre-TACE data. The insufficient data did not enable us to analyze the variation of some characteristics, such as AFP, HBV-DNA and maximum tumor diameter, before and after TACE treatment. Third, TACE procedures may vary across different centers despite complying with relevant guidelines. Finally, because most of the patients in our study had HBV infection, our nomogram requires further validation in areas with different underlying etiologies of HCC worldwide.

In conclusion, by incorporating 5 post-TACE predictors of PCR, we constructed an easy-to-use and accurate nomogram. The nomogram can estimate the possibility of PCR after TACE in patients with HCC, guide the subsequent treatment and eventually improve clinical outcomes.

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Footnote

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Hospital (No.: EHBHKY2020-K-028) and by the ethical review board of Mengchao Hepatobiliary Hospital of Fujian Medical University (No.: 2019-063-01). Informed consent was taken from all the patients.

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