

# Efficacy and Safety of Nivolumab Plus Ipilimumab in Patients With Advanced Hepatocellular Carcinoma Previously Treated With Sorafenib

## The CheckMate 040 Randomized Clinical Trial

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**IMPORTANCE** Most patients with hepatocellular carcinoma (HCC) are diagnosed with advanced disease not eligible for potentially curative therapies; therefore, new treatment options are needed. Combining nivolumab with ipilimumab may improve clinical outcomes compared with nivolumab monotherapy.

**OBJECTIVE** To assess efficacy and safety of nivolumab plus ipilimumab in patients with advanced HCC who were previously treated with sorafenib.

**DESIGN, SETTING, AND PARTICIPANTS** CheckMate 040 is a multicenter, open-label, multicohort, phase 1/2 study. In the nivolumab plus ipilimumab cohort, patients were randomized between January 4 and September 26, 2016. Treatment group information was blinded after randomization. Median follow-up was 30.7 months. Data cutoff for this analysis was January 2019. Patients were recruited at 31 centers in 10 countries/territories in Asia, Europe, and North America. Eligible patients had advanced HCC (with/without hepatitis B or C) previously treated with sorafenib. A total of 148 patients were randomized (50 to arm A and 49 each to arms B and C).

**INTERVENTIONS** Patients were randomized 1:1:1 to either nivolumab 1 mg/kg plus ipilimumab 3 mg/kg, administered every 3 weeks (4 doses), followed by nivolumab 240 mg every 2 weeks (arm A); nivolumab 3 mg/kg plus ipilimumab 1 mg/kg, administered every 3 weeks (4 doses), followed by nivolumab 240 mg every 2 weeks (arm B); or nivolumab 3 mg/kg every 2 weeks plus ipilimumab 1 mg/kg every 6 weeks (arm C).

**MAIN OUTCOMES AND MEASURES** Coprimary end points were safety, tolerability, and objective response rate. Duration of response was also measured (investigator assessed with the Response Evaluation Criteria in Solid Tumors v1.1).

**RESULTS** Of 148 total participants, 120 were male (81%). Median (IQR) age was 60 (52.5-66.5). At data cutoff (January 2019), the median follow-up was 30.7 months (IQR, 29.9-34.7). Investigator-assessed objective response rate was 32% (95% CI, 20%-47%) in arm A, 27% (95% CI, 15%-41%) in arm B, and 29% (95% CI, 17%-43%) in arm C. Median (range) duration of response was not reached (8.3-33.7+) in arm A and was 15.2 months (4.2-29.9+) in arm B and 21.7 months (2.8-32.7+) in arm C. Any-grade treatment-related adverse events were reported in 46 of 49 patients (94%) in arm A, 35 of 49 patients (71%) in arm B, and 38 of 48 patients (79%) in arm C; there was 1 treatment-related death (arm A; grade 5 pneumonitis).

**CONCLUSIONS AND RELEVANCE** In this randomized clinical trial, nivolumab plus ipilimumab had manageable safety, promising objective response rate, and durable responses. The arm A regimen (4 doses nivolumab 1 mg/kg plus ipilimumab 3 mg/kg every 3 weeks then nivolumab 240 mg every 2 weeks) received accelerated approval in the US based on the results of this study.

**TRIAL REGISTRATION** ClinicalTrials.gov Identifier: [NCT01658878](https://clinicaltrials.gov/ct2/show/study/NCT01658878)

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Liver cancer is the fourth leading cause of cancer-related deaths worldwide; 75% to 85% of cases are hepatocellular carcinoma (HCC).<sup>1</sup> Most patients are diagnosed with advanced disease unsuitable for resection or transplantation; outcomes remain poor and new effective treatment options are needed. Multikinase inhibitors, including regorafenib, cabozantinib, and the monoclonal antibody ramucirumab, are approved for patients treated with sorafenib; pivotal phase 3 trials report median overall survival ranging from 8.5 to 10.6 months.<sup>2-4</sup>

The anti-programmed cell death 1 (anti-PD-1) checkpoint inhibitors nivolumab and pembrolizumab are approved in the United States and elsewhere as second-line therapy for HCC.<sup>5,6</sup> In CheckMate 040, nivolumab monotherapy demonstrated manageable safety, objective response rate (ORR) of 14%, duration of response of at least 12 months in 59% of patients, and promising long-term median survival of 15.1 months in patients with advanced HCC treated with sorafenib.<sup>5,7</sup> These results led to investigation of nivolumab combination therapies with the goal of durable responses in more patients. Programmed cell death protein 1 and cytotoxic T-lymphocyte-associated protein 4 (CTLA-4) immune checkpoint inhibitors (eg, nivolumab and ipilimumab) promote antitumor immune responses by distinct and complementary mechanisms affecting different signaling pathways. Programmed cell death protein 1 contributes to T-cell exhaustion, mainly in the tumor microenvironment, and CTLA-4 inhibits activated and regulatory T cells in the lymphoid organs.<sup>8,9</sup> Nivolumab plus ipilimumab has proved effective in the treatment of other tumor types (eg, renal cell carcinoma, non-small cell lung cancer, melanoma, microsatellite instability-high/mismatch repair-deficient metastatic colorectal cancer).<sup>10-13</sup> The combination of nivolumab plus ipilimumab has recently been approved in the United States as second-line therapy for HCC.<sup>14</sup> We report the safety and efficacy of nivolumab plus ipilimumab in patients who are sorafenib refractory or sorafenib intolerant and have advanced HCC from CheckMate 040.

## Methods

### Study Design

CheckMate 040 is a multicenter, open-label, multicohort, phase 1/2 randomized clinical trial. For this cohort, patients were recruited from 31 centers in 10 countries/territories in Asia, Europe, and North America. The study was approved by the institutional review board or independent ethics committee at each site and was conducted in accordance with Good Clinical Practice guidelines defined by the International Council for Harmonisation. The report was prepared according to the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline. All patients provided written informed consent to participate based on the principles of the Declaration of Helsinki. The Trial Protocol is available in [Supplement 1](#).

### Patients

Eligible patients were 18 years or older with histologically confirmed advanced HCC (not eligible for surgical/locoregional

## Key Points

**Question** Does adding ipilimumab to nivolumab improve clinical outcomes for patients with advanced hepatocellular carcinoma previously treated with sorafenib?

**Findings** In the CheckMate 040 randomized clinical trial of nivolumab plus ipilimumab in patients with advanced hepatocellular cancer previously treated with sorafenib, patients were randomized 1:1:1 to 3 different treatment arms to evaluate different dosing regimens. Investigator-assessed objective response rate was greater than 30% across treatment arms, and the combination of nivolumab plus ipilimumab led to high overall survival rates and had a manageable safety profile.

**Meaning** The manageable safety profile and promising response rates observed in this study support further investigation of nivolumab plus ipilimumab as a treatment option for this patient population.

therapies or with disease progression after or intolerance of sorafenib) and Child-Pugh liver function class A. Patients were required to have an Eastern Cooperative Oncology Group performance status score of 1 or less and at least 1 untreated target lesion that could be measured in 1 dimension according to Response Evaluation Criteria in Solid Tumors (RECIST) version 1.1.<sup>15</sup>

Eligible patients had HCC with or without hepatitis B virus (HBV) infection or hepatitis C virus (HCV) infection. Patients who had active coinfection with HBV and HCV, or HBV and hepatitis D virus, were not eligible. Hepatitis infection definition and additional eligibility criteria are in the eMethods in [Supplement 2](#).

Race and ethnicity (United States only) were recorded based on the patient's best description at enrollment. This was an important consideration because HCC prevalence, incidence, cause, and mortality vary by race and ethnicity, which has potential implications for tumor control and survival.<sup>16-18</sup>

### Randomization and Masking

Blocked randomization was performed using the Interactive Voice Response System (IVRS) without stratification. Investigators called the IVRS to enroll participants and receive participants' treatment randomizations. Random allocation was implemented by the IVRS, a centralized automated third-party system, using a sequentially numbered list generated by the Randomization Information Management System. This ensured that the sequentially numbered list was concealed until treatment allocation was completed.

Patients were randomized to 1 of 3 dosing arms by 2-stage enrollment. For each dosing arm, 12 patients were enrolled for a safety and tolerability assessment at week 13, and subsequent patients were enrolled after completing the safety assessment. Treatment group information was blinded in the database after randomization.

### Procedures

Patients were randomized 1:1:1 into 3 dosing arms. Arm A was treated with nivolumab 1 mg/kg plus ipilimumab 3 mg/kg every 3 weeks (4 doses). Arm B was treated with nivolumab 3

mg/kg plus ipilimumab 1 mg/kg every 3 weeks (4 doses). Both arm A and arm B regimens were followed by nivolumab 240 mg intravenously every 2 weeks. Arm C was treated with nivolumab 3 mg/kg every 2 weeks plus ipilimumab 1 mg/kg every 6 weeks. Tumors were assessed by computed tomography or magnetic resonance imaging at baseline and every 6 weeks until 48 weeks; thereafter, tumors were assessed every 12 weeks until disease progression. Treatment was permitted beyond initial investigator-assessed RECIST version 1.1 progression with a repeated evaluation at the next tumor assessment visit (6 or 12 weeks). Treatment continued until unacceptable toxic effects emerged, disease progressed as defined by RECIST version 1.1, or consent was withdrawn. Treatment interruptions were permitted to manage adverse events.

### Outcomes

The key objective was to evaluate the safety and tolerability, ORR, and durability of response of combinations of nivolumab and ipilimumab. The coprimary end points were safety and tolerability, and ORR was assessed by investigators per RECIST version 1.1. Secondary and exploratory efficacy end points included ORR, disease control rate, and duration of response, assessed by blinded independent central review (BICR) per RECIST version 1.1, ORR per modified RECIST, and overall survival. Definitions are in the eAppendix in Supplement 2. Additional end points included response stratified by programmed cell death ligand 1 (PD-L1) expression. Tumor biopsies collected at baseline, either fresh or archival, were used retrospectively to analyze tumor PD-L1 expression by immunohistochemistry using the PD-L1 immunohistochemistry 28-8 pharmDx assay (Dako, Agilent Technologies).<sup>5</sup> Investigators assessed safety continuously for up to 100 days after the last dose or until all treatment-related adverse events were resolved to baseline levels or deemed irreversible by investigators using the National Cancer Institute Common Terminology Criteria for Adverse Events version 4.0. Additional safety criteria are listed in the eAppendix in Supplement 2. We assessed patient-reported health status using the 3-level version of the European Quality of Life 5 Dimensions questionnaire (EQ-5D-3L; described in the eAppendix in Supplement 2).

### Statistical Analyses

Objective response rate, complete response rate, and disease control rate with corresponding 2-sided 95% CIs were estimated using the Clopper-Pearson method. Kaplan-Meier methods were used to estimate medians and 95% CIs for duration of response, overall survival, and progression-free survival. Survival outcomes were calculated from date of randomization. The study was not powered to detect differences between the 3 treatment arms. See eMethods and eTable 1 in Supplement 2 for sample size information.

All analyses were performed using the intent-to-treat population, comprising all randomized patients, except for exposure and safety analyses, which were evaluated in randomized patients who received at least 1 dose of the study drug. Patient-reported outcomes were evaluated using descriptive analyses in patients with both a valid baseline and at least

1 postbaseline assessment. Statistical analyses were performed using SAS software, version 9.2 (SAS Institute). CheckMate 040 is registered with ClinicalTrials.gov (NCT01658878).

## Results

Between January 4 and September 26, 2016, a total of 148 patients with advanced HCC were randomized across 3 dosing arms. Of all participants, 120 were male (81%). Median (interquartile range [IQR]) age was 60 (52.5-66.5). All randomized patients were included in efficacy analyses, and 146 treated patients were included in safety and drug exposure analyses (Figure 1). At data cutoff (January 2019), the median follow-up was 30.7 months (IQR, 29.9-34.7). Baseline demographics and clinical characteristics were generally comparable across treatment arms (eTable 2 in Supplement 2). A high proportion of patients had poor prognostic features and HBV-related HCC, and 9% had at least 3 prior systemic therapies. Overall, 146 of 148 patients received prior sorafenib therapy (99%); 84% discontinued sorafenib because of disease progression and 14% because of toxic effects (by investigator assessment).

In arms A, B, and C, investigator-assessed ORR was 32%, 27%, and 29%, and median duration of response was not reached, 15.2 months, and 21.7 months, respectively (Table). Objective response rate by BICR per RECIST version 1.1 was 32% in arm A, 31% in arm B, and 31% in arm C. A total of 7 patients had a complete response by BICR, 4 patients in arm A and 3 patients in arm B. Duration of response, median time to response, and disease control rate were similar across treatment arms. All responses occurred early in treatment (eFigure 1 in Supplement 2). Responses were observed regardless of baseline etiology and PD-L1 status (eTable 3 in Supplement 2).

We observed substantial reductions in tumor burden in all treatment arms (eFigure 2 in Supplement 2), and several responders exhibited deep responses (eFigure 3 in Supplement 2). Median overall survival was 22.8 months (95% CI, 9.4-not reached) in arm A vs 12.5 months (95% CI, 7.6-16.4) in arm B and 12.7 months (95% CI, 7.4-33.0) in arm C (Figure 2A; eTable 4 in Supplement 2). In arm A, the 12-month overall survival rate was 61% (95% CI, 46%-73%) and the 24-month overall survival rate was 48% (95% CI, 34%-61%). Response conferred a survival benefit in the overall population; the median overall survival of patients with complete/partial response was not reached at data cutoff (95% CI, 33.0-not evaluable) vs 14.5 months (95% CI, 8.4-29.6) for patients with stable disease and 8.3 months (95% CI, 6.6-10.8) for patients with progressive disease (Figure 2B; eTable 5 in Supplement 2). When evaluated by baseline etiology, the median overall survival of patients who were HBV/HCV uninfected, HBV infected, or HCV infected in arm A was 22.2 months, 22.8 months, and 14.9 months; in arm B, 11.8 months, 12.1 months, and 16.1 months; and in arm C, 7.4 months, 9.6 months, and 33.0 months, respectively (eTable 3 in Supplement 2), although small subgroups limit comparisons. In each arm, median overall survival by baseline PD-L1 status was comparable.

Figure 1. Enrollment, Randomization, and Outcomes

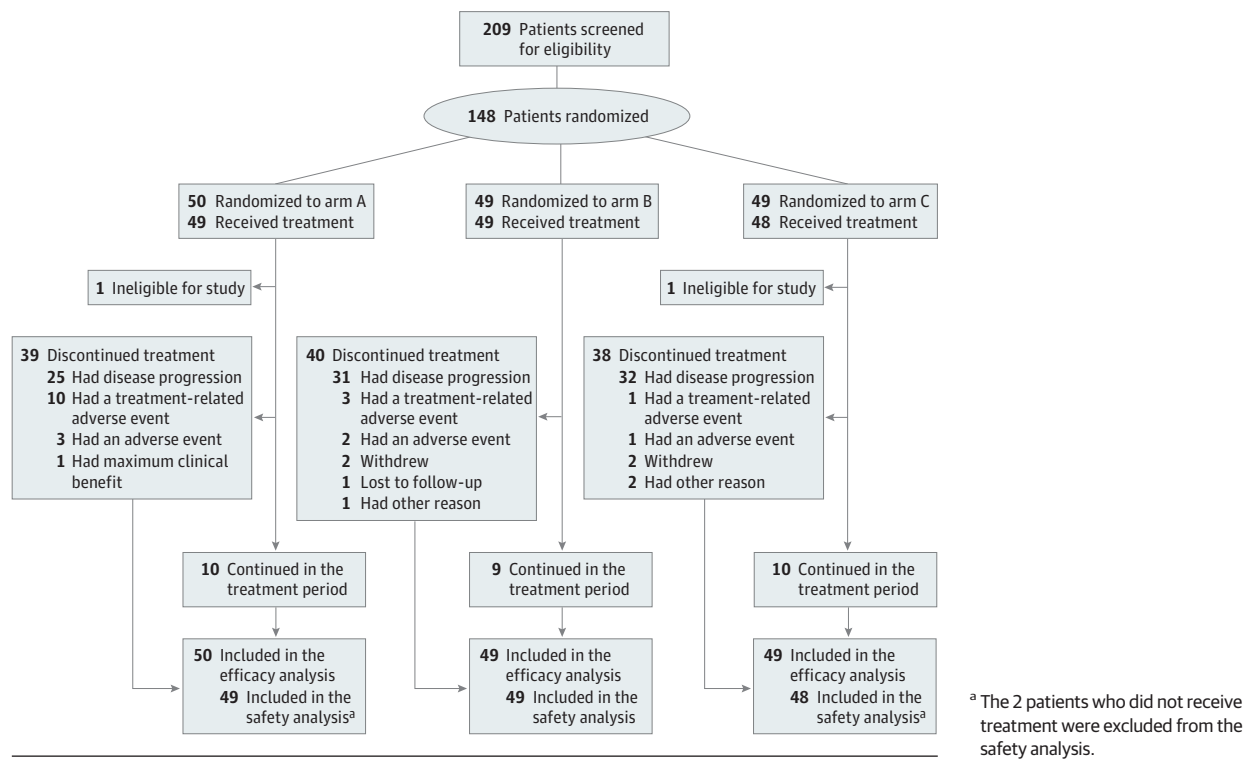


Table. Response, Disease Control, and Durability

Characteristic	No. (%)		
	Arm A <sup>a</sup> (n = 50)	Arm B <sup>b</sup> (n = 49)	Arm C <sup>c</sup> (n = 49)
Response by investigator assessment using RECIST v1.1			
Objective response rate, No. (%) [95% CI]	16 (32) [20 to 47]	13 (27) [15 to 41]	14 (29) [17 to 43]
Duration of response, median (range), mo	NE (8.3 to 33.7+)	15.2 (4.2 to 29.9+)	21.7 (2.8 to 32.7+)
Response by BICR using RECIST v1.1			
Objective response rate, No. (%) [95% CI] <sup>d</sup>	16 (32) [20 to 47]	15 (31) [18 to 45]	15 (31) [18 to 45]
Best overall response			
Complete response	4 (8)	3 (6)	0
Partial response	12 (24)	12 (24)	15 (31)
Stable disease <sup>e</sup>	9 (18)	5 (10)	9 (18)
Progressive disease	20 (40)	24 (49)	21 (43)
Unable to determine <sup>f</sup>	3 (6)	4 (8)	4 (8)
Disease control rate <sup>g</sup>	27 (54)	21 (43)	24 (49)
Duration of response, median (range), mo <sup>h</sup>	17.5 (4.6 to 30.5+)	22.2 (4.2 to 29.9+)	16.6 (4.1+ to 32.0+)
Duration of response of ≥24 mo <sup>h</sup>	5 (31)	4 (27)	5 (33)
Time to response, median (IQR), mo <sup>h</sup>	2.0 (1.3 to 2.7)	2.6 (1.3 to 4.0)	2.7 (1.3 to 2.8)
Response by BICR using mRECIST			
Objective response rate, No. (%) [95% CI] <sup>d</sup>	17 (34) [21 to 49]	16 (33) [20 to 48]	15 (31) [18 to 45]

Abbreviations: BICR, blinded independent central review; IQR, interquartile range; mRECIST, modified Response Evaluation Criteria in Solid Tumors; RECIST, Response Evaluation Criteria in Solid Tumors.

<sup>a</sup> Nivolumab 1 mg/kg plus ipilimumab 3 mg/kg every 3 weeks (4 doses) followed by nivolumab 240 mg intravenously every 2 weeks.

<sup>b</sup> Nivolumab 3 mg/kg plus ipilimumab 1 mg/kg every 3 weeks (4 doses) followed by nivolumab 240 mg intravenously every 2 weeks.

<sup>c</sup> Nivolumab 3 mg/kg every 2 weeks plus ipilimumab 1 mg/kg every 6 weeks.

<sup>d</sup> Defined as complete response plus partial response.

<sup>e</sup> Stable disease does not include 2 patients in arm A and 1 patient in arm B who were reported as noncomplete response/nonprogressive disease and did not meet the definition of stable disease by BICR.

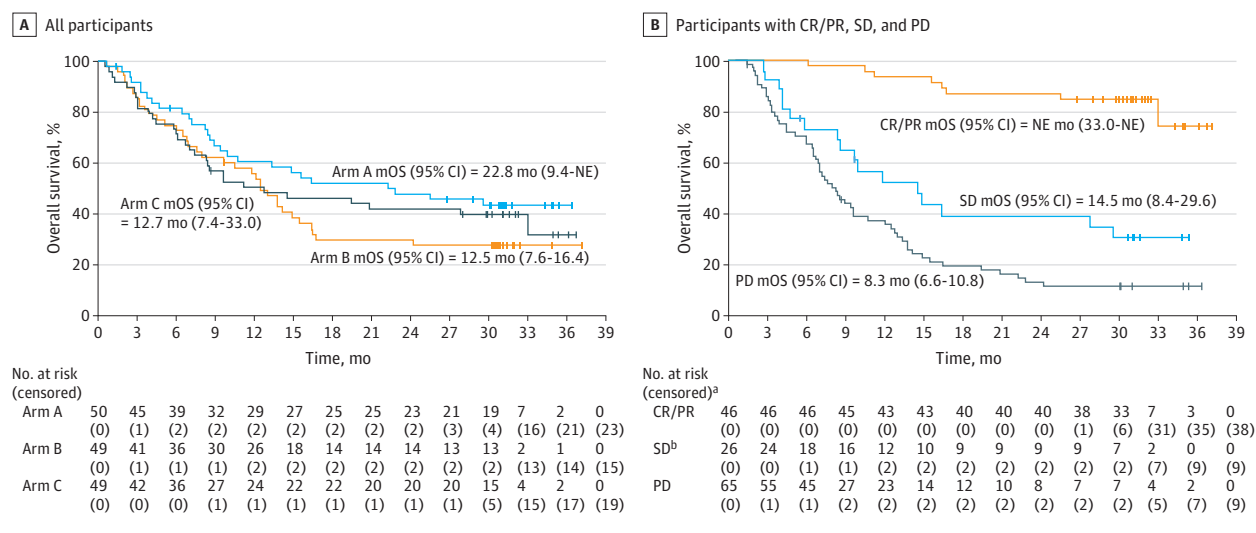
<sup>f</sup> These patients were not scanned; therefore, best overall response could not be determined.

<sup>g</sup> Defined as complete response plus partial response plus stable disease plus noncomplete response/nonprogressive disease.

<sup>h</sup> Patients with a complete response or partial response.

<sup>a</sup> The 2 patients who did not receive treatment were excluded from the safety analysis.

Figure 2. Kaplan-Meier Analysis of Median Overall Survival



A, survival by treatment arm; B, overall population survival stratified by best overall response. CR indicates complete response; mOS, median overall survival; NE, not evaluable; PD, progressive disease; PR, partial response; SD, stable disease.

<sup>a</sup> Eleven patients overall did not have a scan; therefore, best overall response

could not be determined.

<sup>b</sup> Stable disease was reported as noncomplete response/nonprogressive disease in 2 patients in arm A and 1 patient in arm B. These were patients who only had nontarget lesions at baseline and did not meet the definition of stable disease by blinded independent central review.

The median (IQR) treatment duration was longest in arm A (5.1 months [2.1-19.5]) vs arm B (2.3 months [0.7-13.8]) and arm C (4.0 months [1.2-17.8]). Disease progression was the most common reason for treatment discontinuation (arm A, 51% of patients; arms B and C, 69% of patients). The percentage of patients discontinuing the treatment regimen because of study drug toxic effects was highest in arm A (22%) vs arm B (6%) and arm C (2%).

Any-grade treatment-related adverse events were observed in 46 patients (94%) in arm A, 35 patients (71%) in arm B, and 38 patients (79%) in arm C (eTable 6 in Supplement 2). Although arm A had higher rates of treatment-related adverse events than arms B and C, the types of events were similar across arms, and no new safety signals were observed. The types of events in patients with and without HBV or HCV infection were also generally comparable across treatment arms (eTable 7 in Supplement 2). Virologic breakthrough, conservatively defined as a 1-log increase in HBV DNA or HCV RNA from baseline, was observed in 7 of 82 HBV-infected patients (9%) and 4 of 39 HCV-infected patients (10%) overall. Changes in viral kinetics were not associated with treatment-related significant hepatic adverse events. Investigator-reported, any-grade treatment-related adverse events led to discontinuation of either drug in 9 patients (18%) in arm A, 3 patients (6%) in arm B, and 1 patient (2%) in arm C. Among them, 5 patients in arm A, 2 patients in arm B, and 1 patient in arm C had grade 3-4 treatment-related adverse events. Within 100 days of the final dose of study drug, 1 patient from arm A died of a serious treatment-related adverse event (grade 5 pneumonitis).

Arm A had higher rates of immune-mediated adverse events and immune-mediated adverse events leading to discontinuation compared with arms B and C (eTable 6 in

Supplement 2). eFigure 4 in Supplement 2 summarizes the time to onset and time to resolution of any-grade immune-mediated adverse events. The median (IQR) time to onset of hepatic events was 5.6 weeks (3.4-9.3) for arm A, 8.1 weeks (3.0-11.0) for arm B, and 5.9 weeks (3.6-8.6) for arm C. The proportion of hepatic events (median [IQR] time to resolution) that resolved was 9 out of 10 (90%; 6.6 weeks [2.0-15.0]) in arm A, 5 out of 6 (83%; 7.9 weeks [6.7-10.9]) in arm B, and 2 out of 3 (67%; 6.1 weeks [3.9-not evaluable]) in arm C. In arms A, B, and C, of the 10, 6, and 3 patients who had a hepatic immune-mediated adverse event, 7, 3, and 2 received high-dose glucocorticoids ( $\geq 40$  mg of prednisone per day or equivalent) for a median (IQR) of 2 weeks (0.9-7.0), 1 week (0.6-1.1), and 3 weeks (2.0-3.0), respectively. None of these patients received additional immunosuppressive therapy. For all immune-mediated adverse events, standard treatment management algorithms were used, as specified by the Trial Protocol. Of patients who were rechallenged with nivolumab or ipilimumab after experiencing an immune-mediated adverse event in any category, no patients experienced a recurrence of the event after rechallenge (eTable 8 in Supplement 2).

Descriptive analyses indicated a trend for improvement in each arm based on both EQ-5D visual analogue scale and utility index, with some scores reaching general population standards. Patients in arm A experienced greater benefit compared with patients in arms B and C based on the mixed-model repeated-measures analyses. Patients in arm A had improvement in both visual analogue scale (2.1 [SE, 2.6]) and utility index (UK, 0.033 [0.031]; US, 0.027 [0.023]) scores, whereas patients in arms B and C had improvement in visual analogue scale (1.2 [2.3]), but a slight decrease in utility index (UK, -0.016 [0.029]; US, -0.011 [0.021]) overall. The mean

difference between groups favored arm A overall and at most individual time points.

## Discussion

To our knowledge, this is the first report of nivolumab-ipilimumab combination therapy in the treatment of advanced HCC. Nivolumab plus ipilimumab provided a robust clinical benefit in patients treated with sorafenib, with high ORRs (by BICR per RECIST version 1.1) of 16 out of 50 (32%) in arm A, 15 out of 49 (31%) in arm B, and 15 out of 49 (31%) in arm C (7 patients had complete responses). Patients in arm A had the highest complete response rate, most promising median overall survival of 22.8 months, and 12-month survival rates of 61%, 24-month survival rates of 48%, and 30-month overall survival rates of 44%, with improvement in health status relative to the other 2 arms. The higher overall survival observed in arm A vs arms B and C may be due to the higher starting dose of ipilimumab in arm A; however, this study was not powered to detect differences between treatment arms. Across all arms, patients with the best overall response of complete/partial response had substantially improved median overall survival compared with those who had stable disease or progressive disease, underscoring the importance of achieving a response with treatment.

Nivolumab monotherapy demonstrated a median overall survival of 15.1 months and an ORR of 14% in patients who were sorafenib refractory and had advanced HCC.<sup>7</sup> A phase 2 study<sup>6</sup> of the PD-1 inhibitor pembrolizumab reported median overall survival of 12.9 months and an ORR of 17%, and a recent phase 3 study<sup>19</sup> of pembrolizumab monotherapy showed median overall survival of 13.9 months and an ORR of 18% in patients treated with sorafenib. Although comparisons are indirect, our results suggest that nivolumab plus ipilimumab may provide improved efficacy in terms of ORR, and, potentially, survival in arm A relative to anti-PD-L1 monotherapy.

Outcomes with nivolumab plus ipilimumab compare favorably with results of other approved second-line targeted therapies. Pivotal trials of the multikinase inhibitors regorafenib and cabozantinib in patients treated with sorafenib demonstrated median overall survival of 10.6 months and 10.2 months, and ORR of 11% and 4%, respectively.<sup>2,4</sup> In patients with baseline  $\alpha$ -fetoprotein levels of at least 400  $\mu$ g/L, ramucirumab showed a median overall survival of 8.5 months and an ORR of 5%.<sup>3</sup>

The results of this study are consistent with the PD-1/PD-L1 and CTLA-4 pathways having distinct but complementary roles in negatively regulating immune activity.<sup>20</sup> These results confirm that HCC is sensitive to CTLA-4 blockade, as previously suggested in small single-arm trials of tremelimumab.<sup>21,22</sup> These results suggest that increased ipilimumab doses may translate into higher durable responses and improved survival in patients with advanced HCC. Nivolumab-ipilimumab combination trials in advanced melanoma, recurrent small cell lung cancer, and metastatic renal cell carcinoma have also shown some improved responses with higher ipilimumab doses and, where reported, improved overall survival.<sup>23-25</sup>

In this study, responses occurred regardless of HCC etiology or PD-L1 expression. However, because this study was not powered to detect differences between etiologies or PD-L1 status, larger studies are required to draw conclusions on these factors.

This study reported higher rates of adverse events with nivolumab and ipilimumab regimens than have previously been reported with nivolumab monotherapy.<sup>5</sup> However, the safety profile was consistent in presentation and management with that of nivolumab and ipilimumab monotherapy. The safety profile was also consistent with studies investigating nivolumab and ipilimumab in the treatment of other tumor types.<sup>10-12,23,26</sup> In patients with advanced melanoma treated with nivolumab (1 mg/kg) plus ipilimumab (3 mg/kg), 248 of 448 (55.4%) had grade 3 or 4 treatment-related adverse events, and 186 (41.5%) had grade 3 or 4 treatment-related select adverse events.<sup>26</sup> Patients in arm A reported the highest rates of adverse events, immune-mediated adverse events, and discontinuation due to study drug toxic effects. Most immune-mediated adverse events resolved across treatment arms, including hepatic events (occurring in 10 of 49 [20%] patients in arm A, with 90% resolving using protocol-specified management algorithms). The frequency of virologic breakthrough in patients with chronic HBV infection on suppressive antiviral therapy and patients with chronic HCV infection was consistent with reports in the literature in the absence of immuno-oncology therapy.<sup>27-30</sup> Overall, the adverse events were consistent with those previously identified in other tumor types and were effectively managed with established treatment algorithms, and there was a compelling overall survival benefit in patients receiving nivolumab plus ipilimumab. Furthermore, encouraging patient-reported health status results were observed for all arms, particularly arm A, despite higher rates of adverse events in this arm.

## Limitations

Limitations of this study include (1) its design as an open-label phase 1/2 study in a relatively small patient population; (2) its lack of a comparator arm, particularly a nivolumab monotherapy arm; and (3) its lack of patient stratification (owing to small population), with potential prognostic factors not necessarily balanced across the 3 arms. However, the patient cohort was not a highly selected population and included high-risk patients in general who were heavily pretreated with high frequency of extrahepatic spread and elevated  $\alpha$ -fetoprotein levels. New larger, randomized, active comparator-controlled clinical studies are being initiated to investigate the efficacy benefits.

## Conclusions

For patients with advanced HCC previously treated with sorafenib, nivolumab-ipilimumab regimens had manageable safety profiles and durable responses with high ORRs. Overall survival rates were promising, especially for arm A. Based on the results of this study, nivolumab 1 mg/kg

plus ipilimumab 3 mg/kg every 3 weeks followed by nivolumab 240 mg every 2 weeks or 480 mg every 4 weeks received accelerated approval in the United States as a second-line therapy for HCC. Investigation of this combination is under way as first-line therapy in patients with HCC (NCT04039607).

#### ARTICLE INFORMATION

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**Correction:** This article was corrected on December 3, 2020, to fix Armando Santoro's affiliations.

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