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TITLE:

A Phase 2 Study of Pembrolizumab (MK-3475) as Monotherapy in Subjects with Advanced Hepatocellular Carcinoma (KEYNOTE-224)

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DOCUMENT HISTORY

Document	Date of Issue	Overall Rationale
3475-224-08	24-JUN-2022	Merck Sharp & Dohme Corp. underwent an entity name and address change to Merck Sharp & Dohme LLC, Rahway, NJ, USA. This conversion resulted only in an entity name change and update to the address.
3475-224-07	05-FEB-2021	To add language to include the requirement of roll over of trial participants into an extension trial (if available) when this trial is completed
3475-224-06	23-MAY-2018	To add an additional cohort for first-line treatment
3475-224-05	13-DEC-2017	To modify benefit-risk text modified per request from Agence Nationale de Sécurité du Médicament et des Produits de Santé (ANSM) and align with a prior protocol clarification letter (PCL).
3475-224-04	12-DEC-2017	To provide current, comprehensive guidelines for management of immune-related adverse events, survival follow up procedures and analysis of survival data, mRECIST evaluation of exploratory objectives and exploratory efficacy endpoints
3475-224-03	11-OCT-2016	To address German HA request to add language to exclude subjects with a hypersensitivity to pembrolizumab's excipients (exclusion criterion 16)
3475-224-02	11-JUL-2016	To address German HA request to add language to exclude subjects with a hypersensitivity to study drug
3475-224-01	22-FEB-2016	To clarify and correct inclusion/exclusion criteria, trial flow chart, supportive care guidelines, irRECIST text, and statistical analyses
Original Protocol	15-JAN-2016	Not applicable

SUMMARY OF CHANGES

PRIMARY REASON(S) FOR THIS AMENDMENT:

Section Number (s)	Section Title(s)	Description of Change (s)	Rationale
Title Page	Title page	Sponsor entity name and address change.	Merck Sharp & Dohme Corp. underwent an entity name and address change to Merck Sharp & Dohme LLC, Rahway, NJ, USA. This conversion resulted only in an entity name change and update to the address.
Section 12.1	Code of Conduct for Clinical Trials		
Throughout	Throughout		

ADDITIONAL CHANGE(S) FOR THIS AMENDMENT:

No additional changes.

1.0 TRIAL SUMMARY

Abbreviated Title	A Phase 2 Study of Pembrolizumab (MK-3475) as Monotherapy in Subjects with Advanced Hepatocellular Carcinoma
Sponsor Product Identifiers	MK-3475 Pembrolizumab
Trial Phase	Phase 2
Clinical Indication	Hepatocellular carcinoma (HCC)
Trial Type	Interventional
Type of control	No treatment control
Route of administration	Intravenous (IV)
Trial Blinding	Unblinded Open-label
Treatment Groups	Pembrolizumab 200 mg IV every 3 weeks
Number of trial subjects	Approximately 150 (100 subjects in Cohort 1 and 50 subjects in Cohort 2) subjects will be enrolled.
Estimated duration of trial	The Sponsor estimates that the trial will require approximately 60 months from the time the first subject signs the informed consent until the last subject's last study-related phone call or visit.
Duration of Participation	Each subject will participate in the trial from the time the subject signs the informed consent form (ICF) through the final contact. After a screening phase of up to 28 days, each subject will receive pembrolizumab beginning on Day 1 of each 3-week dosing cycle. Treatment will continue until progressive disease, unacceptable adverse events, intercurrent illness that prevents further administration of treatment, investigator's decision to withdraw the subject, subject withdrawal of consent, pregnancy of the subject, noncompliance with trial treatment or procedure requirements, subject receives 35 treatments (approx. 2 years) of pembrolizumab, or administrative reasons requiring cessation of treatment. Subjects who stop pembrolizumab as a result of obtaining a confirmed complete response (CR) or those subjects who stop after receiving 35 trial treatments may be eligible, at the discretion of the investigator, for an additional 17 trial treatments (approx. 1 year) after progressive disease if they meet the criteria for re-treatment (Second Course Phase) and the study is ongoing. Subjects who discontinue for reasons other than progressive disease will have post-treatment follow-up visits for monitoring disease status until progressive disease, initiating a non-study cancer treatment, withdrawing consent from study participation, or becoming lost to follow-up. All subjects will be followed (e.g., by telephone or visit) for overall survival until death, withdrawal of consent from study participation, or the end of the study, whichever comes first. After the end of trial treatment, each subject will be followed for 30 days for adverse event monitoring. Serious adverse events will be collected for 90 days after the end of treatment or for 30 days after the end of treatment if the subject initiates new anticancer therapy, whichever is earlier. Upon study completion, participants are discontinued and may be enrolled in a pembrolizumab extension study, if available.

Randomization Ratio	Not applicable
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A list of abbreviations used in this document can be found in Section 12.9.

2.0 TRIAL DESIGN

2.1 Trial Design

This is a single-arm, open-label, multi-site Phase 2 trial of pembrolizumab (MK-3475) in subjects with advanced hepatocellular carcinoma (HCC). For Cohort 1, the trial will include previously systemically treated subjects with a histologically or cytologically confirmed diagnosis of HCC (fibrolamellar and mixed hepatocellular/cholangiocarcinoma subtypes are not eligible) based on pathology report. For Cohort 2, the trial will include subjects with a radiologically or histologically or cytologically confirmed diagnosis of HCC who have not received prior systemic therapy in the advanced disease setting. To be eligible, subjects must have disease not amenable to a curative treatment approach (eg, transplant, surgery, or ablation). In addition, subjects in Cohort 1 will have evidence of disease progression after stopping treatment with sorafenib or else intolerance to sorafenib. Subjects must also have at least one measurable lesion that is confirmed by the central imaging vendor per Response Evaluation Criteria in Solid Tumors (RECIST) 1.1, Child Pugh liver score A, an Eastern Cooperative Oncology Group (ECOG) performance score of 0 or 1, and predicted life expectancy of greater than 3 months. Subjects will be enrolled regardless of tissue PD-L1 biomarker status. Subjects will not be required to provide a tumor tissue sample for biomarker analysis but are strongly urged to do so if tissue is available. Approximately 150 subjects will be allocated to 1 of the following 2 cohorts:

Cohort 1 (2L): approximately 100 subjects who received prior systemic therapy of sorafenib for HCC in the advanced disease setting

Cohort 2 (1L): approximately 50 subjects who did not receive prior systemic therapy for HCC in the advanced disease setting.

The primary objective of this trial is to determine the objective response rate (ORR) of pembrolizumab given as monotherapy. Beginning with screening, all imaging assessments will be submitted for central imaging vendor review and will be evaluated using RECIST 1.1. On-study imaging assessments will be performed every 9 weeks (Q9W) calculated from the date of allocation and independent of treatment delays. RECIST 1.1 will be used by the site for treatment decisions until the first radiologic evidence of progressive disease (PD).

Following the first radiologic evidence of PD by RECIST 1.1, treatment decisions may be made by the adaptation of RECIST 1.1 as described in Section 4.2.3.2 termed immune-related RECIST (irRECIST) to accommodate the tumor response patterns seen with pembrolizumab treatment (e.g., tumor flare). This was first described by Nishino, et al. 2013 [1] and is further modified for the pembrolizumab program. For a clinically stable subject with first radiologic evidence of PD, it is at the discretion of the site investigator to continue treating the subject with pembrolizumab until PD is confirmed at least 4 weeks after the date of the first tumor imaging suggesting PD per the site investigator. If radiologic PD is confirmed by the subsequent tumor imaging, the subject should be discontinued from

treatment unless, in the opinion of the investigator, the subject is achieving a clinically meaningful benefit; an exception for continued treatment may be considered following consultation with the Sponsor.

Subjects may continue to be treated with pembrolizumab until PD is confirmed by RECIST 1.1, unacceptable adverse events (AEs), intercurrent illness that prevents further administration of treatment, investigator's decision to withdraw the subject, subject withdrawal of consent, pregnancy of the subject, noncompliance with trial treatment or procedure requirements, administrative reasons, or the subject has received 35 trial treatments (approximately 2 years) with pembrolizumab. Subjects who discontinue trial treatment for a reason other than disease progression will move into the Follow-up Phase and should be assessed every 12 weeks (84±7 days) by radiologic imaging to monitor disease status. Disease status will continue to be monitored until whichever of the following occurs first: The start of new anti-cancer treatment, disease progression, death, or the end of the study. All subjects will be followed every 12 weeks for overall survival (OS) until death, withdrawal of consent from participation in the study, or the end of the study, whichever comes first.

Subjects who attain a CR by 2 tumor imaging assessments at least 4 weeks apart and who have received at least 8 treatments (approximately 6 months of therapy) with pembrolizumab may discontinue treatment at the discretion of the investigator after receiving at least 2 treatments beyond the initial determination of a CR. Subjects who stop pembrolizumab after receiving 35 trial treatments (approx. 2 years) for reasons other than PD or intolerance or who stop after attaining a CR may be eligible for retreatment with up to an additional 17 treatments (second course of treatment, approximately 1 year) after they have experienced radiographic PD (see Section 5.8.1). The decision to re-treat will be at the discretion of the investigator only if no other cancer treatment was administered since the last dose of pembrolizumab, the subject still meets the parameters listed in the inclusion and exclusion criteria, and the trial remains open.

Adverse events will be monitored throughout the trial and graded in severity according to the guidelines outlined in the National Cancer Institute (NCI) Common Terminology Criteria for Adverse Events (CTCAE) version 4.0 (Section 12.6). After the end of treatment, each subject will be followed for 30 days for AE monitoring. Serious adverse events (SAEs) will be collected for 90 days after the end of treatment or 30 days after the end of treatment if the subject initiates new anticancer therapy, whichever is earlier.

To supplement the routine trial monitoring outlined in this protocol, an external data monitoring committee (eDMC) will monitor the interim data from this trial (Cohort 1 only). Details regarding the role of the eDMC are provided in the eDMC Charter.

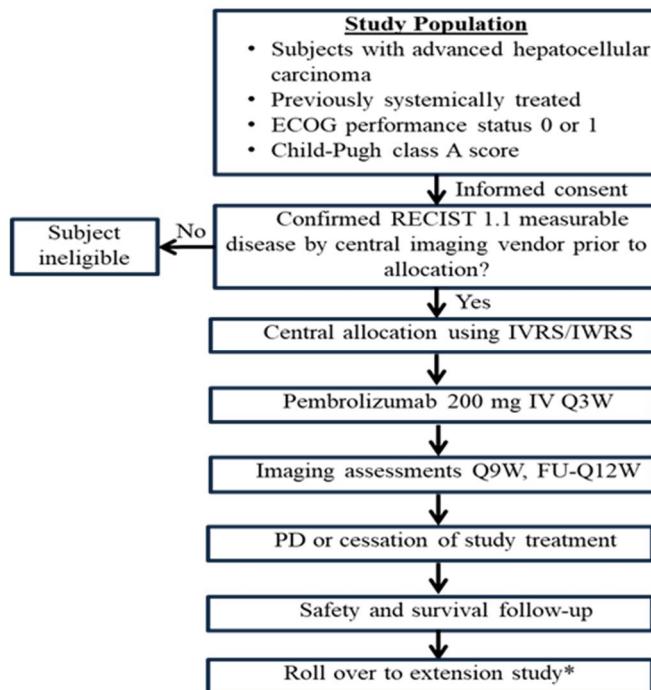
An interim analysis (see Section 8.7) of the safety and efficacy data from the first 20 patients enrolled in Cohort 1 will be performed to inform planning of other studies in the pembrolizumab development program. This analysis will be performed by the Clinical Biostatistics department of the Sponsor.

Upon study completion, participants are discontinued and may be enrolled in a pembrolizumab extension study, if available.

This study will be conducted in conformance with Good Clinical Practices (GCP).

Specific procedures to be performed during the trial, as well as their prescribed times and associated visit windows, are outlined in the Trial Flow Chart - Section 6.0. Details of each procedure are provided in Section 7.0 – Trial Procedures.

2.2 Trial Diagram



*Participants may roll over if extension study is available

Abbreviations: ECOG = Eastern Cooperative Oncology Group; IV = intravenous; IVRS = interactive voice response system; IWRS = Integrated web response system; PD = progressive disease; Q3W = every 3 weeks; Q9W = every 9 weeks; Q12W – every 12 weeks; RECIST = Response Evaluation Criteria in Solid Tumors;

Figure 1 Trial Diagram

3.0 OBJECTIVE(S) & HYPOTHESIS(ES)

Intravenous administration of pembrolizumab in subjects with HCC with no curative option after disease progression on sorafenib or intolerance of sorafenib (Cohort 1) and, separately, in subjects with HCC who had not received treatment for systemic disease in the advanced setting (Cohort 2):

3.1 Primary Objective(s) & Hypothesis(es)

(1) Objective: To estimate the ORR, per RECIST 1.1 assessed by central imaging vendor.

Hypothesis: No hypothesis testing will be performed.

3.2 Secondary Objective(s) & Hypothesis(es)

(1) Objective: To evaluate the duration of response (DOR), disease control rate (DCR), time to progression (TTP), and progression-free survival (PFS) per RECIST 1.1 assessed by central imaging vendor, and OS.

(2) Objective: To determine the safety and tolerability of pembrolizumab monotherapy.

3.3 Exploratory Objectives

(1) Objective: To evaluate ORR, DOR, DCR, TTP, and PFS per irRECIST assessed by the central imaging vendor.

(2) Objective: To evaluate PFS, ORR, DOR, DCR, and TTP per modified RECIST for HCC (mRECIST) assessed by central imaging vendor review.

(3) Objective: To evaluate ORR, DOR, DCR, TTP, and PFS according to investigator-assessed scans per RECIST 1.1.

(4) Objective: To identify molecular (genomic, metabolic and/or proteomic) determinants of response or resistance (e.g., PD-L1 IHC, gene expression profiling, or genomic variation) to pembrolizumab and other treatments in this study, using blood and /or tumor tissue to define novel predictive and pharmacodynamic biomarkers and better understand the mechanism of action of pembrolizumab.

(5) Objective: To explore the response of underlying hepatitis B virus (HBV) or hepatitis C virus (HCV) if present to pembrolizumab as assessed by viral loads and viral serologies.

(6) Objective: For Cohort 1 only, to explore the relationship between cause of sorafenib discontinuation (intolerant vs. radiographic progression of disease) and response to pembrolizumab.

4.0 BACKGROUND & RATIONALE

4.1 Background

Refer to the Investigator's Brochure (IB)/approved labeling for detailed background information on MK-3475.

Liver cancer is the second leading cause of cancer deaths in the world and has one of the most rapidly rising mortality rates of any cancer in the United States. Most HCC arises in the setting of liver cirrhosis from varied causes, including viral hepatitis, excessive alcohol consumption, hemochromatosis, and metabolic syndrome [2]. As a consequence of these different etiologies, HCC is a heterogeneous malignancy. Despite advances in early detection, liver transplantation and liver-directed therapies, about 70% of HCC patients present with advanced disease with no curative option. HCC is resistant to most traditional chemotherapy agents, and the median survival for patients with advanced disease is typically 6–9 months without therapy.

The oral tyrosine kinase inhibitor sorafenib is the current standard of care worldwide for treatment of patients with advanced HCC in the first line based on a large Phase 3 trial in a Western population. In this trial, time to progression was 5.5 months and OS was 10.7 months in the treatment arm, compared with 2.8 and 7.9 months in the control arm [3], respectively. The hazard ratio for OS was 0.69, [95% CI 0.55-0.87], p<0.001 [3]. A similar study conducted in the Asia-Pacific region showed an almost identical hazard ratio for sorafenib of 0.68 [95% CI 0.50-0.93], p=0.014, although OS was shorter in this trial [4]. Several recent randomized clinical trials comparing other agents to sorafenib in the first-line setting have been negative, although lenvatinib was non-inferior with respect to overall survival [5], and has already been approved in Japan for first-line HCC; however sorafenib remains the only Food and Drug Administration (FDA)-approved systemic therapy for 1L HCC patients in the United States. In parts of Asia, the FOLFOX regimen (folinic acid, 5-fluorouracil, and oxaliplatin) has also been approved, based on a randomized trial comparing FOLFOX4 to doxorubicin [6]. In this trial, there was a non-significant trend toward improved OS in the FOLFOX arm, with some imbalances in the populations favoring the FOLFOX arm. Despite these advances, continued investigation of additional agents for advanced HCC patients without a curative option remains crucial. All other agents assessed as first-line therapy as well as several other agents assessed in the second-line setting have failed to show improved survival over sorafenib or placebo [7].

Currently, regorafenib is the only globally approved second-line therapy following sorafenib treatment in patients with advanced HCC [8]. Recently, cabozantinib has demonstrated improved overall survival versus placebo in patients with advanced HCC who failed prior sorafenib treatment [9]. While these both have demonstrated improved survival, the benefits remain modest with associated side effects. Several large randomized trials again failed to show a significant survival advantage against placebo in the second line, including brivanib [10], everolimus [11], and ramucirumab [12]. Chemotherapy drugs including capecitabine and the gemcitabine/oxaliplatin (GEMOX) combination have also been used in the second line in small trials [13] [14]. Nivolumab received accelerated approval for the second-line treatment of HCC in 2017 [15].

4.1.1 Pharmaceutical and Therapeutic Background

Pembrolizumab (MK-3475) is a potent and highly selective humanized monoclonal antibody (mAb) of the IgG4/kappa isotype designed to directly block the interaction between PD-1 and its ligands, programmed death ligand 1 (PD-L1) and programmed death ligand 2 (PD-L2). KEYTRUDA® (pembrolizumab) has recently been approved in the United States for the treatment of patients with unresectable or metastatic melanoma and disease progression following treatment with ipilimumab or a BRAF inhibitor, if BRAF V600 mutation-positive. Pembrolizumab was also recently approved for the treatment of patients with metastatic non-small cell lung cancer (NSCLC) whose tumors express PD-L1 as determined by a Food and Drug Administration (FDA)-approved test, with disease progression on or after platinum-containing chemotherapy.

The importance of intact immune surveillance in controlling neoplastic growth has been known for decades [16]. Accumulating evidence shows a correlation between tumor-infiltrating lymphocytes (TILs) in cancer tissue and favorable prognosis in various malignancies [17] [18] [19] [20] [21]. In particular, the presence of CD8+ T-cells and the ratio of CD8+ effector T-cells to FoxP3+ regulatory T-cells seem to correlate with improved prognosis and long-term survival in many solid tumors.

The PD-1 receptor-ligand interaction is a major pathway hijacked by tumors to suppress immune control. The normal function of PD-1, expressed on the cell surface of activated T-cells under healthy conditions, is to down-modulate unwanted or excessive immune responses, including autoimmune reactions. PD-1 (encoded by the gene *Pdcd1*) is an Ig superfamily member related to CD28 and CTLA-4 which has been shown to negatively regulate antigen receptor signaling upon engagement of its ligands (PD-L1 and/or PD-L2) [22] [23].

The structure of murine PD-1 has been identified [24]. PD-1 and family members are type I transmembrane glycoproteins containing an Ig Variable-type (V-type) domain responsible for ligand binding and a cytoplasmic tail which is responsible for the binding of signaling molecules. The cytoplasmic tail of PD-1 contains 2 tyrosine-based signaling motifs, an immunoreceptor tyrosine-based inhibition motif (ITIM), and an immunoreceptor tyrosine-based switch motif (ITSM).

Following T-cell stimulation, PD-1 recruits the tyrosine phosphatases SHP-1 and SHP-2 to the ITSM motif within its cytoplasmic tail, leading to the dephosphorylation of effector molecules such as CD3 ζ , PKC θ , and ZAP70 which are involved in the CD3 T-cell signaling cascade [22] [25] [26] [27]. The mechanism by which PD-1 down-modulates T-cell responses is similar to, but distinct from, that of CTLA-4 as both molecules regulate an overlapping set of signaling proteins [28] [29]. PD-1 was shown to be expressed on activated lymphocytes including peripheral CD4+ and CD8+ T-cells, B-cells, T-regulatory cells and natural killer cells [30] [31]. Expression has also been shown during thymic development on CD4-/CD8- (double negative) T-cells as well as subsets of macrophages and dendritic cells [32].

The ligands for PD-1 (PD-L1 and PD-L2) are constitutively expressed or can be induced in a variety of cell types, including non-hematopoietic tissues as well as in various tumors [33] [34] [35] [28]. Both ligands are type I transmembrane receptors containing both IgV- and IgC-like domains in the extracellular region and contain short cytoplasmic regions with no known signaling motifs. Binding of either PD-1 ligand (PD-L1 or PD-L2) to PD-1 inhibits T-cell activation triggered through the T-cell receptor. PD-L1 is expressed at low levels on various non-hematopoietic tissues, most notably on vascular endothelium, whereas PD-L2 protein is only detectably expressed on antigen-presenting cells found in lymphoid tissue or chronic inflammatory environments. PD-L2 is thought to control immune T-cell activation in lymphoid organs, whereas PD-L1 serves to dampen unwarranted T-cell function in peripheral tissues [28]. Although healthy organs express little (if any) PD-L1, a variety of cancers were demonstrated to express abundant levels of this T-cell inhibitor. PD-1 has been suggested to regulate tumor-specific T-cell expansion in subjects with melanoma [36].

4.1.2 Pre-clinical and Clinical Trials

Therapeutic studies in mouse models have shown that the administration of antibodies blocking the PD-1/PD-L1 interaction enhances infiltration of tumor-specific CD8+ T-cells and leads ultimately to tumor rejection, either as a monotherapy or in combination with other treatment modalities. Anti-mouse PD-1 and anti-mouse PD-L1 antibodies have demonstrated anti-tumor responses as monotherapy in models of squamous cell carcinoma, pancreatic carcinoma, melanoma, and colorectal carcinoma. Blockade of the PD-1 pathway effectively promotes CD8+ T-cell infiltration into the tumor and the presence of interferon- γ , granzyme B and perforin, indicating that the mechanism of action involves local infiltration and activation of effector T-cell function in vivo [37] [38] [39] [40] [41] [42]. Experiments have confirmed the in vivo efficacy of PD-1 blockade as a monotherapy as well as in combination with chemotherapy in syngeneic mouse tumor models (see the IB).

Clinical trials have demonstrated efficacy using pembrolizumab in subjects with advanced melanoma, non-small cell lung cancer (NSCLC), head and neck cancer, bladder cancer, Hodgkin's lymphoma, triple-negative breast cancer, and gastric adenocarcinoma. In addition, recent data demonstrate emerging evidence of single-agent activity in additional tumor types such as mesothelioma, urothelial cancer, ovarian cancer, neuroendocrine carcinoma, and small cell lung cancer.

In a mouse model of HCC, blockade of PD-1 with immunostimulatory monoclonal antibodies extends survival [43]. HCC patients with higher tumoral expression of PD-L1 had a significantly poorer prognosis than patients with lower expression, and tumor expression of PD-L1 is an independent predictor for postoperative recurrence in HCC patients [44]. High expression levels of PD-1 on tumor-infiltrating lymphocytes (TILs) and peripheral blood mononuclear cells (PBMCs) have also been correlated with a poor prognosis in HCC patients after surgical resection [45].

The Phase I/II trial of the anti-PD-1 antibody, nivolumab, in subjects with advanced HCC demonstrated an ORR by blinded independent central review of 14%, with several durable responses. Responses were seen both in viral-mediated cancers and those without an underlying viral etiology. Responses were also seen in those with tumors positive or negative for PD-L1 tumor staining by immunohistochemistry. Results showed the safety

profile of nivolumab in HCC to be generally consistent with that previously reported in other tumor types, and no maximum tolerated dose (MTD) has been identified. These data provide additional preliminary evidence that anti-PD-1 therapy can yield durable responses with an acceptable toxicity profile in patients with advanced HCC [15].

4.1.3 Ongoing Clinical Trials

Ongoing clinical trials of pembrolizumab are being conducted in advanced melanoma, NSCLC, and a number of other advanced solid tumor indications and hematologic malignancies. For study details, refer to the IB.

4.2 Rationale

4.2.1 Rationale for the Trial and Selected Subject Population

HCC often develops in the setting of inflammation of various types, including viral infections. In a gene-expression profiling study, non-tumoral tissue from patients with HCC with an inflammatory signature predicted worsened OS [46]. As discussed above, HCC patients with higher tumor expression of PD-L1 have a significantly poorer prognosis than patients with lower expression [44]. In addition, high expression levels of PD-1 on T-cells, both on tumor infiltrating lymphocytes and peripheral blood mononuclear cells, also correlate with increased stage and higher recurrence rates in HCC patients after surgical resection [45].

Recently, immunotherapy has been shown to produce antitumor effects in HCC, a tumor which has shown resistance to traditional forms of chemotherapy. Cytotoxic T-lymphocyte-associated protein (CTLA)-4 inhibition with tremelimumab was evaluated in a small study of HCV-associated HCC patients [47]. Seventeen patients were evaluable for response, and 3 partial responses were seen for 3.6, 9.2 and 15.8 months. Stable disease was the best response seen in 59%, and of these, 45% were stable for over 6 months. Toxicity was manageable, despite early elevations in transaminases.

As discussed above, the interim analysis of a Phase 1/2 trial of the anti-PD-1 antibody, nivolumab, in subjects with advanced HCC demonstrated an ORR of 14.3% [48]. Responses were seen both in viral-mediated cancers and those without an underlying viral etiology. Results also showed the safety profile of nivolumab in HCC to be generally consistent with that previously reported in other tumor types, and no maximum tolerated dose (MTD) has been identified [49].

4.2.2 Rationale for Dose Selection/Regimen

The dose of pembrolizumab planned to be studied in this trial is 200 mg Q3W. The dose recently approved in the United States and several other countries for treatment of melanoma and NSCLC subjects is 2 mg/kg Q3W. Information on the rationale for selecting the 200 mg Q3W dose is summarized below. Keynote-001, an open-label Phase 1 study, was conducted to evaluate the safety, tolerability, pharmacokinetics (PK) and pharmacodynamics, and anti-tumor activity of single agent pembrolizumab. The dose escalation portion of this trial evaluated three dose levels, 1 mg/kg, 3 mg/kg and 10 mg/kg, administered every 2 weeks

(Q2W) and dose expansion cohorts evaluated 2 mg/kg Q3W and 10 mg/kg Q3W in subjects with advanced solid tumors. All dose levels were well tolerated and no dose-limiting toxicities were observed. This first-in-human study of pembrolizumab showed evidence of target engagement and objective evidence of tumor size reduction at all dose levels. No maximum tolerated dose (MTD) has been identified. In addition, two randomized cohort evaluations of melanoma subjects receiving pembrolizumab at a dose of 2 mg/kg versus 10 mg/kg Q3W have been completed, and one randomized cohort evaluating 10 mg/kg Q3W versus 10 mg/kg Q2W has also been completed. The clinical efficacy and safety data demonstrate a lack of important differences in the efficacy and safety profiles across doses.

An integrated body of evidence suggests that 200 mg Q3W is expected to provide a similar response to 2 mg/kg Q3W, 10 mg/kg Q3W and 10 mg/kg Q2W. Previously, a flat pembrolizumab exposure-response relationship for efficacy and safety has been found in subjects with melanoma in the range of doses between 2 mg/kg and 10 mg/kg. Exposures for 200 mg Q3W are expected to lie within this range and will be close to those obtained with 2 mg/kg Q3W dose.

A population PK model, which characterized the influence of body weight and other patient covariates on exposure, has been developed. The PK profile of pembrolizumab is consistent with that of other humanized monoclonal antibodies, which typically have a low clearance and a limited volume of distribution. The distribution of exposures from the 200 mg fixed dose are predicted to considerably overlap those obtained with the 2 mg/kg dose and importantly will maintain individual patient exposures within the exposure range established in melanoma and NSCLC associated with maximal clinical response. Pharmacokinetic properties of pembrolizumab, and specifically the weight-dependency in clearance and volume of distribution are consistent with no meaningful advantage to weight-based dosing relative to fixed dosing.

In translating to other tumor indications, similarly flat exposure-response relationships for efficacy and safety as observed in subjects with melanoma can be expected, as the anti-tumor effect of pembrolizumab is driven through immune system activation rather than through a direct interaction with tumor cells, rendering it independent of the specific tumor type. In addition, available PK results in subjects with melanoma, NSCLC, and other tumor types support a lack of meaningful difference in pharmacokinetic exposures obtained at tested doses among tumor types. Thus the 200 mg Q3W fixed-dose regimen is considered an appropriate fixed dose for other tumor indications as well.

A fixed dose regimen will simplify the dosing regimen to be more convenient for physicians and to reduce potential for dosing errors. A fixed dosing scheme will also reduce complexity in the logistical chain at treatment facilities and reduce wastage. The existing data suggest 200 mg Q3W as the appropriate dose for pembrolizumab.

4.2.3 Rationale for Endpoints

4.2.3.1 Efficacy Endpoints

The primary efficacy objective of this study is to evaluate the anti-tumor activity of pembrolizumab in subjects after disease progression on sorafenib or intolerance of sorafenib (Cohort 1) or who had not received treatment for systemic disease in the advanced setting (Cohort 2). The ORR will be used as the primary endpoint per RECIST 1.1 criteria as assessed by the central imaging vendor.

4.2.3.1.2 Secondary Efficacy Endpoints

The secondary efficacy objectives of this study are to evaluate DOR, and determine the safety and tolerability of pembrolizumab in subjects with HCC. DCR, TTP, and PFS per RECIST 1.1 will also be assessed by the central imaging vendor; and OS will also be examined.

4.2.3.1.3 Exploratory Efficacy Endpoints

Exploratory efficacy objectives of this study are to explore ORR, DOR, DCR, TTP and PFS per 1) irRECIST assessed by the central imaging vendor and 2) investigator assessment using RECIST 1.1 3) measurements based on RECIST 1.1 assessed by the central imaging vendor and 4) mRECIST by the central imaging vendor, to assess these different evaluations in an HCC population. Additional objectives of this study are to explore the association between genomic, metabolic and/or proteomic biomarkers and antitumor efficacy of pembrolizumab based on RECIST 1.1 as assessed by the central imaging vendor. The relationship between cause of sorafenib discontinuation (intolerance vs. radiographic progression to disease) and response to pembrolizumab in terms of overall survival will also be explored.

4.2.3.2 Immune-related RECIST

RECIST 1.1 will be adapted to account for the unique tumor response characteristics seen with pembrolizumab treatment. Immunotherapeutic agents such as pembrolizumab may produce anti-tumor effects by potentiating endogenous cancer-specific immune responses. The response patterns seen with such an approach may extend beyond the typical time course of responses seen with cytotoxic agents, and can manifest a clinical response after an initial increase in tumor burden or even the appearance of new lesions. Standard RECIST 1.1 may, thus, not provide an accurate response assessment of immunotherapeutic agents such as pembrolizumab.

Based on an analysis of patients with melanoma enrolled in Keynote 001, 7% of evaluable patients experienced delayed or early tumor pseudoprogression. Of note, patients who had progressive disease by RECIST 1.1 but not by immune-related response criteria had longer OS than patients with progressive disease by both criteria. Additionally, the data suggest that RECIST 1.1 may underestimate the benefit of pembrolizumab in approximately 15% of patients. These findings support the need to apply a modification to RECIST 1.1 that takes

into account the unique patterns of atypical response in immunotherapy and enable treatment beyond initial radiographic progression.

Immune-related RECIST (irRECIST) is RECIST 1.1 adapted to account for the unique tumor response seen with immuno-therapeutics as described in Nishino et al., CCR 2013 [1]. The assessment of unidimensional target lesions and response categories per irRECIST are identical to RECIST 1.1. However, MSD has implemented an adaptation related to new lesions, non-target and tumor burden assessment in order to confirm radiographic progression. irRECIST will be used by local site investigators to assess tumor response and progression, and make treatment decisions as well as by the central imaging vendor in support of all secondary and exploratory response endpoints. Confirmation of PD for irRECIST endpoints will be taken from central imaging retrospectively, according to irRECIST definition.

For further information on irRECIST, see Section 7.1.4.1.6.

4.2.3.3 Safety Endpoints

The safety objective of this trial is to characterize the safety and tolerability of pembrolizumab in subjects after disease progression on sorafenib or intolerance of sorafenib (Cohort 1) or who had not received treatment for systemic disease in the advanced setting (Cohort 2). The primary safety analysis will be based on subjects who have toxicities as defined by CTCAE, version 4.0 (Section 12.6).

The attribution to drug, time-of-onset, duration of the event, its resolution, and any concomitant medications administered will be recorded. AEs will be analyzed including, but not limited to, all AEs, SAEs, fatal AEs, and laboratory changes. Furthermore, specific events will be collected and designated as events of clinical interest (ECIs) as described in Section 7.2.3.2.

The mandatory Safety Follow-Up Visit should be conducted approximately 30 days after the last dose of trial treatment or before the initiation of a new anti-neoplastic treatment, whichever comes first. All AEs that occur prior to the Safety Follow-Up Visit should be recorded. Subjects with an AE of Grade >1 will be followed until the resolution of the AE to Grade 0-1 or until the beginning of a new anti-neoplastic therapy, whichever occurs first. SAEs that occur within 90 days following cessation of treatment, or 30 days following cessation of treatment if the subject initiates new anticancer therapy, whichever is earlier, should be followed and recorded.

4.2.3.4 Biomarker Research

Introduction: Cancer immunotherapies are an important novel class of anti-tumor agents. However, much remains to be learned about how cancer immunotherapies work and how best to leverage these new drugs in treating patients. Thus, to aid future patients, it is important to investigate the determinants of response or resistance to cancer immunotherapies, as well as determinants of adverse events in the course of our clinical trials. To that end we seek to define novel predictive/pharmacodynamic biomarkers and the best strategies of combination therapy with immuno-oncology drugs. To fully leverage the

clinical data collected in this trial, we will also collect biospecimens (blood components, tumor material, etc.) to support biomarker analyses of cellular components (e.g., protein, DNA, RNA, metabolites) and other blood-soluble molecules. Investigations may include but are not limited to:

Germline (blood) DNA analyses (e.g., single nucleotide polymorphism analyses, whole exome sequencing, whole genome sequencing):

This research will evaluate whether genetic variation within a clinical trial population correlates with response to the treatment(s) under evaluation. If genetic variation is found to predict efficacy or adverse events, the data might inform optimal use of therapies in the patient population. Furthermore, it is important to evaluate germline DNA variation across the genome in order to interpret tumor-specific DNA mutations.

Tumor DNA analyses:

The application of new technologies, such as next generation sequencing, has provided scientists the opportunity to identify tumor-specific DNA changes (ie, mutations, methylation status, microsatellite instability etc.). Key molecular changes of interest to immune-oncology drug development are the mutational burden of tumors and the clonality of T-cells in the tumor microenvironment. Increased mutational burden (sometimes referred to as a 'hyper-mutated' state) is one of the major mechanisms of neo-antigen presentation in the context of a tumor. The increased presence of foreign-like peptides on the cell surface due to somatic mutations in the DNA of the tumor increases the chances that the tumor will be 'visible' to the adaptive immune system through the MHC-I antigen presentation mechanism.

There are a number of mechanisms by which a tumor can have increased mutational burden, such as defects in key genes related to DNA mismatch repair mechanisms or environmental induced factors such as smoking or UV light exposure. Additionally, a DNA tetrapeptide neo-antigen mutational signature can also be obtained by use of bioinformatic prediction tools of HLA-restricted mutated peptide binding to MHC class I and to the T-cell. There is a potential that in the hyper-mutated state, the presence of neo-antigen mutational patterns and the detection of increased T-cell clonality, both of which can be determined by use of next-generation sequencing methods, may correlate with response to pembrolizumab therapy and/or that the converse, the 'hypomutated' state (the absence of neo-antigens) may correlate with non-response. To conduct this type of research, it is important to identify tumor-specific mutations that occur across all genes in the tumor genome. Thus, genome wide approaches may be used for this effort. Note that in order to understand tumor-specific mutations, it is necessary to compare the tumor genome with the germline genome (e.g., from germline blood DNA).

Tumor and blood RNA analyses:

Both genome-wide and targeted messenger RNA (mRNA) expression profiling and sequencing in tumor tissue and in blood may be performed to define gene signatures that correlate to clinical response to treatment with pembrolizumab or other immunotherapies. Pembrolizumab induces a response in tumors that likely reflects an inflamed/ immune

phenotype. Specific immune-related gene sets (such as those capturing interferon-gamma transcriptional pathways) may be evaluated and new signatures may be identified. Individual genes related to the immune system may also be evaluated (e.g., interleukin-10). MicroRNA profiling may also be pursued.

Proteomics and Immunohistochemistry (IHC) using Blood or Tumor:

Tumor and blood samples from this study may undergo proteomic analyses (eg, PD-L1 IHC). PD-L1 protein level, as assessed by IHC in tumor sections, has been shown to correlate with response to pembrolizumab in patients with NSCLC, and a PD-L1 IHC diagnostic is marketed for use with pembrolizumab in NSCLC. Preliminary data indicates that this association may also be true in additional cancer types (ie, triple-negative breast cancer, head and neck, and gastric). Additional tumor- or blood-derived proteins may also correlate with response to pembrolizumab. Therefore, tumor tissue may be subjected to proteomic profiling using a variety of platforms that could include but are not limited to immunoassay and/or liquid chromatography/mass spectrometry. This approach could identify novel protein biomarkers that could aid in patient selection for pembrolizumab (MK-3475) therapy.

Other Blood Derived Biomarkers

In addition to expression within the tumor tissue, tumor derived proteins (e.g., PD-L1) or tumor derived DNA can be shed from tumor and released into the blood. In the case of proteins, enzyme-linked immunoassay can measure such proteins in serum and plasma and correlate this expression with response to pembrolizumab therapy, as well as levels of protein in the tumor. DNA can be analyzed using next generation sequencing or polymerase chain reaction (PCR) based technologies. Advantages to this method are that blood is a less invasive compartment from which tumor derived protein or nucleic acid biomarkers may be measured.

4.2.3.5 Future Biomedical Research

The Sponsor will conduct Future Biomedical Research on specimens collected for future biomedical research during this clinical trial. This research may include genetic analyses (DNA), gene expression profiling (RNA), proteomics, metabolomics (serum, plasma) and/or the measurement of other analytes.

Such research is for biomarker testing to address emergent questions not described elsewhere in the protocol (as part of the main trial) and will only be conducted on specimens from appropriately consented subjects. The objective of collecting specimens for Future Biomedical Research is to explore and identify biomarkers that inform the scientific understanding of diseases and/or their therapeutic treatments. The overarching goal is to use such information to develop safer, more effective drugs/vaccines, and/or to ensure that subjects receive the correct dose of the correct drug/vaccine at the correct time. The details of this Future Biomedical Research sub-trial are presented in Section 12.2 - Collection and Management of Specimens for Future Biomedical Research. Additional informational material for institutional review boards/ethics committees (IRBs/ERCs) and investigational site staff is provided in Section 12.3.

4.3 Benefit/Risk

It cannot be guaranteed that subjects in clinical trials will directly benefit from treatment during participation, as clinical trials are designed to provide information about the safety and effectiveness of an investigational medicine. However, experience with this drug approved in other indications, as well as with similar drugs in HCC suggests that study subjects may receive a clinical benefit (see Section 4.1.1).

Additional details regarding specific benefits and risks for subjects participating in this clinical trial may be found in the accompanying IB and Informed Consent documents.

5.0 METHODOLOGY

5.1 Entry Criteria

5.1.1 Diagnosis/Condition for Entry into the Trial

Male and female subjects with advanced HCC and with no curative option after disease progression on sorafenib or intolerance of sorafenib (Cohort 1) or who had not received treatment for systemic disease in the advanced setting (Cohort 2) will be enrolled in this trial.

5.1.2 Subject Inclusion Criteria

In order to be eligible for participation in this trial, the subject must:

1. Be willing and able to provide written informed consent for the trial. The subject may also provide consent for Future Biomedical Research (FBR). However, the subject may participate in the main trial without participating in FBR.
2. Be ≥ 18 years of age on day of signing informed consent.
3. For Cohort 1 only: Have histologically or cytologically confirmed diagnosis of HCC (fibrolamellar and mixed hepatocellular/cholangiocarcinoma subtypes are not eligible) based on pathology report. For Cohort 2 only: Have an HCC diagnosis confirmed by radiology, histology, or cytology (fibrolamellar and mixed hepatocellular/cholangiocarcinoma subtypes are not eligible).

Radiologic confirmation diagnosis is provided by the study site. Definition of radiological confirmation: Clinical findings consistent with the diagnosis of liver cirrhosis and a liver mass measuring at least 2 cm with characteristic vascularization (intense enhancement seen in the hepatic arterial-dominant phase and contrast washout in the late portal venous phase) seen in either triphasic computed tomography (CT) scan or magnetic resonance imaging (MRI).

4. Have Barcelona Clinic Liver Cancer (BCLC) Stage C disease or BCLC Stage B disease not amenable to locoregional therapy or refractory to locoregional therapy, and not amenable to a curative treatment approach (see Section 12.8).
5. Have a Child-Pugh class A liver score within 7 days of first dose of study drug (see Section 12.7).

6. Have a predicted life expectancy of greater than 3 months.
7. Have measurable disease based on RECIST 1.1 as confirmed by the blinded central imaging vendor.

Note: the same image acquisition and processing parameters should be used throughout the study for a given subject.

8. Have a performance status of 0 or 1 using the ECOG Performance Scale within 7 days of first dose of study drug.
9. For Cohort 1 only: Have documented objective radiographic progression after stopping treatment with sorafenib or else intolerance to sorafenib.

The definition of sorafenib intolerance will be:

Any Grade ≥ 2 drug-related AE which, despite supportive therapy, recurred after sorafenib treatment interruption of at least 7 days and dose reduction resulting in the subject requesting, or the physician recommending discontinuation due to toxicity.

10. Subjects with chronic infection by HCV who are untreated are allowed on study. In addition, subjects with successful HCV treatment (defined as sustained virologic response [SVR] 12 or SVR 24) are allowed as long as 4 weeks have passed between completion of HCV therapy and start of study drug.
11. Have a negative urine or serum pregnancy test within 72 hours prior to receiving the first dose of study medication (Cycle 1, Day 1) (female subjects of childbearing potential). If the urine test is positive or cannot be confirmed as negative, a serum pregnancy test will be required.
12. Be willing to use an adequate method of contraception for the course of the study through 120 days after the last dose of study medication (male and female subjects of childbearing potential [see Section 5.7.2]).

Note: Abstinence is acceptable if this is the usual lifestyle and preferred contraception for the subject.

13. Demonstrate adequate organ function as defined in [Table 1](#).

Table 1 Adequate Organ Function Laboratory Values

System	Laboratory Value
Hematological	
Absolute neutrophil count	$\geq 1200/\mu\text{L}$
Platelets	$\geq 60,000/\mu\text{L}$
Hemoglobin	$\geq 8 \text{ g/dL}$ without transfusion or EPO dependency within 7 days.
Renal	
Creatinine OR Measured or calculated creatinine clearance (GFR can also be used in place of creatinine or creatinine clearance)	$\leq 1.5 \times \text{ULN}$ OR $\geq 60 \text{ mL/min}$ for subject with creatinine levels $>1.5 \times$ institutional ULN <i>Note: Creatinine clearance should be calculated per institutional standard</i>
Hepatic	
Total bilirubin	$\leq 2 \text{ mg/dL}$, or direct bilirubin $\leq \text{ULN}$ for those with total bilirubin $>2 \text{ mg/dL}$
AST (SGOT) and ALT (SGPT)	$\leq 5 \times \text{ULN}$
Albumin	$\geq 3.0 \text{ g/dL}$
Coagulation	
INR or PT aPTT (Cohort 1 only)	$\leq 1.5 \times \text{ULN}$ unless subject is receiving anticoagulant therapy as long as PT or aPTT (cohort 1) is within therapeutic range of intended use of anticoagulants

Abbreviations: ALT=alanine aminotransferase; aPTT=activated partial thromboplastin time; AST=aspartate aminotransferase; EPO = erythropoietin; GFR=glomerular filtration rate; INR=international normalized ratio; PT=prothrombin time; PTT=partial thromboplastin time; SGOT=serum glutamic oxaloacetic transaminase; SGPT=serum glutamic pyruvic transaminase; ULN=upper limit of normal

5.1.3 Subject Exclusion Criteria

The subject must be excluded from participating in the trial if the subject:

1. Is currently participating and receiving study therapy or has participated in a study of an investigational agent and received study therapy, herbal/complementary oral or IV medicine, or used an investigation device within 4 weeks of the first dose of treatment. Subjects must also have recovered from associated therapy (ie, to Grade ≤ 1 or baseline) and from adverse events due to any prior therapy.
2. For Cohort 1 only: Has received sorafenib within 14 days of first dose of study medication.
3. Has had esophageal or gastric variceal bleeding within the last 6 months. All subjects will be screened for esophageal varices, unless such screening has been performed in the past 12 months before first dose of treatment. If varices are present, they should be treated according to institutional standards before starting trial treatment.

4. Has clinically apparent ascites on physical examination.
Note: ascites detectable on imaging studies only IS allowed.
5. Portal vein invasion at the main portal (Vp4), inferior vena cava, or cardiac involvement of HCC based on imaging.
6. Has had encephalopathy in the last 6 months. Subjects on rifaximin or lactulose to control their encephalopathy are not allowed.
7. Had a solid organ or hematologic transplant.
8. For Cohort 1 only: Had prior systemic therapy for HCC other than sorafenib, or intercurrent local therapy to the liver tumor between sorafenib and study drug. For Cohort 2 only: Had prior systemic therapy in the advanced disease setting.
9. Has active autoimmune disease that has required systemic treatment in past 2 years (ie, with use of disease-modifying agents, corticosteroids, or immunosuppressive drugs). Replacement therapy (eg, thyroxine, insulin, or physiologic corticosteroid replacement therapy for adrenal or pituitary insufficiency, etc.) is not considered a form of systemic treatment.
10. Has a diagnosis of immunodeficiency or is receiving systemic steroid therapy or any other form of immunosuppressive therapy within 7 days prior to the first dose of trial treatment. The use of physiologic doses of corticosteroids may be approved after consultation with the Sponsor.
11. Has received locoregional therapy to liver (transcatheter chemoembolization [TACE], transcatheter embolization [TAE], radiation, radioembolization, or ablation) or major surgery to liver or other site within 6 weeks in Cohort 1 and 4 weeks in Cohort 2 prior to the first dose of study drug. Minor surgery (eg, simple excision, tooth extraction) must have occurred at least 7 days prior to the first dose of trial treatment (Cycle 1, Day 1). Subjects must have recovered adequately (ie., Grade \leq 1 or baseline) from the toxicity and/or complications from any intervention prior to starting therapy.
12. Has a diagnosed additional malignancy within 5 years for Cohort 1 and 3 years for Cohort 2 prior to first dose of trial treatment with the exception of curatively treated basal cell carcinoma of the skin, squamous cell carcinoma of the skin and/or curatively resected in situ cervical and/or breast cancers.
13. Has radiographically detectable (even if asymptomatic and/or previously treated) central nervous system (CNS) metastases and/or carcinomatous meningitis as assessed by local site investigator.
14. Has a known history of, or any evidence of, interstitial lung disease or active non-infectious pneumonitis.
15. Has an active infection requiring systemic therapy
16. Has a known severe hypersensitivity (\geq Grade 3) to pembrolizumab, its active substance and/or any of its excipients. (Refer to the Investigator's Brochure for a list of excipients.).

17. Has a history or current evidence of any condition, therapy, or laboratory abnormality that might confound the results of the trial, interfere with the subject's participation for the full duration of the trial, or is not in the best interest of the subject to participate, in the opinion of the treating investigator, including dialysis.
18. Has known psychiatric or substance abuse disorders that would interfere with cooperation with the requirements of the trial.
19. Is pregnant or breastfeeding, or expecting to conceive or father children within the projected duration of the trial, starting with the screening visit through 120 days after the last dose of trial treatment.
20. Has received prior immunotherapy including anti-PD-1, anti-PD-L1, or anti-PD-L2 agents, or if the subject has previously participated in MSD pembrolizumab clinical trials.
21. Has a known history of human immunodeficiency virus (HIV) (HIV 1/2 antibodies).
22. Has untreated active Hepatitis B

Note: To qualify for enrollment, antiviral therapy for HBV must be given for at least 3 months, and HBV viral load must be less than 100 IU/mL prior to first dose of study drug. Those on active HBV therapy with viral loads under 100 IU/mL should stay on the same therapy throughout trial treatment. Those subjects who are anti-HBc (+) and negative for HBsAg, and have an HBV viral load under 100 IU/mL irrespective of their anti-HBS value do not require HBV anti-viral prophylaxis but need close monitoring.

23. For Cohort 1 only: Has dual infection with HBV/HCV or other hepatitis combinations at study entry.
For Cohort 2 only: Has dual active HBV infection (HBsAg (+) and/or detectable HBV DNA) and HCV infection (detectable HCV RNA) at study entry.
24. Has received a live vaccine within 30 days of planned start of study therapy (Cycle 1, Day 1).

Note: Killed virus vaccines used for seasonal influenza vaccines for injection are allowed; however intranasal influenza vaccines (eg, FluMist[®]) are live attenuated vaccines and are not allowed.

5.2 Trial Treatment(s)

The treatment to be used in this trial is outlined below in [Table 2](#).

Table 2 Trial Treatment

Drug	Dose/Potency	Dose Frequency	Route of Administration	Regimen	Use
Pembrolizumab (MK-3475)	200 mg	Q3W	IV Infusion	Day 1 of each 21-day cycle	Experimental

IV = intravenous; Q3W = every 3 weeks.

Trial treatment should begin within 3 days of allocation. However, every effort should be made to begin trial treatment on the day of allocation.

The investigator shall take responsibility for and shall take all steps to maintain appropriate records and ensure appropriate supply, storage, handling, distribution and usage of trial treatments in accordance with the protocol and any applicable laws and regulations.

5.2.1 Dose Selection/Modification

5.2.1.1 Dose Selection (Preparation)

The rationale for selection of the dose to be used in this trial is provided in Section 4.0 Background & Rationale. Details on preparation and administration of pembrolizumab are provided in the Pharmacy Manual.

5.2.1.2 Dose Interval Modification for Non-hepatic Drug-related Adverse Events

Adverse events associated with pembrolizumab exposure may represent an immunologic etiology. These immune-related AEs (irAEs) may occur shortly after the first dose or several months after the last dose of pembrolizumab treatment and may affect more than one body system simultaneously. Therefore, early recognition and initiation of treatment is critical to reduce complications. Based on existing clinical trial data, most irAEs were reversible and could be managed with interruptions of pembrolizumab administration of corticosteroids and/or other supportive care. For suspected irAEs, ensure adequate evaluation to confirm etiology or exclude other causes. Additional procedures or tests such as bronchoscopy, endoscopy, or skin biopsy may be included as part of the evaluation. Based on the severity of irAEs, withhold or permanently discontinue pembrolizumab and administer corticosteroids. Dose modification and toxicity management guidelines for irAEs associated with pembrolizumab are provided in [Table 3](#).

Table 3 Dose Modification and Toxicity Management Guidelines for Immune-related AEs Associated with Pembrolizumab

General instructions: <ol style="list-style-type: none"> 1. Corticosteroid taper should be initiated upon AE improving to Grade 1 or less and continue to taper over at least 4 weeks. 2. For situations where pembrolizumab has been withheld, pembrolizumab can be resumed after AE has been reduced to Grade 1 or 0 and corticosteroid has been tapered. Pembrolizumab should be permanently discontinued if AE does not resolve within 12 weeks of last dose or corticosteroids cannot be reduced to ≤ 10 mg prednisone or equivalent per day within 12 weeks. 3. For severe and life-threatening irAEs, IV corticosteroid should be initiated first followed by oral steroid. Other immunosuppressive treatment should be initiated if irAEs cannot be controlled by corticosteroids. 				
Immune-related AEs (irAEs)	Toxicity grade or conditions (CTCAEv4.0)	Action taken to pembrolizumab	irAE management with corticosteroid and/or other therapies	Monitor and follow-up
Pneumonitis	Grade 2	Withhold	<ul style="list-style-type: none"> • Administer corticosteroids (initial dose of 1-2 mg/kg prednisone or equivalent) followed by taper 	<ul style="list-style-type: none"> • Monitor participants for signs and symptoms of pneumonitis • Evaluate participants with suspected pneumonitis with radiographic imaging and initiate corticosteroid treatment • Add prophylactic antibiotics for opportunistic infections
	Grade 3 or 4, or recurrent Grade 2	Permanently discontinue		
Diarrhea / Colitis	Grade 2 or 3	Withhold	<ul style="list-style-type: none"> • Administer corticosteroids (initial dose of 1-2 mg/kg prednisone or equivalent) followed by taper 	<ul style="list-style-type: none"> • Monitor participants for signs and symptoms of enterocolitis (ie, diarrhea, abdominal pain, blood or mucus in stool with or without fever) and of bowel perforation (ie, peritoneal signs and ileus). • Participants with \geq Grade 2 diarrhea suspecting colitis should consider GI consultation and performing endoscopy to rule out colitis. • Participants with diarrhea/colitis should be advised to drink liberal quantities of clear fluids. If sufficient oral fluid intake is not feasible, fluid and electrolytes should be substituted via IV infusion.
	Grade 4	Permanently discontinue		

Immune-related AEs (irAEs)	Toxicity grade or conditions (CTCAEv4.0)	Action taken to pembrolizumab	irAE management with corticosteroid and/or other therapies	Monitor and follow-up
Type 1 diabetes mellitus (T1DM) or Hyperglycemia	Newly onset T1DM or Grade 3 or 4 hyperglycemia associated with evidence of β -cell failure	Withhold	<ul style="list-style-type: none"> Initiate insulin replacement therapy for participants with T1DM Administer anti-hyperglycemic in participants with hyperglycemia 	<ul style="list-style-type: none"> Monitor participants for hyperglycemia or other signs and symptoms of diabetes.
Hypophysitis	Grade 2	Withhold	<ul style="list-style-type: none"> Administer corticosteroids and initiate hormonal replacements as clinically indicated. 	<ul style="list-style-type: none"> Monitor for signs and symptoms of hypophysitis (including hypopituitarism and adrenal insufficiency)
	Grade 3 or 4	Withhold permanently discontinue ¹ or		
Hyperthyroidism	Grade 2	Continue	<ul style="list-style-type: none"> Treat with non-selective beta-blockers (eg, propranolol) or thionamides as appropriate 	<ul style="list-style-type: none"> Monitor for signs and symptoms of thyroid disorders.
	Grade 3 or 4	Withhold or permanently discontinue ¹		
Hypothyroidism	Grade 2-4	Continue	<ul style="list-style-type: none"> Initiate thyroid replacement hormones (eg, levothyroxine or liothyronine) per standard of care 	<ul style="list-style-type: none"> Monitor for signs and symptoms of thyroid disorders.
Nephritis and Renal dysfunction	Grade 2	Withhold	<ul style="list-style-type: none"> Administer corticosteroids (prednisone 1-2 mg/kg or equivalent) followed by taper. 	<ul style="list-style-type: none"> Monitor changes of renal function
	Grade 3 or 4	Permanently discontinue		
Myocarditis	Grade 1 or 2	Withhold	<ul style="list-style-type: none"> Based on severity of AE administer corticosteroids 	<ul style="list-style-type: none"> Ensure adequate evaluation to confirm etiology and/or exclude other causes
	Grade 3 or 4	Permanently discontinue		

Immune-related AEs (irAEs)	Toxicity grade or conditions (CTCAEv4.0)	Action taken to pembrolizumab	irAE management with corticosteroid and/or other therapies	Monitor and follow-up
All other immune-related AEs	Intolerable/persistent Grade 2	Withhold	<ul style="list-style-type: none">Based on type and severity of AE administer corticosteroids	<ul style="list-style-type: none">Ensure adequate evaluation to confirm etiology and/or exclude other causes
	Grade 3	Withhold or discontinue based on the type of event. Events that require discontinuation include and not limited to: Gullain-Barré Syndrome, encephalitis		
	Grade 4 or recurrent Grade 3	Permanently discontinue		

1. Withhold or permanently discontinue pembrolizumab is at the discretion of the investigator or treating physician.

NOTE: For participants with Grade 3 or 4 immune-related endocrinopathy where withhold of pembrolizumab is required, pembrolizumab may be resumed when AE resolves to \leq Grade 2 and is controlled with hormonal replacement therapy or achieved metabolic control (in case of T1DM).

AE = GI = irAE = IV =

Dosing interruptions are permitted in the case of medical/surgical events or for logistical reasons not related to study therapy (eg, elective surgery, unrelated medical events, patient vacation, and/or holidays). Subjects should be placed back on study therapy within 3 weeks of the scheduled interruption, unless otherwise discussed with the Sponsor. The reason for interruption should be documented in the subject's study record.

5.2.1.3 Guidance for Diagnosis and Management of Hepatic Events of Clinical Interest

Cohort 1

In addition to overdose, hepatic ECIs will include any of the following events. All of these events will require holding pembrolizumab treatment, notification of the Sponsor within 24 hours, and a hepatology consultation. Refer to Section 7.2.3.2 for reporting guidelines and the definition of hepatic ECIs.

Immediate assessment

All subjects

- All subjects should be evaluated according to directions below within 72 hours of alert for non-overdose ECI
- Procedures:
 - Consider obtaining a consultation with a hepatologist
 - Obtain a work-up for hepatitis if there is no underlying hepatitis, including hepatitis A, B,C, D, E, Epstein-Barr virus, and cytomegalovirus
 - Assess for ingestion of drugs/supplements with hepatotoxic potential
 - Assess for alcohol ingestion
 - Assess for potential bacterial infection, biliary obstruction, or occult gastrointestinal bleeding
 - Repeat ALT, AST, Tbil, Dbil, ALP, γ -glutamyl transpeptidase (GGT), INR, and CBC with differential
 - Other laboratories or imaging studies as clinically indicated
 - Consider liver biopsy if indicated by hepatologist

Hepatitis C-Infected Subjects (including subjects who previously achieved SVR 12)

- In addition to the above, measure HCV RNA viral load

Hepatitis B-infected Subjects

- HBV DNA, HBsAg, HBeAg, anti-HBc (total and IgM), anti-HBe, and anti-HBs
- Subjects should be questioned about compliance with the use of anti-viral agents.

Permanent Discontinuation Criteria for Subjects with Non-overdose Hepatic ECIs

Therapy should also be permanently discontinued for any of the following:

- ALT >20×ULN
- CP score of ≥ 9 points
- Gastrointestinal bleeding suggestive of portal hypertension (eg, esophageal or gastric varices)
- New onset of clinically detectable ascites
- Encephalopathy
- Recurrence of a severe or life-threatening event, or of any of the laboratory abnormalities listed above, that are presumed to be immune-related

Other subjects may be eligible for treatment interruption (and potential re-start) of pembrolizumab after discussion with the Sponsor (Section 5.8.1).

Diagnosis and Management of Non-Overdose Hepatic ECIs

HCC subjects are at risk for a range of complications that can cause hepatic laboratory abnormalities with or without clinical decompensation. Those with a history of chronic HCV or HBV infection also have the potential to experience virologic flares. Immune-related hepatitis has been observed in ~1% of subjects who received pembrolizumab. The following section provides further guidance on the diagnosis and management of potential hepatic complications among HCC subjects.

a. Hepatitis B Flare

Hepatitis B flares are characterized by rapid elevations of ALT and AST to $>5\times$ ULN and/or $>3\times$ baseline. ALT elevation to $\geq 10\times$ ULN is common. In the absence of hepatic decompensation, ALT/AST elevations are typically isolated (ie, limited/no elevations of bilirubin/ALP). Subjects who are compliant with anti-viral therapy should have continued suppression of HBV DNA at the time of flare; thus, detection of HBV DNA should prompt questioning of subjects for compliance. Laboratory abnormalities secondary to flare are typically observed for 3 to 5 weeks.

Among subjects with HBV, a flare should be considered if this pattern is observed and there is no evidence of an alternative etiology. Guidelines for subjects with a diagnosis of HBV flare are as follows:

- Care should be instituted in consultation with a hepatologist.
- For subjects who have detectable HBV DNA, re-institute anti-viral therapy.
- If the subject is clinically stable, pembrolizumab dosing may be interrupted for up to 12 weeks. Subjects should undergo weekly laboratory tests including: AST, ALT, ALP, Tbil, Dbil, INR, HBsAg, and HBV DNA (if detected at the onset of the flare). Obtain anti-HBe, anti-HBs, and HBV DNA levels (if not detected at the onset of the flare) every 2 to 3 weeks.

- If ALT returns to normal or Grade 1 (if normal at baseline), or to baseline grade (if Grade 2 at baseline) within 12 weeks, and subjects are clinically stable, subjects may restart pembrolizumab treatment. If these conditions are not met, then pembrolizumab treatment should be permanently discontinued.

b. Hepatitis C Recurrence or Flare

Subjects who achieved SVR 12 and subjects with ongoing HCV infection are eligible for enrollment. In rare circumstances, HCV subjects who achieve SVR 12 may relapse at later time points. Relapse is characterized by detection of HCV RNA, often accompanied by ALT elevations to $>5\times\text{ULN}$. In the absence of hepatic decompensation, ALT/AST elevations are typically isolated (ie, limited/no elevations of bilirubin/ALP).

Among subjects with uncontrolled hepatitis C, virologic flares are possible. Hepatitis C flares are characterized by rapid elevations of ALT and AST to $>5\times\text{ULN}$ and/or $>3\times$ baseline along with a rise in HCV RNA. ALT elevation to $\geq 10\times\text{ULN}$ and a 1 log elevation in HCV RNA level are common. In the absence of hepatic decompensation, ALT/AST elevations are typically isolated (ie, limited/no elevations of bilirubin/ALP). Laboratory abnormalities secondary to flare or recurrence are typically observed for 3 to 5 weeks.

Guidelines for subjects with recurrent HCV infection or an HCV flare are described below:

i. Recurrent HCV infection:

If the subject entered the study with an HCV RNA test of “Target not Detected” and has confirmed detectable HCV RNA (2 specimens, 1 week apart), then the subject has experienced a late HCV relapse or a recurrent infection.

- Question the subject about use of injection or inhalation drugs
- At the time of first detection of HCV RNA, send a specimen for HCV genotyping
- Measure AST, ALT, ALP, Tbil, Dbil, and INR weekly
- Measure HCV RNA levels every 2 weeks
- Therapy with HCV anti-viral treatments should be considered.

ii. HCV Flare:

- At the time of first detection of HCV RNA, send a specimen for HCV genotyping
- Measure AST, ALT, ALP, Tbil, Dbil, INR weekly
- Measure HCV RNA levels every 2 weeks
- Therapy with HCV anti-viral treatments should be considered.

iii. For both recurrent infection and HCV flare: if ALT returns to normal or Grade 1 (if normal at baseline), or to baseline grade (if Grade 2 at baseline) within 12 weeks, and the subjects are clinically stable, subjects may restart pembrolizumab treatment. If these conditions are not met, then pembrolizumab treatment should be permanently discontinued.

c. Immune-related hepatitis

i. Description: Immune-related hepatitis due to pembrolizumab should be suspected if any of the following is seen:

- AST or ALT baseline values are less than $2\times$ ULN, and AST or ALT laboratory values increase to $\geq 5\times$ ULN
- Among subjects with baseline ALT or AST $\geq 2\times$ ULN, levels increase to $>3\times$ the baseline level
- AST/ALT >500 U/L regardless of baseline level
- Among subjects with baseline Tbil levels <1.5 mg/dL: a value of >2.0 mg/dL
- Among subjects with baseline Tbil levels that are ≥ 1.5 mg/dL: a value of $\geq 2\times$ the baseline level
- Total bilirubin >3.0 mg/dL regardless of baseline level.

Immune-related hepatitis is a diagnosis made after excluding other possible etiologies for the change. Viral flare (if applicable), biliary or vascular obstruction, infection, medications, and alcohol use must be ruled out (see below).

ii. Management

- Interrupt pembrolizumab treatment and alert the sponsor as per ECI criteria above for ALT, AST, bilirubin, and hepatic decompensation.
- Start IV corticosteroid (methylprednisolone 125 mg) followed by oral corticosteroid (1-2 mg/kg/day).
- Monitor with biweekly laboratory tests including AST, ALT, Tbil, Dbil, ALP, and INR.
- If symptoms and laboratory tests resolve to Grade ≤ 1 or baseline (if abnormal at baseline), taper steroids over 28 days. Pembrolizumab treatment may be restarted after steroid treatment has been tapered to prednisone ≤ 10 mg/day (or equivalent dose of another agent). Treatment and laboratory results must be reported on a CRF.
- If laboratory abnormalities do not resolve within 3 weeks, or steroids cannot be lowered to ≤ 10 mg/day (or prednisone equivalent) within 12 weeks, or subjects show evidence of decompensation to CP C status or have esophageal or variceal bleeding at any point, treatment must be permanently discontinued. This must be reported on a CRF.

d. Other Hepatic Events of Clinical Interest

- Infection should be ruled out with cultures of blood, urine, and ascites (if possible), as well as chest x-ray and abdominal imaging if relevant. If an infection is found, antibiotics should be started.
- If Tbil is elevated above baseline, imaging should be obtained to rule out vascular compromise, biliary obstruction, and/or tumor progression. If biliary obstruction is present, consultation with a gastroenterologist and/or an interventional radiologist should be obtained to see if the obstruction may be relieved.
- A careful review of drugs, including herbal and alternative medications, should be obtained, and alcohol use should be ruled out. See Section 5.5.2 for drugs which may interfere with hepatic function.
- For all of these cases, subjects may resume pembrolizumab treatment if they are clinically stable after appropriate therapy or discontinue the causative agent, as long as laboratory values have returned to Grade 1 or baseline (if normal or Grade 1 at start) or to baseline grade within 3 weeks.
- Treatment must be permanently discontinued if the subject is off pembrolizumab therapy for infection, obstruction, or drug/alcohol-related toxicity for more than 3 weeks, or if they have esophageal bleeding, or become Child-Pugh C at any point.

Cohort 2

Hepatic ECIs have been described in Section 7.2.3.2. All of these HECIs will require holding pembrolizumab treatment and notification of the Sponsor within 24 hours. All cases of retreatment and permanent discontinuation must be reported to the Sponsor and recorded in the database.

Immediate assessment in case of HECI:

All Subjects

- All subjects should be considered for evaluation according to the directions below within 72 hours of the alert for a non-overdose ECI.
- Procedures:
 - Consider obtaining a consultation with a hepatologist
 - Obtain a work-up for hepatitis if there is no underlying hepatitis, including hepatitis A, B, C, D, E, Epstein-Barr virus, and cytomegalovirus
 - Assess for ingestion of drugs/supplements with hepatotoxic potential
 - Assess for alcohol ingestion
 - Assess for potential bacterial infection, biliary obstruction, or occult gastrointestinal bleeding

- Repeat ALT, AST, total bilirubin (Tbil), direct bilirubin (Dbil), alkaline phosphatase (ALP), γ -glutamyl transpeptidase (GGT), INR, and complete blood count (CBC) with differential
- Measure HCV RNA viral load (applies only for participants who have current active HCV infection or had infection in the past)
- HBV DNA, HBsAg, HBeAg, anti-HBc (total and IgM), anti-HBe, and anti-HBs (Note: participants should be questioned about compliance with the use of anti-viral agents)
- Other laboratories or imaging studies as clinically indicated
- Consider liver biopsy if indicated

HCC patients are at risk for a range of complications that can cause hepatic laboratory abnormalities with or without clinical decompensation. Those with a history of chronic HCV or HBV infection also have the potential to experience virologic flares. Immune-related hepatitis has been observed in ~1% of participants who received pembrolizumab. The following section provides further guidance on the diagnosis and management of potential hepatic complications among HCC subjects in this study ([Table 4](#)).

Table 4 Guidance for Diagnosis and Management of Hepatic Events of Clinical Interest

Event	Diagnosis	Management
Hepatitis B consider flare or change in HBV immunologic status	1) Rapid elevation of ALT to $>5\times$ ULN and/or $>3\times$ baseline	Interrupt treatment for up to 12 weeks Check for compliance if HBV is detectable Measure safety labs for AST, ALT, ALP, T Bili, D Bili, INR on weekly basis Measure HBsAg, HBV DNA on weekly basis (if detected at the time of onset of ECI) Evaluate the following every 2 to 3 weeks: <ul style="list-style-type: none">• anti-HBe, HBe antigen, anti-HBs, and HBV DNA levels (if not detected at the onset of ECI) Restart treatment only if ALT returns to normal or Grade 1 (if normal at baseline), or to baseline grade (if Grade 2 at baseline) within 12 weeks, and the participant is clinically stable, otherwise the participant should be permanently discontinued

Event	Diagnosis	Management
Hepatitis C exacerbation in participants with positive baseline HCV RNA	Rapid elevation of ALT to $>5\times$ ULN and/or $>3\times$ baseline	Interrupt study treatment for up to 12 weeks Assess use of injection or inhalation drugs Check HCV genotype at the time of first detection of HCV RNA to rule out new infection
Relapse of HCV infection for participants with successfully treated or new HCV infection on study intervention	If HCV RNA was TND at baseline, and now has confirmed detectable HCV RNA (2 specimens, 1 week apart)	Measure safety labs for AST, ALT, ALP, T Bili, D Bili, INR on weekly basis Measure HCV RNA levels every 2 weeks Consider starting HCV anti-viral therapy; discuss risk benefit with sponsor before starting. Restart treatment only if ALT returns to normal or G1 (if normal at baseline), or to baseline grade (if G2 at baseline) within 12 weeks, and the participant is clinically stable, otherwise, the participant should be permanently discontinued
Immune-related Hepatitis	If any of the HECI criteria is met as defined in the protocol Section 8.4.7 Note: Immune-related hepatitis is a diagnosis made after excluding other possible etiologies such as Viral flare, biliary or vascular obstruction, infection, medications, and alcohol use usually immune-related hepatitis response to dechallenge and/or steroids and occurs with rechallenge	Interrupt study treatment for up to 12 weeks Start IV corticosteroid 60 mg/day of prednisone or equivalent followed by oral corticosteroid Monitor with biweekly laboratory tests including AST, ALT, T Bili, D Bili, ALP, and INR Restart study treatment only if: a) Abnormal laboratory values resolve to Grade ≤ 1 or baseline (if abnormal at baseline); then steroids may be tapered b) Taper steroid over 28 days c) Steroid treatment is tapered to prednisone <10 mg/day or equivalent within 12 weeks Permanently Discontinue participant if: a) Laboratory abnormalities do not resolve within 3 weeks b) Steroids cannot be lowered to ≤ 10 mg/day (or prednisone equivalent) within 12 weeks c) Evidence of decompensation to CP C status

Event	Diagnosis	Management
Other Causes	<p>Rule out infection with blood, urine, and ascites culture – antibiotics should be started if infection is found</p> <p>If total bilirubin is elevated, imaging should be obtained to rule out vascular compromise, biliary obstruction, and/or tumor progression by imaging</p> <p>Ruled out alcohol use and hepatotoxic drugs including herbal and alternative medications</p>	<p>Interrupt treatment for up to 12 weeks</p> <p>Restart study treatment only if laboratory values have returned to Grade 1 or baseline (if normal or Grade 1 at start) or to baseline grade within 3 weeks</p> <p>If biliary obstruction is present, consultation with a gastroenterologist and/or an interventional radiologist should be obtained to see if the obstruction may be relieved</p>

Abbreviations: ALP=alkaline phosphatase; ALT=alanine aminotransferase; AST=aspartate aminotransferase; D Bili=direct bilirubin; DNA=deoxyribonucleic acid; ECI=events of clinical interest; HBe=hepatitis B early antibody; HBs=hepatitis B surface; HBsAg= hepatitis B surface antigen; HBV=hepatitis B virus; HCV=hepatitis C virus; HECl=hepatic events of clinical interest; RNA=ribonucleic acid; INR=international normalized ratio; T Bili=total bilirubin; ULN=upper limit of normal

Permanent Discontinuation Criteria for Subjects with Non-overdose Hepatic ECI

Therapy should also be permanently discontinued for any of the following:

- ALT >20×ULN (confirmed within 1 week)
- CP score of >9 points
- Hepatic Encephalopathy
- If ascites is not due to PD and not manageable by intervention within 3 days

Recurrence of a severe or life-threatening event, or of any of the laboratory abnormalities listed above, that are presumed to be immune-related.

5.2.2 Timing of Dose Administration

Cycle 1 Day 1 treatment with pembrolizumab should begin on the day of allocation, but no later than 3 days from the date the subject is allocated to trial treatment. However, every effort should be made to begin trial treatment on the day of allocation.

For all additional cycles of pembrolizumab, treatment may be administered up to 3 days before or 3 days after the scheduled Day 1 of each cycle due to administrative reasons per the investigator's judgment.

All trial treatments will begin on Day 1 of each cycle after all pre-dose study procedures and assessments have been completed as detailed on the Trial Flow Chart –Section 6.0

Pembrolizumab will be administered as a 30 minute IV infusion every 3 weeks. Sites should make every effort to target infusion timing to be as close to 30 minutes as possible. However, given the variability of infusion pumps from site to site, a window of -5 minutes and +10 minutes is permitted (ie, infusion time is 30 minutes: -5 min/+10 min).

The Pharmacy Manual contains specific instructions for the preparation of the pembrolizumab infusion fluid and administration of infusion solution.

All trial treatments will be administered on an outpatient basis.

5.2.3 Trial Blinding

This is an open-label trial; therefore, the Sponsor, investigator and subject will know the treatment administered.

5.3 Randomization or Treatment Allocation

Treatment allocation will occur centrally using an interactive voice response system/integrated web response system (IVRS/IWRS). All enrolled subjects will be allocated to receive pembrolizumab 200 mg IV Q3W as monotherapy in an unblinded fashion.

5.4 Stratification

No stratification based on age, sex or other characteristics will be used in this trial.

5.5 Concomitant Medications/Vaccinations (Allowed & Prohibited)

Medications or vaccinations specifically prohibited in the exclusion criteria are not allowed during the ongoing trial. If there is a clinical indication for any medication or vaccination specifically prohibited during the trial, discontinuation from trial therapy or vaccination may be required. The investigator should discuss any questions regarding this with the Sponsor Clinical Director. The final decision on any supportive therapy or vaccination rests with the investigator and/or the subject's primary physician. However, the decision to continue the subject on trial therapy or vaccination schedule requires the mutual agreement of the investigator, the Sponsor and the subject.

5.5.1 Acceptable Concomitant Medications

All treatments that the investigator considers necessary for a subject's welfare may be administered at the discretion of the investigator in keeping with the community standards of

medical care. All concomitant medication will be recorded on the case report form (CRF) including all prescription, over-the-counter (OTC), and IV medications and fluids. If changes occur during the trial period, documentation of drug dosage, frequency, route, and date should also be included on the CRF.

Palliative and supportive care is permitted during the course of the trial for underlying medical conditions and management of symptoms. Surgery for tumor control or symptom management is not permitted during the study. Palliative radiotherapy is permitted to a single lesion if considered medically necessary by the treating physician as long as the lesion is NOT a RECIST 1.1 defined target lesion and radiation is NOT administered for tumor control. Trial therapy should be held during the course of palliative radiotherapy and should be resumed no earlier than the next scheduled administration of trial therapy. The specifics of the radiation treatment, including the location, will be recorded on the CRF.

All medications received within 30 days before the first dose of trial treatment and within 30 days after the last dose of trial treatment should be recorded. Medications administered more than 30 days after the last dose of trial treatment should be recorded for SAEs and events of clinical interest (ECIs) as defined in Section 7.2.3.

5.5.2 Prohibited Concomitant Medications

Subjects are prohibited from receiving the following therapies during the Screening and Treatment Phase (including retreatment for post-CR relapse) of this trial:

- Antineoplastic systemic chemotherapy or biological therapy
- Immunotherapy not specified in this protocol
- Chemotherapy not specified in this protocol
- Investigational agents other than pembrolizumab
- Radiation/local therapy for tumor control. Radiation for pain or palliation is acceptable.
- Live vaccines within 30 days prior to the first dose of trial treatment (Cycle 1 Day 1) and while participating in the trial. Examples of live vaccines include, but are not limited to, the following: measles, mumps, rubella, chickenpox, yellow fever, rabies, bacille Calmette-Guerin vaccine (BCG), and typhoid (oral) vaccine. The killed virus vaccines used for seasonal influenza vaccines for injection are allowed; however live attenuated intranasal influenza vaccines (eg, FluMist[®]) are not allowed.
- Glucocorticoids (inhaled steroids as part of a stable regimen for the treatment of asthma/chronic obstructive pulmonary disease are permitted) for any purpose other than to modulate symptoms from an adverse event suspected of having an

immunologic etiology. The use of physiologic doses of corticosteroids may be approved after consultation with the Sponsor.

- Note: Use of prophylactic corticosteroids to avoid allergic reactions (eg, IV contrast dye) is permitted.

Subjects who, in the assessment by the investigator, require the use of any of the aforementioned treatments for clinical management should be discontinued from trial treatment. Subjects may receive other medications that the investigator deems to be medically necessary. It is important for investigators to review each medication (prescription and non-prescription) the subject is taking before starting the study and at each study visit.

- At each visit, subjects should be questioned about any new drug they are taking.
- To minimize the risk of adverse drug interactions, every effort should be made to limit the number of concomitant drugs to those that are truly essential.
- Drugs known to be hepatotoxic (ie, drugs with a warning of hepatotoxicity in the package insert) should be avoided during the dosing period. Investigators are encouraged to review each medication for potential hepatotoxicity by searching the www.livertox.nih.gov website.

Listed below are specific restrictions for concomitant therapy during the course of the trial.

The following medications/therapies should be avoided during the dosing period and for 14 days thereafter:

Known hepatotoxic drugs, including but not limited to:

- Etifoxine
- Isoniazid
- Nitrofurantoin
- Ketoconazole
- Amiodarone
- Phenytoin

Herbal Supplements/Alternative Medicines

- No herbal supplements or alternative medicines are allowed during this study.

The exclusion criteria describe other medications that are prohibited in this trial.

There are no prohibited therapies during the post-treatment follow-up phase.

5.6 Rescue Medications & Supportive Care

5.6.1 Rescue Medications

No rescue medications are specified to be used in this trial.

5.6.2 Supportive Care Guidelines

Subjects should receive appropriate supportive care measures as deemed necessary by the treating investigator. Suggested supportive care measures for the management of adverse events with potential immunologic etiology are outlined below. Where appropriate, these guidelines include the use of oral or intravenous treatment with corticosteroids as well as additional anti-inflammatory agents if symptoms do not improve with administration of corticosteroids. Note that several courses of steroid tapering may be necessary as symptoms may worsen when the steroid dose is decreased. For each disorder, attempts should be made to rule out other causes such as metastatic disease or bacterial or viral infection, which might require additional supportive care. The treatment guidelines are intended to be applied when the investigator determines the events to be related to trial treatment.

Note: if after the evaluation the event is determined not to be related, the investigator does not need to follow the treatment guidance (as outlined below). Refer to Section 5.2.1.2 for dose interval modification.

It may be necessary to perform conditional procedures such as bronchoscopy, endoscopy, or skin photography as part of evaluation of the event.

- **Hepatic:**

Guidance for Diagnosis and Management of Hepatic Events of Clinical Interest can be found in Section 5.2.1.3.

- **Pneumonitis:**

- For **Grade 2 events**, treat with systemic corticosteroids. When symptoms improve to Grade 1 or less, steroid taper should be started and continued over no less than 4 weeks.
- For **Grade 3-4 events**, immediately treat with intravenous steroids. Administer additional anti-inflammatory measures, as needed.
- Add prophylactic antibiotics for opportunistic infections in the case of prolonged steroid administration.

- **Diarrhea/Colitis:**

Subjects should be carefully monitored for signs and symptoms of enterocolitis (such as diarrhea, abdominal pain, blood or mucus in stool, with or without fever) and of bowel perforation (such as peritoneal signs and ileus).

- All subjects who experience diarrhea/colitis should be advised to drink liberal quantities of clear fluids. If sufficient oral fluid intake is not feasible, fluid and electrolytes should be substituted via IV infusion. For **Grade 2 or higher**

diarrhea, consider GI consultation and endoscopy to confirm or rule out colitis.

- For **Grade 2 diarrhea/colitis**, administer oral corticosteroids.
- For **Grade 3 or 4 diarrhea/colitis**, treat with intravenous steroids followed by high dose oral steroids.
- When symptoms improve to Grade 1 or less, steroid taper should be started and continued over no less than 4 weeks.
- **Type 1 diabetes mellitus (if new onset, including diabetic ketoacidosis [DKA]) or \geq Grade 3 Hyperglycemia, if associated with ketosis (ketonuria) or metabolic acidosis (DKA)**
 - For new onset T1DM or **Grade 3-4** Hyperglycemia
 - Insulin replacement therapy is recommended for T1DM and for Grade 3-4 hyperglycemia associated with metabolic acidosis or ketonuria.
 - Evaluate patients with plasma glucose and a metabolic panel, urine ketones, HbA1c and C-peptide.
- **Hypophysitis:**
 - For **Grade 2** events, treat with corticosteroids. When symptoms improve to Grade 1 or less, steroid taper should be started and continued over no less than 4 weeks. Replacement of appropriate hormones may be required as the steroid dose is tapered.
 - For **Grade 3-4** events, treat with an initial dose of IV corticosteroids followed by oral corticosteroids. When symptoms improve to Grade 1 or less, steroid taper should be started and continued over no less than 4 weeks. Replacement of appropriate hormones may be required as the steroid dose is tapered.
- **Hyperthyroidism or Hypothyroidism:**

Thyroid disorders can occur at any time during treatment. Monitor patients for changes in thyroid function (at the start of treatment, periodically during treatment, and as indicated based on clinical evaluation) and for clinical signs and symptoms of thyroid disorders.

 - **Grade 2** hyperthyroidism events (and **Grade 2-4** hypothyroidism):
 - In hyperthyroidism, non-selective beta-blockers (eg, propranolol) are suggested as initial therapy.
 - In hypothyroidism, thyroid hormone replacement therapy, with levothyroxine or liothyronine, is indicated per standard of care.
 - **Grade 3-4** hyperthyroidism
 - Treat with an initial dose of IV corticosteroid followed by oral corticosteroids. When symptoms improve to Grade 1 or less, steroid taper should be started and continued over no less than 4 weeks.

Replacement of appropriate hormones may be required as the steroid dose is tapered.

• **Renal Failure or Nephritis:**

- For Grade 2 events, treat with corticosteroids.
- For Grade 3-4 events, treat with systemic corticosteroids.
- When symptoms improve to Grade 1 or less, steroid taper should be started and continued over no less than 4 weeks.

• **Management of Infusion Reactions:**

Signs and symptoms usually develop during or shortly after drug infusion and generally resolve completely within 24 hours of completion of infusion.

Pembrolizumab may cause severe or life-threatening infusion-reactions including severe hypersensitivity or anaphylaxis. Signs and symptoms usually develop during or shortly after drug infusion and generally resolve completely within 24 hours of completion of infusion. Dose modification and toxicity management guidelines on pembrolizumab associated infusion reaction are provided in [Table 5](#).

Table 5 Infusion Reaction Treatment Guidelines

NCI CTCAE Grade	Treatment	Premedication at subsequent dosing
<u>Grade 1</u> Mild reaction; infusion interruption not indicated; intervention not indicated	Increase monitoring of vital signs as medically indicated until the subject is deemed medically stable in the opinion of the investigator.	None
<u>Grade 2</u> Requires infusion interruption but responds promptly to symptomatic treatment (eg, antihistamines, NSAIDS, narcotics, IV fluids); prophylactic medications indicated for ≤ 24 hours	Stop Infusion and monitor symptoms. Additional appropriate medical therapy may include but is not limited to: IV fluids Antihistamines NSAIDs Acetaminophen Narcotics Increase monitoring of vital signs as medically indicated until the subject is deemed medically stable in the opinion of the investigator. If symptoms resolve within one hour of stopping drug infusion, the infusion may be restarted at 50% of the original infusion rate. Otherwise dosing will be held until symptoms resolve and the subject should be premedicated for the next scheduled dose. Subjects who develop Grade 2 toxicity despite adequate premedication should be permanently discontinued from further trial treatment administration.	Subject may be premedicated 1.5 h (± 30 minutes) prior to infusion of pembrolizumab with: Diphenhydramine 50 mg PO (or equivalent dose of antihistamine). Acetaminophen 500-1000 mg PO (or equivalent dose of antipyretic).

NCI CTCAE Grade	Treatment	Premedication at subsequent dosing
<u>Grades 3 or 4</u> Grade 3: Prolonged (ie, not rapidly responsive to symptomatic medication and/or brief interruption of infusion); recurrence of symptoms following initial improvement; hospitalization indicated for other clinical sequelae (eg, renal impairment, pulmonary infiltrates) Grade 4: Life-threatening; pressor or ventilatory support indicated	Stop Infusion. Additional appropriate medical therapy may include but is not limited to: IV fluids Antihistamines NSAIDs Acetaminophen Narcotics Oxygen Pressors Corticosteroids Epinephrine* Increase monitoring of vital signs as medically indicated until the subject is deemed medically stable in the opinion of the investigator. Hospitalization may be indicated. *In cases of anaphylaxis, epinephrine should be used immediately. Subject is permanently discontinued from further trial treatment administration.	No subsequent dosing

Appropriate resuscitation equipment should be available in the room and a physician readily available during the period of drug administration.

For further information, please refer to the Common Terminology Criteria for Adverse Events v4.0 (CTCAE) at <http://ctep.cancer.gov>

Abbreviations: CTCAE= Common Toxicity Criteria for Adverse Events; IV=intravenous; NCI=National Cancer Institute; NSAIDs=non-steroidal anti-inflammatory drugs; PO=by mouth

5.7 Diet/Activity/Other Considerations

5.7.1 Diet

Subjects should maintain a normal diet unless modifications are required to manage an AE such as diarrhea, nausea, or vomiting.

5.7.2 Contraception

Pembrolizumab may have adverse effects on a fetus in utero. Furthermore, it is not known if pembrolizumab has transient adverse effects on the composition of sperm.

For this trial, male subjects will be considered to be of non-reproductive potential if they have azoospermia (whether due to having had a vasectomy or due to an underlying medical condition).

Female subjects will be considered of non-reproductive potential if they are either:

- (1) postmenopausal (defined as at least 12 months with no menses without an alternative medical cause; in women <45 years of age a high follicle-stimulating hormone [FSH] level in the postmenopausal range may be used to confirm a post-menopausal state in women not using hormonal contraception or hormonal replacement therapy. In the absence of 12 months of amenorrhea, a single FSH measurement is insufficient);

OR

- (2) have had a hysterectomy and/or bilateral oophorectomy, bilateral salpingectomy, or bilateral tubal ligation/occlusion at least 6 weeks prior to screening;

OR

- (3) has a congenital or acquired condition that prevents childbearing.

Female and male subjects of reproductive potential must agree to avoid becoming pregnant or impregnating a partner, respectively, while receiving pembrolizumab (MK-3475) and for 120 days after the last dose. Subjects must comply with one of the following:

- (1) practice abstinence[†] from heterosexual activity;

OR

- (2) use (or have their partner use) acceptable contraception during heterosexual activity. Acceptable methods of contraception are[‡]:

Single method (one of the following is acceptable):

- intrauterine device (IUD)
- vasectomy of a female subject's sole male partner
- contraceptive rod implanted into the skin

Combination method (requires use of two of the following):

- diaphragm with spermicide (cannot be used in conjunction with cervical cap/spermicide)
- cervical cap with spermicide (nulliparous women only)
- contraceptive sponge (nulliparous women only)
- male condom or female condom (cannot be used together)
- hormonal contraceptive: oral contraceptive pill (estrogen/progestin pill or progestin-only pill), contraceptive skin patch, vaginal contraceptive ring, or subcutaneous contraceptive injection

[†]Abstinence (relative to heterosexual activity) can be used as the sole method of contraception if it is consistently employed as the subject's preferred and usual lifestyle and if considered acceptable by local regulatory agencies and ERCs/IRBs. Periodic abstinence (eg, calendar, ovulation, sympto-thermal, post-ovulation methods, etc.) and withdrawal are not acceptable methods of contraception.

‡If a contraceptive method listed above is restricted by local regulations/guidelines, then it does not qualify as an acceptable method of contraception for subjects participating at sites in this country/region.

Subjects should be informed that taking the study medication may involve unknown risks to the fetus (unborn baby) if pregnancy were to occur during the study. In order to participate in the study, subjects of childbearing potential must adhere to the contraception requirement (described above) from the day of study medication initiation (or 14 days prior to the initiation of trial treatment [Cycle 1 Day 1] for oral contraception) throughout the study period up to 120 days after the last dose of trial therapy. If there is any question that a subject of childbearing potential will not reliably comply with the requirements for contraception, that subject should not be entered into the study.

For countries or sites that follow the Clinical Trial Facilitation Group guidance, please use the following:

Pembrolizumab may have adverse effects on a fetus in utero. Furthermore, it is not known if it may have transient adverse effects on the composition of sperm. Therefore, non-pregnant, non-breastfeeding women may only be enrolled if they are willing to follow the Clinical Trial Facilitation Group (CTFG) Guidance (Final Version 2014-09-15, Sections 4.1 and 4.2) for highly effective birth control as outlined below, or are considered to be highly unlikely to conceive. Highly unlikely to conceive is defined as 1) surgically sterilized, or 2) postmenopausal (a woman who is ≥ 45 years of age and has not had menses for greater than 1 year will be considered postmenopausal), or 3) not heterosexually active for the duration of the study. Subjects should use birth control methods that can achieve a failure rate of less than 1% per year when used consistently and correctly and are considered as highly effective birth control methods. Such methods include:

- Combined (estrogen and progestogen containing) hormonal contraception associated with inhibition of ovulation:
 - Oral
 - Intravaginal
 - Transdermal
- Progestogen-only hormonal contraception associated with inhibition of ovulation:
 - Oral
 - Injectable
 - Implantable
- IUD
- Intrauterine hormone-releasing system (IUS)
- Bilateral tubal occlusion
- Vasectomized partner
- Sexual abstinence

Subjects should start using birth control from study Visit 1 throughout the study period up to 120 days after the last dose of study therapy.

Subjects should be informed that taking the study medication may involve unknown risks to the fetus (unborn baby) if pregnancy were to occur during the study. In order to participate in the study they must adhere to the contraception requirement (described above) for the duration of the study and during the follow-up period defined in Section 7.2.2 – Reporting of Pregnancy and Lactation to the Sponsor. If there is any question that a subject will not reliably comply with the requirements for contraception, that subject should not be entered into the study.

5.7.3 Use in Pregnancy

If a subject inadvertently becomes pregnant while on treatment with pembrolizumab, the subject will immediately be removed from the trial treatment. The site will contact the subject at least monthly and document the subject's status until the pregnancy has been completed or terminated. The outcome of the pregnancy will be reported to the Sponsor without delay and within 24 hours if the outcome is a serious adverse experience (eg, death, abortion, congenital anomaly, or other disabling or life-threatening complication to the mother or newborn). The study investigator will make every effort to obtain permission to follow the outcome of the pregnancy and report the condition of the fetus or newborn to the Sponsor. If a male subject impregnates his female partner, the study personnel at the site must be informed immediately and the pregnancy must be reported to the Sponsor and followed as described in Section 7.2.2 (Reporting of Pregnancy and Lactation to the Sponsor).

5.7.4 Use in Nursing Women

It is unknown whether pembrolizumab is excreted in human milk. Since many drugs are excreted in human milk, and because of the potential for serious adverse reactions in the nursing infant, subjects who are breast-feeding are not eligible for enrollment.

5.8 Subject Withdrawal/Discontinuation Criteria

Subjects may withdraw consent at any time for any reason or be dropped from the trial at the discretion of the investigator should any untoward effect occur. In addition, a subject may be withdrawn by the investigator or the Sponsor if enrollment into the trial is inappropriate, the trial plan is violated, or for administrative and/or other safety reasons. Specific details regarding discontinuation or withdrawal procedures; including specific details regarding withdrawal from Future Biomedical Research, are provided in Section 7.1.5 – Other Procedures.

In this trial, a subject may discontinue treatment but continue to participate in survival follow up, as long as the subject does not withdraw consent. Once a subject has discontinued initial treatment, he/she may be eligible for retreatment if deemed medically appropriate and the subject meets the criteria, as outlined in Section 7.1.6.

A subject must be discontinued from the trial for any of the following reasons:

- The subject or legal representative (such as a parent or legal guardian) withdraws consent.
- The subject is lost to follow-up.

A subject must be discontinued from treatment (but may continue to be monitored in the trial) for any of the following reasons:

- The subject or legal representative (such as a parent or legal guardian) withdraws consent for treatment
- Confirmed radiographic PD (irPD) as outlined in Section 7.1.4 (exception if Sponsor approves treatment continuation)
- Unacceptable adverse events as described in Section 7.2.
- Intercurrent illness that prevents further administration of treatment
- Investigator's decision to withdraw the subject
- The subject has a confirmed positive urine or serum pregnancy test
- Noncompliance with trial treatment or procedure requirements
- Administrative reasons
- Completed 35 treatments with pembrolizumab
 - *Note: 35 treatments (approx. 2 years) are calculated from the first dose. Subjects who stop pembrolizumab after receiving 35 treatments may be eligible for retreatment if they progress after stopping trial treatment provided they meet the requirements detailed in Section 7.1.6. Subjects may be retreated in the Second Course Phase with up to 17 (approx. 1 year) additional trial treatments.*

The End of Treatment and Follow-up visit procedures are listed in Section 7.1.6 and the Trial Flow Chart in Section 6.0. After the end of treatment, each subject will be followed for a minimum of 30 days for adverse event monitoring (serious adverse events will be collected for up to 90 days after the end of treatment as described in Section 7.2.3). Subjects who discontinue trial treatment for a reason other than disease progression will move into the Follow-up Phase of the study and should be assessed every 12 weeks (84±7 days) by radiologic imaging to monitor disease status, or more frequently if clinically indicated. Disease status will be monitored until the subject experiences PD, initiates a non-study cancer treatment, withdraws consent from participation in the study, or becomes lost to follow-up. After documented PD each subject will be followed (eg, by telephone or visit) for OS until death, withdrawal of consent from participating in the study, or the end of the study, whichever occurs first.

5.8.1 Discontinuation of Study Therapy after Complete Response

Discontinuation of treatment may be considered for subjects who have attained confirmed CR that have received at least 8 trial treatments (approx. 6 months) pembrolizumab and had at least 2 treatments with pembrolizumab beyond the date when the initial CR was declared.

Subjects who stop then experience radiographic PD may be eligible for up to 17 additional treatments (approx. 1 year) with pembrolizumab in the Second Course Phase at the discretion of the investigator if:

- No cancer treatment was administered since the last dose of pembrolizumab
- The subject meets the parameters listed in the Inclusion/Exclusion criteria
- The trial is ongoing

Subjects will resume therapy at the same dose and schedule as at the time of initial discontinuation. Additional details are provided in Section 7.1.6.2.1. Response or progression in this Second Course Phase will not count towards the primary endpoint in this trial.

5.9 Subject Replacement Strategy

A subject who discontinues from the trial will not be replaced.

5.10 Beginning and End of the Trial

The overall trial begins when the first subject signs the informed consent form. The overall trial ends when the last subject completes the last study-related phone-call or visit, discontinues from the trial or is lost to follow-up (i.e. the subject is unable to be contacted by the investigator).

5.11 Clinical Criteria for Early Trial Termination

Early trial termination will be the result of the criteria specified below:

The clinical trial may be terminated early if the extent (incidence and/or severity) of emerging effects/clinical endpoints is such that the risk/benefit ratio to the trial population as a whole is unacceptable. In addition, further recruitment in the trial or at (a) particular trial site(s) may be stopped due to insufficient compliance with the protocol, GCP, and/or other applicable regulatory requirements, procedure-related problems, or the number of discontinuations for administrative reasons is too high.

6.0 TRIAL FLOW CHART

6.1 Initial Treatment with Pembrolizumab

Trial Period:	Screening Phase	Treatment Cycles (3-Week Cycles)								End of Treatment	Post-treatment		
Treatment Cycle/Title:	Screening	1	2	3	4	5	6	7	≥8	Discon	Safety Follow Up	Follow-up Visits	Survival Follow Up ^a
Scheduling Window (Days) ^b	-28 to -1		±3	±3	±3	±3	±3	±3	±3	At Time of Discon	30 Days Post Last Dose	Every 12 Weeks Post Discon	Every 12 Weeks
Administrative Procedures													
Informed consent	X												
Informed consent for future biomedical research (optional)	X												
Inclusion/exclusion criteria	X												
Subject identification card	X												
Demographics and medical history (to include smoking and alcohol use)	X												
Prior and concomitant medication review	X	X	X	X	X	X	X	X	X	X			
Post-study anticancer therapy status											X	X	X
Survival status ^c		← →											X
Clinical Procedures/Assessments													
Review adverse events ^d	X	X	X	X	X	X	X	X	X	X	X	X	
Full physical examination	X										X	X	
Directed physical examination		X	X	X	X	X	X	X	X				
Child-Pugh score ^e	X ^f												
Height, weight, and vital signs (T, P, RR, BP) ^g	X	X	X	X	X	X	X	X	X				
12-Lead electrocardiogram	X												
Upper endoscopy	X ^h												
ECOG performance status	X ^f	X	X	X	X	X	X	X	X				
Pembrolizumab administration		X ^c	X	X	X	X	X	X	X				

Trial Period:	Screening Phase	Treatment Cycles (3-Week Cycles)								End of Treatment	Post-treatment		
		1	2	3	4	5	6	7	≥8		Discon	Safety Follow Up	Follow-up Visits
Treatment Cycle/Title:	Screening									At Time of Discon	30 Days Post Last Dose	Every 12 Weeks Post Discon	Every 12 Weeks
Scheduling Window (Days) ^b	-28 to -1		±3	±3	±3	±3	±3	±3	±3	±3	±7	±7	±7
LOCAL Laboratory Assessments													
Pregnancy test ⁱ	X	X ^j	X	X	X	X	X	X	X	X	X		
PT/INR and aPTT (Cohort 1 only)	X ^f		X	X	X	X	X	X	X	X	X	X	
CBC with differential ^k	X ^f		X	X	X	X	X	X	X	X	X	X	
Chemistry panel and liver panel ^k	X ^f		X	X	X	X	X	X	X	X	X	X	
Urinalysis ^l	X ^f		X		X		X		X	X	X		
T3, FT4, and TSH ^l	X ^f		X		X		X		X	X	X	X	
AFP ^m	X ^f		X	X	X	X	X	X	X	X	X	X	
C-Reactive protein (Cohort 1 only) ⁿ		X	X			X				X			
Anti-HCV (Cohort 1 only)	X												
<u>If Anti-HCV positive:</u> (Cohort 1 only)													
• HCV genotype	X												
• HCV viral load ^o	X	X	X	X	X	X	X	X		X			
Anti-HBc (total and IgM), anti-HBs, HBV viral load, HBsAg (Cohort 1 only)	X												
<u>If (1) HBsAg+ or (2) anti-HBc+, anti-HBs-, and HBsAg- and viral load <100 IU/mL:</u> (Cohort 1 only)													
• Anti-HDV (Cohort 1 only)	X												
• Anti-HBe and HBeAg (Cohort 1 only)	X												
• HBsAg and HBV viral load (Cohort 1 only) ^o		X	X	X	X	X	X	X		X			
• Anti-HBc (total), anti-HBe, anti-HBs, and HBe antigen (Cohort 1 only) ^o					X				X		X		

Trial Period:	Screening Phase	Treatment Cycles (3-Week Cycles)								End of Treatment	Post-treatment		
		1	2	3	4	5	6	7	≥8		Discon	Safety Follow Up	Follow-up Visits
Treatment Cycle/Title:	Screening									At Time of Discon	30 Days Post Last Dose	Every 12 Weeks Post Discon	Every 12 Weeks
Scheduling Window (Days) ^b	-28 to -1		±3	±3	±3	±3	±3	±3	±3	±3	±7	±7	±7
CENTRAL Laboratory Assessments													
Anti-HCV (Cohort 2 only)	X												
If Anti-HCV positive: (Cohort 2 only)													
• HCV genotype	X												
• HCV viral load ^p	X												
Anti-HBc (total and IgM) ^p , anti-HBs ^p , HBV viral load ^p , HBsAg ^p (Cohort 2 only)	X												
If (1) HBsAg+ or (2) anti-HBc+, anti-HBs-, and HBsAg- and viral load <100 IU/mL: (Cohort 2 only)													
• Anti-HDV (Cohort 2 only)	X												
• Anti-HBe and HBeAg (Cohort 2 only) ^p	X												
Blood for genetic analyses ^q		X											
Blood for biomarker studies (serum and plasma) ⁿ		X	X			X				X			
Blood for ctDNA (plasma) ^v		X	X			X				X			
Blood for RNA analysis ⁿ		X	X			X				X			
Tumor tissue for biomarker analysis ^r	X												
Efficacy Measurements													
Tumor imaging	X ^s	X ^t						X ^u		X			

Trial Period:	Screening Phase	Treatment Cycles (3-Week Cycles)								End of Treatment	Post-treatment		
		1	2	3	4	5	6	7	≥8		Discon	Safety Follow Up	Follow-up Visits
Treatment Cycle/Title:	Screening									At Time of Discon	30 Days Post Last Dose	Every 12 Weeks Post Discon	Every 12 Weeks
Scheduling Window (Days) ^b	-28 to -1		±3	±3	±3	±3	±3	±3	±3	±3	±7	±7	±7

a. In subjects that experience site-assessed PD or start a new anti-cancer therapy, contact should be made (example; by telephone) Q12W to assess for survival status.
b. Cycle 1 treatment must be given within 3 days of allocation. The window for each visit is ±3 days unless otherwise noted.
c. After documented local site assessed disease progression, or the start of new anticancer treatment; contacts are approximately every 12 weeks by telephone. Updated survival status may be requested by the Sponsor at any time during the course of the study. Upon Sponsor notification, all participants who do not/will not have a scheduled study visit or study contact during the Sponsor defined time period will be contacted for their survival status (excluding participants that have a previously recorded death event in the collection tool).
d. SAEs will be followed through 90 days following cessation of treatment, or 30 days following cessation of treatment if the subject initiates new anticancer therapy, whichever is earlier. All protocol specified hepatic ECIs will be collected throughout the study as listed in Section 7.2.3.2. If any of the hepatic ECI criteria are met, collect the Child-Pugh Score until the hepatic ECIs resolve.
e. If any of the hepatic ECI criteria are met, collect the Child-Pugh Score until the hepatic ECIs resolve.
f. ECOG Performance Status, Child-Pugh Score and laboratory tests for screening and determining eligibility are to be performed within 7 days prior to the first dose of trial treatment except hepatitis and thyroid tests, which may be performed within 28 days.
g. Height will be measured at Visit 1 only.
h. Upper endoscopy to be performed at any time within 12 months before the first dose of study drug.
i. For women of reproductive potential, a urine or serum pregnancy test should be performed within 72 hours prior to Day 1 of each treatment cycle and 30 days post treatment. If a urine test is positive or is not evaluable, a serum test is required. Subjects must be excluded/discontinued in the event of a positive test result. Pregnancy tests (serum and/or urine tests) should be repeated if required by local guidelines. In Cohort 2, pregnancy testing is to be done only at screening and whenever an expected menstrual cycle is missed or when pregnancy is otherwise suspected; unless there is a country-specific regulation to have monthly testing.
j. Not necessary if screening evaluation performed within 72 hours.
k. CBC with differential, chemistry panel, and liver panel to be performed every cycle. Liver panel to include albumin, ALT, AST, total bilirubin, alkaline phosphatase, direct bilirubin, GGT, and total protein.
l. While on treatment, urinalysis and thyroid function tests will be performed every other cycle.
m. For Cohort 1, AFP will be measured every 3 weeks (21 +/-7 days) calculated from the date of allocation. For Cohort 2, AFP will be measured every 9 weeks (63 +/-7 days) calculated from the date of allocation.
n. Whole blood samples should be collected pre-dose at Cycle 1, Cycle 2, Cycle 5, and again at discontinuation or progression of disease. These samples can be taken up to 72 hours prior to dosing.
o. At screening, subjects must have results within 28 days of first dose; at each subsequent visit, the values must be evaluated before the next visit (3 weeks later). HBsAg, HBV viral load, and HCV viral load are to be performed every 3 weeks during treatment, or earlier if clinically indicated. Anti-HBc (total), anti-HBe, anti-HBs, and HBe antigen are to be performed every 12 weeks during treatment, or earlier if clinically indicated. Additional tests to be performed for ECIs are described in Section 5.2.1.3.

Trial Period:	Screen-ing Phase	Treatment Cycles (3-Week Cycles)								End of Treatment	Post-treatment		
		1	2	3	4	5	6	7	≥ 8		Discon	Safety Follow Up	Follow-up Visits
Treatment Cycle/Title:	Screen-ing									At Time of Discon	30 Days Post Last Dose	Every 12 Weeks Post Discon	Every 12 Weeks
Scheduling Window (Days)^b	-28 to -1		± 3		± 7	± 7	± 7						
<p>If the viral load results are not reported in IU/mL, the site should provide the conversion factor specific for the assay method used to convert the assay units of measure to IU/mL.</p> <p>p. For Cohort 2, HCV RNA, anti-HBc (total and IgM), HBSAg, anti-HBs, and HBV DNA will be tested only at screening. Participants must have baseline results within 28 days of first dose. Post baseline tests will be done in case of HECI, following HECI management guidance provided in section 5.2.1.3 for cohort 2. All additional post-baseline laboratory tests should be performed by a central laboratory, if possible.</p> <p>q. Details for collection of blood for genetic testing can be found in: Section 7.1.3.5 Planned Genetic Analysis Sample Collection.</p> <p>r. Tissue is not required for enrollment, but is strongly encouraged if available. Newly obtained tissue is preferred (ie, after sorafenib treatment in Cohort 1 only); formalin-fixed, paraffin-embedded block specimens are preferred to slides. Leftover tumor tissue will be stored for future biomedical research if the subject signs the Future Biomedical Research (FBR) consent. FNA samples are acceptable if available.</p> <p>s. Screening tumor imaging will be performed within 21 days prior to allocation. Confirmation of baseline measurable disease per RECIST 1.1 by the central imaging vendor is required prior to subject allocation. Imaging at screening should include the chest, abdomen, and pelvis, as detailed in the Site Imaging Manual.</p> <p>t. The first on-study imaging time point will be performed at 9 weeks (63 ± 7 days) calculated from the date of allocation and will continue to be performed Q9W (63 ± 7 days), or earlier if clinically indicated. Imaging details can be found in the Site Imaging Manual.</p> <p>u. In subjects who discontinue study therapy without confirmed PD by the site per irRECIST, tumor imaging should be performed at the time of treatment discontinuation. If previous tumor imaging was obtained within 4 weeks prior to the date of discontinuation, then additional tumor imaging at treatment discontinuation is not required.</p> <p>v. For cohort 1, plasma for ctDNA should be collected pre-dose only at C1D1. For cohort 2, plasma for ctDNA should be collected at C1D1, C2D1, C5D1, and then every 3 cycles after that until EOT</p>													

6.2 Second Course Treatment

Trial Period:	Treatment Cycles								End of Treatment	Post-treatment			
	1	2	3	4	5	6	7	8 and Beyond		Discon	Safety Follow Up	Follow-up Visits	Survival Follow Up ^a
Treatment Cycle/Title:									At Time of Discon	30 Days Post-Discon	Every 12 Weeks Post Discon	Every 12 Weeks	
Scheduling Window (Days) ^b		± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 7	± 7	± 7	
Administrative Procedures													
Eligibility criteria	X												
Concomitant medication review	X	X	X	X	X	X	X	X	X	X			
Clinical Procedures/Assessments													
Review adverse events ^c	X	X	X	X	X	X	X	X	X	X	X	X	
Full physical examination	X									X			
Directed physical examination		X	X	X	X	X	X	X					
Child-Pugh Score ^d	X ^e												
Weight, and vital signs (T, P, RR, BP)	X	X	X	X	X	X	X	X	X				
ECOG performance status ^e	X	X	X	X	X	X	X	X	X				
Post-study anticancer therapy status										X	X	X	
Survival status ^f	← →											X	
Trial Treatment Administration													
Pembrolizumab	X	X	X	X	X	X	X	X					
LOCAL Laboratory Assessments													
Pregnancy test ^g	X	X	X	X	X	X	X	X	X	X			
PT/INR and aPTT (Cohort 1 only)	X ^e	X	X	X	X	X	X	X	X	X	X		
CBC with differential ^h	X ^e	X	X	X	X	X	X	X	X	X	X		
Chemistry panel ^h	X ^e	X	X	X	X	X	X	X	X	X	X		
Urinalysis ⁱ	X ^e		X		X		X	X	X				
T3, FT4, and TSH ⁱ	X ^e		X		X		X	X	X		X		
AFP ^j	X ^e	X	X	X	X	X	X	X				X	
Anti-HCV (Cohort 1 only) ^k	X												
If Anti-HCV positive: (Cohort 1 only)													
• HCV viral load ^l	X	X	X	X	X	X	X	X		X			
• HCV genotype	X												

Trial Period:	Treatment Cycles								End of Treatment	Post-treatment			
	Treatment Cycle/Title:	1	2	3	4	5	6	7	8 and Beyond	Discon	Safety Follow Up	Follow-up Visits	Survival Follow Up^a
										At Time of Discon	30 Days Post-Discon	Every 12 Weeks Post Discon	Every 12 Weeks
Scheduling Window (Days)^b		± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 7	± 7		± 7
If (1) HBsAg+ or (2) anti-HBc+, anti-HBs-, HBsAg- and viral load <100 IU/mL (Cohort 1 only)													
• HBsAg and HBV viral load ^l	X	X	X	X	X	X	X	X		X			
• Anti-HBc (total), anti-HBe, anti-HBs, and HBe antigen ^l					X				X				
Central Laboratory Assessments													
Efficacy Measurements													
Anti-HCV (Cohort 2 only) ^k	X												
If Anti-HCV positive: (Cohort 2 only)													
• HCV viral load ^m	X												
• HCV genotype	X												
Anti-HBc (total and IgM), anti-HBs, HBV viral load, HBsAg (Cohort 2 only) ^m	X												
If (1) HBsAg+ or (2) anti-HBc+, anti-HBs-, HBsAg- and viral load <100 IU/mL (Cohort 2 only)													
• Anti-HDV (Cohort 2 only)	X												
• Anti-HBe and HBeAg (Cohort 2 only) ^m	X												
Tumor imaging	X ⁿ	X ⁿ						X ^o		X			
<p>a. In subjects that experience site assessed PD or starts a new anti-cancer therapy contact should be made (by telephone or visit) Q12W to assess for survival status.</p> <p>b. In general, the window for each visit is ± 3 days unless otherwise noted.</p> <p>c. SAEs will be followed through 90 days following cessation of treatment, or 30 days following cessation of treatment if the subject initiates new anticancer therapy, whichever is earlier. All protocol specified hepatic ECIs will be collected throughout the study as listed in Section 7.2.3.2. If any of the hepatic ECI criteria are met, collect the Child-Pugh Score until the hepatic ECIs resolve.</p> <p>d. If any of the hepatic ECI criteria are met, collect the Child-Pugh Score until the hepatic ECIs resolve.</p> <p>e. Laboratory and ECOG tests for determining eligibility are to be performed within 7 days prior to the first retreatment dose of pembrolizumab.</p> <p>f. After documented local site assessed disease progression, or the start of new anticancer treatment; contacts are approximately every 12 weeks by telephone. Updated survival status may be requested by the Sponsor at any time during the course of the study. Upon Sponsor notification, all participants who do not/will not have a scheduled study visit or study contact during the Sponsor defined time period will be contacted for their survival status (excluding participants that have a previously</p>													

Trial Period:	Treatment Cycles								End of Treatment	Post-treatment			
	1	2	3	4	5	6	7	8 and Beyond		Discon	Safety Follow Up	Follow-up Visits	Survival Follow Up ^a
Treatment Cycle/Title:									At Time of Discon	30 Days Post-Discon	Every 12 Weeks Post Discon	Every 12 Weeks	
Scheduling Window (Days) ^b	± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 3	± 7	± 7	± 7	

recorded death event in the collection tool).

- g. For women of reproductive potential, a urine or serum pregnancy test should be performed within 72 hours prior to day 1 of each treatment cycle and 30 days post treatment. A serum test can be done if urine is not appropriate. Additionally, if urine test is positive or is not evaluable, a serum test is required. Subjects must be excluded/discontinued in the event of a positive test results. Pregnancy tests (serum and/or urine tests) should be repeated if required by local guidelines. In Cohort 2, pregnancy testing is to be done only at screening and whenever an expected menstrual cycle is missed or when pregnancy is otherwise suspected; unless there is a country-specific regulation to have monthly testing.
- h. After Cycle 1, laboratory samples can be collected up to 72 hours prior to the scheduled time point. CBC, chemistry and Liver Panel, to be performed every cycle. Liver panel to include albumin, ALT, AST, GGT, total bilirubin, alkaline phosphatase, direct bilirubin, and total protein. .
- i. While on treatment, urinalysis and thyroid function tests will be performed every other cycle. Thyroid evaluations must be available and reviewed before the next scheduled visit
- j. For Cohort 1, AFP will be measured every 3 weeks (21 +/-7 days) calculated from the date of allocation. For Cohort 2, AFP will be measured every 9 weeks (63 +/-7 days) calculated from the date of allocation. AFP evaluations must be available and reviewed before the next scheduled visit.
- k. If anti-HCV was negative prior to retreatment in the Second Course Phase, anti-HCV must be performed.
- l. At each visit, the values must be evaluated before the next visit (3 weeks later). HBsAg, HBV viral load, and HCV viral load are to be performed every 3 weeks during treatment, or earlier if clinically indicated. Anti-HBc (total), anti-HBe, anti-HBs, and HBe antigen are to be performed every 12 weeks during treatment, or earlier if clinically indicated. Additional tests to be performed for ECIs are described in Section 5.2.1.3. If the viral load results are not reported in IU/mL, the site should provide the conversion factor specific for the assay method used to convert the assay units of measure to IU/mL.
- m. For Cohort 2, HCV RNA, anti-HBc (total and IgM), HBSAg, anti-HBs, and HBV DNA will be tested only at screening. Participants must have baseline results within 28 days of first dose. Post baseline tests will be done in case of HECl, following HECl management guidance provided in section 5.2.1.3 for cohort 2. All additional post-baseline laboratory tests should be performed by a central laboratory, if possible.
- n. Tumor imaging should be performed within 21 days prior to starting or restarting treatment with pembrolizumab and continue to be performed every 9 weeks (63±7 days) calculated from the first dose of retreatment, or more frequently if clinically indicated.
- o. Tumor imaging should be performed at the time of treatment discontinuation. If previous tumor imaging was obtained within 4 weeks prior to the date of discontinuation, then additional tumor imaging at treatment discontinuation is not mandatory.

7.0 TRIAL PROCEDURES

7.1 Trial Procedures

The Trial Flow Chart - Section 6.0 summarizes the trial procedures to be performed at each visit. Individual trial procedures are described in detail below. It may be necessary to perform these procedures at unscheduled time points if deemed clinically necessary by the investigator.

Furthermore, additional evaluations/testing may be deemed necessary by the investigator and or the Sponsor for reasons related to subject safety. In some cases, such evaluation/testing may be potentially sensitive in nature (e.g., HIV, Hepatitis C, etc.), and thus local regulations may require that additional informed consent be obtained from the subject. In these cases, such evaluations/testing will be performed in accordance with those regulations.

7.1.1 Administrative Procedures

7.1.1.1 Informed Consent

The investigator or qualified designee must obtain documented consent from each potential subject or each subject's legally acceptable representative prior to participating in a clinical trial or Future Biomedical Research. If there are changes to the subject's status during the trial (e.g., health or age of majority requirements), the investigator or qualified designee must ensure the appropriate consent is in place.

7.1.1.1.1 General Informed Consent

Consent must be documented by the subject's dated signature or by the subject's legally acceptable representative's dated signature on a consent form along with the dated signature of the person conducting the consent discussion.

A copy of the signed and dated consent form should be given to the subject before participation in the trial.

The initial informed consent form, any subsequent revised written informed consent form and any written information provided to the subject must receive the IRB/ERC's approval/favorable opinion in advance of use. The subject or his/her legally acceptable representative should be informed in a timely manner if new information becomes available that may be relevant to the subject's willingness to continue participation in the trial. The communication of this information will be provided and documented via a revised consent form or addendum to the original consent form that captures the subject's dated signature or by the subject's legally acceptable representative's dated signature.

Specifics about a trial and the trial population will be added to the consent form template at the protocol level.

The informed consent will adhere to IRB/ERC requirements, applicable laws and regulations and Sponsor requirements.

7.1.1.1.2 Consent and Collection of Specimens for Future Biomedical Research

The investigator or qualified designee will explain the Future Biomedical Research consent to the subject, answer all of his/her questions, and obtain written informed consent before performing any procedure related to the Future Biomedical Research sub-trial. A copy of the informed consent will be given to the subject.

7.1.1.2 Inclusion/Exclusion Criteria

All inclusion and exclusion criteria will be reviewed by the investigator or qualified designee to ensure that the subject qualifies for the trial.

7.1.1.3 Subject Identification Card

All subjects will be given a Subject Identification Card identifying them as participants in a research trial. The card will contain trial site contact information (including direct telephone numbers) to be utilized in the event of an emergency. The investigator or qualified designee will provide the subject with a Subject Identification Card immediately after the subject provides written informed consent. At the time of treatment allocation/randomization, site personnel will add the treatment/randomization number to the Subject Identification Card.

The subject identification card also contains contact information for the emergency unblinding call center so that a health care provider can obtain information about trial medication/vaccination in emergency situations where the investigator is not available.

7.1.1.4 Medical History

A medical history will be obtained by the investigator or qualified designee. Medical history will include smoking and alcohol use, all active conditions, and any condition diagnosed within the prior 10 years that are considered to be clinically significant by the investigator.

If the subject has lost at least 15 lbs. (6.8 kg) over the 3 months prior to screening, “weight loss” should be entered as an active condition on the Medical History. As well, any autoimmune disorders, regardless of onset date, should be recorded.

Disease details regarding the subject’s HCC will be recorded separately and not listed as medical history.

7.1.1.5 Disease Details

The investigator or qualified designee will obtain prior and current details regarding the subject’s HCC.

7.1.1.6 Prior and Concomitant Medications Review

7.1.1.6.1 Prior Medications

The investigator or qualified designee will review prior medication use, including any protocol-specified washout requirement, and record prior medication taken by the subject within 30 days of the first dose of trial medication, including alternative/complementary

medications. Prior anti-cancer treatment for HCC will be recorded separately and not listed as a prior medication. In addition, for all subjects with a history of hepatitis B or hepatitis C, information on past and /or present anti-viral treatment will be collected.

7.1.1.6.1.1 Prior Treatment Details for HCC

The investigator or qualified designee will review all prior anti-cancer treatments including systemic treatments, radiation, local therapy, and surgeries.

7.1.1.6.2 Concomitant Medications

The investigator or qualified designee will record medication, if any, taken by the subject during the trial from the time of signing the informed consent form until the Safety Follow-up Visit. In addition, new medications started during the Second Course Phase through the Second Course Safety Follow-up Visit should be recorded.

All medications related to reportable SAEs and ECIs should be recorded as defined in Section 7.2.3.

7.1.1.7 Subsequent Anti-Cancer Status

The investigator or qualified designee will review all new anti-cancer therapy initiated after the last dose of trial treatment. If a subject initiates a new anti-cancer therapy within 30 days after the last dose of trial treatment, the 30-day Safety Follow-up visit must occur before the first dose of the new therapy.

Once new anti-cancer therapy has been initiated the subject will move into survival follow-up. Details regarding survival status follow-up are outlined in 7.1.6.3.3 – Survival Follow-up.

7.1.1.8 Assignment of Screening Number

All consented subjects will be given a unique screening number that will be used to identify the subject for all procedures that occur prior to randomization or treatment allocation. Each subject will be assigned only one screening number. Screening numbers must not be re-used for different subjects.

Any subject who is screened multiple times will retain the original screening number assigned at the initial screening visit.

Specific details on the screening visit requirements (screening/rescreening) are provided in Section 7.1.6.

7.1.1.9 Assignment of Treatment/Randomization Number

All eligible subjects will be allocated by non-random assignment, and will receive a treatment number referred to as an allocation number. The allocation number identifies the subject for all procedures occurring after treatment allocation to pembrolizumab. Once an allocation number is assigned to a subject, it can never be re-assigned to another subject.

A single subject cannot be assigned more than 1 allocation number.

7.1.1.10 Trial Compliance (Medication/Diet/Activity/Other)

Interruptions from the protocol-specified treatment plan for greater than 12 weeks between pembrolizumab doses for non-drug-related or administrative reasons require consultation between the investigator and the Sponsor and written documentation of the collaborative decision on subject management.

The total volume of pembrolizumab infused will be compared to the total volume prepared to determine compliance with each dose of pembrolizumab administered. The instructions for preparing and administering pembrolizumab are provided in the Pharmacy Manual.

Administration of trial medication will be witnessed by the investigator, trial staff, or qualified designee per institutional guidelines and procedures.

7.1.2 Clinical Procedures/Assessments

7.1.2.1 Adverse Event Monitoring

The investigator or qualified designee will assess each subject to evaluate for potential new or worsening AEs as specified in the Trial Flow Chart and more frequently if clinically indicated. Adverse events will be graded and recorded throughout the trial and during the follow-up period according to NCI CTCAE version 4.0 (see Section 12.6). Toxicities will be characterized in terms regarding seriousness, causality, toxicity grading, and action taken with regard to trial treatment.

All AEs of unknown etiology associated with pembrolizumab exposure should be evaluated to determine if it is possibly an event of a potentially immunologic etiology; see Section 5.6.2.

Please refer to Section 7.2 for detailed information regarding the assessment and recording of AEs.

7.1.2.2 Physical Exam

7.1.2.2.1 Full Physical Exam

The investigator or clinical designee will perform a complete physical exam during the screening period. Clinically significant abnormal findings should be recorded as medical history. Additional full physical exams should be performed as specified in the Trial Flow Chart - Section 6.0. Assessment for possible ascites and encephalopathy should be noted on every examination. After the first dose of trial treatment new clinically significant abnormal findings should be recorded as AEs.

7.1.2.2.2 Directed Physical Exam

For cycles that do not require a full physical exam per the Trial Flow Chart - Section 6.0, the investigator or qualified designee will perform a directed physical exam as clinically indicated prior to dosing on Day 1 of each treatment cycle. Assessment for possible ascites and encephalopathy should be noted on every examination. New clinically significant abnormal findings should be recorded as AEs.

7.1.2.3 Height, Weight, and Vital Signs

The investigator or qualified designee will take vital signs at screening, prior to the administration of each dose of trial treatment, and at treatment discontinuation as specified in the Trial Flow Chart - Section 6.0. Height will be measured at Visit 1 only.

Vital signs should include temperature, pulse, respiratory rate, blood pressure, height, and weight.

7.1.2.4 12-Lead Electrocardiogram

A standard 12-lead electrocardiogram (ECG) will be performed one time during screening using local standard procedures. Clinically significant abnormal findings should be recorded as medical history. Additional time points may be performed as clinically necessary.

7.1.2.5 Eastern Cooperative Oncology Group Performance Status

The investigator or qualified designee will assess ECOG Performance Status (see Section 12.5) at screening, prior to dosing on Day 1 of each treatment cycle, and at discontinuation of trial treatment as specified in the Trial Flow Chart – Section 6.0.

7.1.2.6 Child-Pugh Score

Originally developed in 1973, the Child-Pugh score was used to estimate the risk of operative mortality in patients with bleeding esophageal varices. It has since been modified, refined, and become a widely used tool to assess prognosis in patients with chronic liver disease and cirrhosis. The score considers five factors, three of which assess the synthetic function of the liver (ie, Tbil level, serum albumin, and coagulation parameters [INR or PT]) and two of which are based on clinical assessment (ie, degree of ascites and degree of hepatic encephalopathy).

7.1.3 Laboratory Procedures/Assessments

Details regarding specific laboratory procedures/assessments to be performed in this trial are provided below. The total amount of blood/tissue to be drawn/collected over the course of the trial (from pre-trial to post-trial visits), including approximate blood/tissue volumes drawn/collected by visit and by sample type per subject can be found in the Procedure Manual.

Refer to the Trial Flow Chart - Section 6.0 for the schedule of laboratory assessments.

7.1.3.1 Laboratory Safety Evaluations (Hematology, Chemistry and Urinalysis)

Laboratory tests for hematology, chemistry, and urinalysis are specified in [Table 6](#).

Table 6 Laboratory Tests

Hematology	Chemistry	Urinalysis	Other
Hematocrit	Albumin	Blood	Pregnancy test (serum or urine) ^a
Hemoglobin	Alkaline phosphatase	Glucose	PT/INR
Platelet count	Alanine aminotransferase	Protein	aPTT (Cohort 1 only)
WBC (total and differential) ^b	Aspartate aminotransferase	Specific gravity	Total T3 or Free T3, FT4, and TSH ^{c,d}
RBC	Bicarbonate ^e	Microscopic exam, if abnormal results are noted	Anti-HCV ^f
Absolute lymphocyte count ^b	Calcium		HCV viral load ^f
Absolute neutrophil count ^b	Chloride		HCV genotype ^f
	Creatinine		anti-HBs ^f
	Glucose		
	Phosphorus		HBsAg ^f
	Potassium		Anti-HBc ^f (total and IgM)
	Sodium		HBeAg ^f
	Total bilirubin		anti-HBe ^f
	Direct bilirubin		HBV viral load ^f
			Anti-HDV ^f
			AFP ^d
	Total protein		CRP (Cohort 1 only)
			GGT
	Blood urea nitrogen		

a. Perform on women of childbearing potential only 72 hours prior to Day 1 of Cycle 1. Pregnancy tests must be repeated prior to every cycle if required or as specified per local regulatory guidance.
 b. Report % or absolute results per standard of practice. Report the results in the same manner throughout the study.
 c. T3 is preferred; if not available free T3 may be tested.
 d. If the local laboratory is unable to perform these tests, the site should submit the sample to the central laboratory for testing. Details are provided in the Laboratory Manual.
 e. If this test is not done as part of local standard of care, this test does not need to be performed.
 f. All hepatitis tests will be done centrally

AFP = alpha-fetoprotein; aPTT = activated partial thrombin time; CRP = C-reactive protein; FT4 = free thyroxine; GGT = gamma-glutamyl transferase; HBc = Hepatitis B core; HBeAg = Hepatitis B e antigen; HBe = hemoglobin E; HBs = hepatitis B surface; HBsAg = hepatitis B surface antigen; HBV = hepatitis B virus; HCV = hepatitis C virus; HDV = hepatitis D virus; IgM = gamma M immunoglobulin; INR = insulin receptor; PT = prothrombin time; RBC = red blood cells; T3 = triiodothyronine; TSH = thyroid-stimulating hormone (thyrotropin); WBC = white blood cells.

Laboratory tests for screening should be performed within 7 days prior to the first dose of trial treatment. An exception is hepatitis serologies and thyroid tests, which may be performed within 28 days prior to first dose. Subjects eligible for retreatment with pembrolizumab should have imaging performed within 21 days and laboratory test performed within 7 days prior to the first dose of trial treatment in the Second Course Phase.

After Cycle 1, in both the Initial Treatment Phase and the Second Course Phase, pre-dose laboratory safety tests can be conducted up to 72 hours prior to dosing with the exception of AFP, CRP (cohort 1 only), and thyroid function test.

Laboratory test results must be reviewed by the investigator or qualified designee and found to be acceptable prior to administration of each dose of trial treatment, unless otherwise specified in the Trial Flow Chart (Section 6.0). Unresolved abnormal laboratory values that are drug-related AEs should be followed until resolution. Laboratory tests do not need to be repeated after the end of treatment if laboratory results are within normal range.

7.1.3.1.1 Pregnancy Tests

All women who are being considered for participation in the trial, and who are not surgically sterilized or postmenopausal, must be tested for pregnancy within 72 hours of each cycle of trial treatment and 30 days post treatment. If a urine test is positive or not evaluable a serum test will be required. Subjects must be excluded/discontinued from the study in the event of a positive or borderline-positive test result.

7.1.3.2 Central Laboratory Assessments

Sample collection timing, storage and shipment instructions for the central laboratory assessments will be provided in the Laboratory Manual.

7.1.3.3 Blood Samples for RNA Analysis, and Biomarker Studies

Information about sample collection, storage and shipment for blood, plasma, and serum is provided in the Procedure Manual. Any leftover samples from the RNA analysis and biomarker studies will be stored for future biomedical research if the subject signs the FBR consent.

7.1.3.4 Tumor Tissue

Supplying tumor tissue for biomarker analysis is strongly encouraged but is not required for study enrollment. Biopsies should not be performed for the sole purpose of biomarker analysis for this protocol. Newly obtained tissue is preferred (after sorafenib treatment in Cohort 1 only) to an archival sample. Formalin-fixed, paraffin-embedded (FFPE) block specimens are preferred to slides. If only slides can be sent, they should be sent within 7 days of cutting from the block. Fine needles aspirate (FNA) samples are acceptable if available. If the subject signs the FBR consent, any leftover tissue that would ordinarily be discarded at the end of the main study will be retained for FBR.

Detailed instructions for tissue collection, processing and shipment are provided in the Procedures Manual.

7.1.3.5 Planned Genetic Analysis Sample Collection

Sample collection, storage and shipment instructions for Planned Genetic Analysis samples will be provided in the Procedure Manual. This sample should be drawn for planned analysis

of the association between genetic variants in DNA and drug response. If there is either a documented law or regulation prohibiting collection, or if the IRB/IEC does not approve the collection of the sample for these purposes, then this sample will not be collected at that site. If the sample is collected, leftover extracted DNA will be stored for future biomedical research if the subject signs the FBR consent. If the planned genetic analysis is not approved, but FBR is approved and consent is given, this sample will be collected for the purpose of FBR.

7.1.3.6 Future Biomedical Research Sample Collection

The following specimens are to be obtained as part of Future Biomedical Research:

- DNA for future research.
- Leftover tumor for future research
- Leftover DNA
- Leftover RNA
- Leftover plasma and serum from Biomarker Studies

7.1.4 Efficacy Measurements

7.1.4.1 Tumor Imaging and Assessment of Disease

The process for image collection and transmission to the central imaging vendor can be found in the Site Imaging Manual (SIM). Tumor imaging should be acquired by computed tomography (computed tomography [CT], strongly preferred). Magnetic resonance imaging (MRI) should be used when CT is contraindicated or for imaging in the brain. MRI of the abdomen may also be used if it is the local standard of care. The same imaging technique regarding modality and use of contrast must be used in a subject throughout the trial to optimize the visualization of existing and new tumor burden.

Expedited confirmation of measurable disease based on RECIST 1.1 by the central imaging vendor at screening will be used to determine subject eligibility. Confirmation of measurable disease by the central imaging vendor per RECIST 1.1 is required prior to subject allocation. Although RECIST 1.1 references a maximum of 5 target lesions in total and 2 per organ, MSD allows a maximum of 10 target lesions in total and 5 per organ.

All scheduled images for all study subjects from the sites will be submitted to the central imaging vendor for retrospective review. In addition, additional imaging (including other modalities) that are obtained at an unscheduled time point to determine disease progression, as well as imaging obtained for other reasons but captures radiologic progression, should be submitted to the central imaging vendor as well.

7.1.4.1.1 Initial Tumor Imaging

Initial tumor imaging at screening must be performed within 21 days prior to the date of allocation. The site study team must review screening images to confirm the subject has measurable disease per RECIST 1.1. Prior to allocation, the screening images must be

submitted to the central imaging vendor for confirmation of measurable disease per RECIST 1.1.

Scans performed as part of routine clinical management are acceptable for use as screening tumor imaging if they are of diagnostic quality, were performed within 21 days prior to the date of allocation, and can be assessed by the central imaging vendor.

7.1.4.1.2 Tumor Imaging During the Trial

The first on-study imaging assessment should be performed at 9 weeks (63 ± 7 days) from the date of allocation. Subsequent tumor imaging should be performed Q9W (63 ± 7 days) or more frequently if clinically indicated. Imaging timing should follow calendar days and should not be adjusted for delays in cycle starts. Imaging should continue to be performed until disease progression (unless site principal investigator [PI] elects to continue treatment and follow irRECIST), the start of new anti-cancer treatment, withdrawal of consent, death, or notification by the Sponsor, whichever occurs first. All supplemental imaging must be submitted to the central imaging vendor for retrospective review.

Per RECIST 1.1, partial response (PR) and CR should be confirmed by a repeat tumor imaging assessment ≥ 4 weeks from the date the response was first documented. The tumor imaging for confirmation of response may be performed ≥ 4 weeks after the first indication of response, or at the next scheduled scan (ie, 9 weeks later), whichever is clinically indicated. Subjects will then return to regular scheduled imaging every 9 weeks (63 ± 7 days), starting with the next scheduled imaging time point. Subjects who obtain a local confirmation scan do not need to undergo the next scheduled tumor imaging if it is <4 weeks later; tumor imaging may resume at the subsequent scheduled imaging time point.

Per irRECIST (Section 7.1.4.1.6), disease progression should be confirmed by the site at least 4 weeks after site-assessed 1st radiologic evidence of PD in clinically stable subjects. Subjects who have unconfirmed disease progression may continue on treatment at the discretion of the site investigator until progression is confirmed by the site provided they have met the conditions detailed in Section 7.1.4.1.6. Subjects who obtain a confirmation scan do not need to undergo the next scheduled tumor imaging if it is <4 weeks later; tumor imaging may resume at the subsequent scheduled imaging time point if clinically stable. Subjects who have confirmed disease progression as assessed by the site will discontinue the treatment. Exceptions are detailed in Section 7.1.4.1.6.

7.1.4.1.3 End of Treatment and Follow-up Tumor Imaging

In subjects who discontinue trial treatment, tumor imaging should be performed at the time of treatment discontinuation. If a previous scan was obtained within 4 weeks prior to the date of discontinuation, then a scan at treatment discontinuation is not mandatory. In subjects who discontinue trial treatment due to documented disease progression, this is the final required tumor imaging.

In subjects who discontinue trial treatment without documented disease progression, every effort should be made to continue monitoring their disease status by tumor imaging using the same imaging schedule used while on treatment every 12 weeks (84 ± 7 days to monitor disease status until (1) the start of new anti-cancer treatment, (2) disease progression, (3) death, or (4) the end of the study, whichever occurs first.

7.1.4.1.4 Second Course (Retreatment) Tumor Imaging

A scan must be performed within 21 days prior to restarting treatment with pembrolizumab. Local reading (investigator assessment with site radiology reading) will be used to determine eligibility. Imaging should be submitted to the central imaging vendor for retrospective verification.

The first on-study imaging assessment should be performed 12 weeks (84±7 days) after the restart of treatment. Subsequent tumor imaging should be performed every 9 weeks (63±7 days), or more frequently if clinically indicated.

Per irRECIST 1.1 (Section 7.1.4.1.6), if tumor imaging shows initial PD, tumor assessment should be repeated ≥ 4 weeks later in order to confirm PD with the option of continuing treatment while awaiting radiologic confirmation of progression. Subjects who obtained a confirmation scan do not need to undergo scheduled tumor imaging if it is <4 weeks later and may wait until the next scheduled imaging time point if clinically stable.

Imaging should continue to be performed until disease progression, the start of new anti-cancer treatment, withdrawal of consent, death, or notification by the Sponsor, whichever occurs first. Disease progression may be confirmed at least 4 weeks after the first tumor imaging indicating progressive disease in clinically stable subjects.

In subjects who discontinue trial treatment, tumor imaging should be performed at the time of treatment discontinuation. If a previous scan was obtained within 4 weeks prior to the date of discontinuation, then a scan at treatment discontinuation is not mandatory. In subjects who discontinue trial treatment due to documented disease progression, this is the final required tumor imaging.

In subjects who discontinue trial treatment without documented disease progression, every effort should be made to continue monitoring their disease status by radiologic imaging every 9 weeks (63±7 days) until the start of new anti-cancer treatment, disease progression, death, or the end of the study, whichever occurs first.

7.1.4.1.5 RECIST 1.1 Assessment of Disease

RECIST 1.1 will be applied by the central imaging vendor as the primary measure for assessment of tumor response, date of disease progression, and as a basis for all protocol guidelines related to disease status (eg, discontinuation of study therapy). Confirmation of PR and CR for RECIST 1.1 will be taken from central imaging retrospectively.

7.1.4.1.6 Modified RECIST (mRECIST) Assessment of Disease

Modified RECIST for HCC allows evaluation of treatment effects that are not reflected in simple total size changes of lesions, and protects against premature assessment of progression based on benign changes due to cirrhosis. Details are fully described in [50]. Extrahepatic lesion assessment, as well as response categories and definitions are identical to RECIST 1.1. Key differences from RECIST 1.1 include:

- Lesions within the liver parenchyma are measured so as to include only the portion showing increased contrast enhancement in the arterial phase.

- New lesions in the liver must meet 1 of the following conditions to be considered indicators of progression:
 - At least 10 mm in longest diameter, and showing typical HCC enhancement (enhancement during the arterial phase and washout during the portal venous phase)
 - At least 10 mm in longest diameter with atypical enhancement, but showing at least 10 mm of growth on a subsequent scan
 - Porta hepatis lymph nodes should never be selected as target lesions, and should only be followed as non-target lesions if their short axis measurement at screening is ≥ 20 mm.

7.1.4.1.7 irRECIST Assessment of Disease

irRECIST is RECIST 1.1 adapted as described below to account for the unique tumor response seen with immunotherapeutic drugs. irRECIST will be used by site investigator/local radiology review to assess tumor response and progression, and make treatment decisions. This data will be collected in the clinical database. Treatment efficacy based on irRECIST as assessed by the central imaging vendor review will be evaluated retrospectively.

When feasible, subjects should not be discontinued until progression is confirmed by the local site investigator/radiology assessment. This allowance to continue treatment despite initial radiologic progressive disease (PD) takes into account the observation that some subjects can have a transient tumor flare in the first few months after the start of immunotherapy, and then experience subsequent disease response. Subjects that are deemed clinically unstable are not required to have repeat tumor imaging for confirmation of PD. Tumor flare includes any of the following scenarios:

- Worsening of existing target lesion(s)
- Worsening of existing non-target lesion(s)
- Development of new lesion(s)

In subjects who have initial evidence of radiological PD by RECIST 1.1 as determined by the site, it is at the discretion of the PI whether to continue a subject on trial treatment until repeat imaging is obtained (using irRECIST for subject management, see [Table 7](#) and [Figure 2](#)). This clinical judgment decision by the site investigator should be based on the subject's overall clinical condition, including performance status, clinical symptoms, and laboratory data. Subjects may receive trial treatment and tumor assessment should be repeated ≥ 4 weeks later to confirm PD by irRECIST per site assessment. Clinical stability is defined as the following:

- 1) Absence of symptoms and signs indicating clinically significant progression of disease, including worsening of laboratory values,
- 2) No decline in ECOG performance status,
- 3) Absence of rapid progression of disease, and

- 4) Absence of progressive tumor at critical anatomical sites (eg, cord compression) requiring urgent alternative medical intervention.

Any subject deemed clinically unstable should be discontinued from trial treatment at site-assessed first radiologic evidence of PD and is not required to have repeat imaging for PD confirmation.

In determining whether or not the tumor burden has increased or decreased per irRECIST, the local site investigator should consider all target and non-target lesions as well as any incremental new lesion(s).

Scenarios where PD is not confirmed at repeat imaging if ALL of the following occur by irRECIST:

- Target lesion sum of diameters is <20% or <5 mm absolute increase compared to nadir,
- Non-target disease resulting in initial PD is qualitatively stable or improved,
- New lesion resulting in initial PD is qualitatively stable or improved,
- No incremental new lesion(s) since last evaluation, and
- No incremental new non-target lesion progression since last evaluation.

If repeat imaging does not confirm PD by irRECIST as assessed by the local site investigator and the subject continues to be clinically stable, treatment may continue and follow the regular imaging schedule.

Scenarios where PD is confirmed at repeat imaging if ANY of the following occur by irRECIST:

- Target lesion sum of diameters remains $\geq 20\%$ and at least 5 mm absolute increase compared to nadir,
- Non-target disease resulting in initial PD is qualitatively worse,
- New lesion resulting in initial PD is qualitatively worse,
- Additional new lesion(s) since last evaluation, or
- Additional new non-target lesion progression since last evaluation.

If repeat imaging confirms PD due to any of the scenarios listed above, subjects will be discontinued from study therapy.

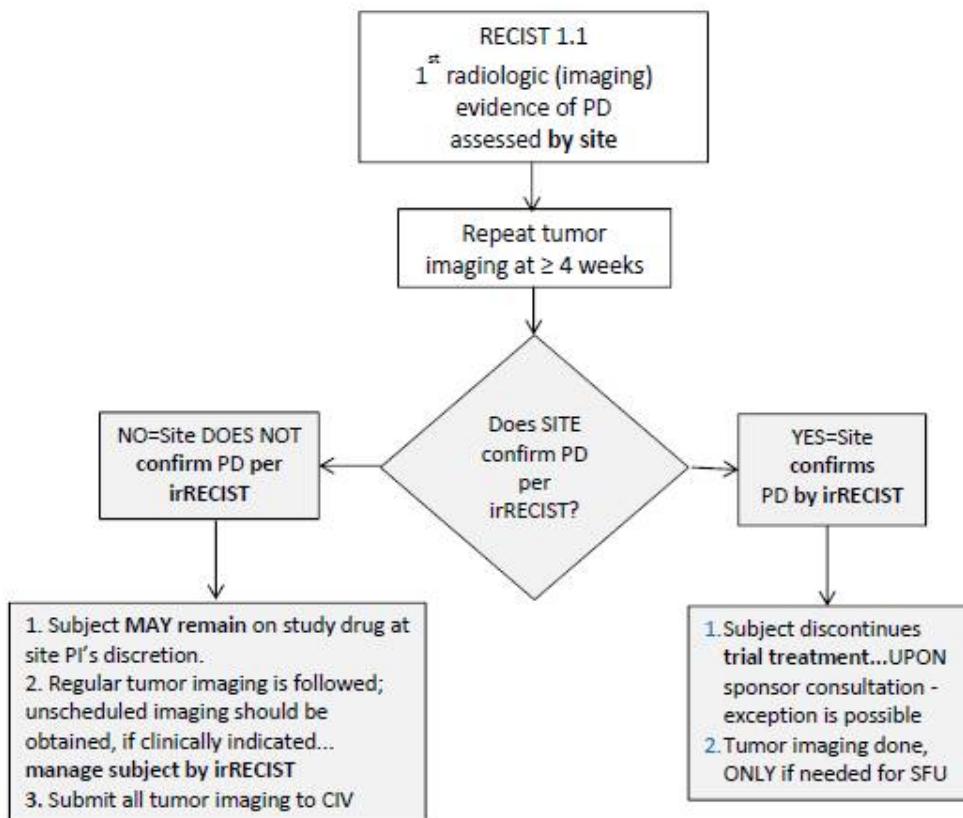
NOTE: If a subject has confirmed radiographic progression (ie, 2 scans at least 4 weeks apart demonstrating progressive disease) per irRECIST, but the subject is achieving a clinically meaningful benefit and there is no further increase in the tumor burden at the confirmatory tumor imaging, an exception to continue treatment may be considered following consultation with the Sponsor. In this case, if treatment is continued, tumor imaging should continue to be performed following the intervals as outlined in Section 6.0 Trial Flow Chart; consultation with the Sponsor is also necessary after each subsequent site assessment of irPD for treatment to be continued. All images must be submitted to the central imaging vendor.

Additional details about irRECIST are referenced in MSD Tip Sheet for RECIST 1.1 and irRECIST.

Table 7 Imaging and Treatment after First Radiologic Evidence of Progressive Disease

	Clinically Stable		Clinically Unstable	
	Imaging	Treatment	Imaging	Treatment
First radiologic evidence of PD by RECIST 1.1	Repeat imaging at ≥ 4 weeks at site to confirm PD	May continue trial treatment at the local site Investigator's discretion while awaiting confirmatory tumor imaging by site by irRECIST.	Repeat imaging at ≥ 4 weeks to confirm PD per physician discretion only	Discontinue treatment
Repeat tumor imaging confirms PD by irRECIST at the local site	No additional imaging required	Discontinue treatment (exception is possible upon consultation with sponsor)	No additional imaging required	N/A
Repeat tumor imaging shows SD, PR or CR by irRECIST by the local site	Continue regularly scheduled imaging assessments	Continue treatment at the local site Investigator's discretion	Continue regularly scheduled imaging assessments	May restart trial treatment if condition has improved and/or clinically stable per Investigator's discretion. Next tumor image should occur according to the regular imaging schedule outlined in the protocol.

CR = complete response; irRECIST = immune-related response evaluation criteria in solid tumors; N/A = not applicable; PD = progressive disease; PFS = progression-free survival; PR = partial response; SD = stable disease.



Abbreviations: CIV=central imaging vendor; irRECIST=immune-related Response Evaluation Criteria in Solid Tumors; PD=progressive disease; PI=principal investigator.

Figure 2 Imaging and Treatment for Clinically Stable Subjects after First Radiologic Evidence of Progressive Disease Assessed by the Site

7.1.5 Other Procedures

7.1.5.1 Withdrawal/Discontinuation

Subjects who discontinue/withdraw from treatment prior to completion of the treatment regimen should be encouraged to continue to be followed for all remaining study visits.

When a subject discontinues/withdraws from participation in the trial, all applicable activities scheduled for the end of treatment visit should be performed at the time of discontinuation. Any adverse events which are present at the time of discontinuation/withdrawal should be followed in accordance with the safety requirements outlined in Section 7.2 - Assessing and Recording Adverse Events. Subjects who attain a CR or complete 35 trial treatments (approximately 2 years) may discontinue treatment with the option of restarting treatment if they meet the criteria specified in Section 7.1.6.2. After discontinuing treatment following assessment of a CR or the 35 trial treatments, subjects should return to the site for a Safety Follow-up visit (Section 7.1.6.3.1) and then proceed to the Follow-up Period of the study (Section 7.1.6.3.2).

7.1.5.1.1 Withdrawal From Future Biomedical Research

Subjects may withdraw their consent for Future Biomedical Research and have their specimens and all derivatives destroyed. Subjects may withdraw consent at any time by contacting the principal investigator for the main trial. If medical records for the main trial are still available, the investigator will contact the Sponsor using the designated mailbox (clinical.specimen.management@MSD.com), and a form will be provided by the Sponsor to obtain appropriate information to complete specimen withdrawal. Subsequently, the subject's specimens will be removed from the biorepository and be destroyed. A letter will be sent from the Sponsor to the investigator confirming the destruction. It is the responsibility of the investigator to inform the subject of completion of destruction. Any analyses in progress at the time of request for destruction or already performed prior to the request being received by the Sponsor will continue to be used as part of the overall research trial data and results. No new analyses would be generated after the request is received.

In the event that the medical records for the main trial are no longer available (e.g., if the investigator is no longer required by regulatory authorities to retain the main trial records) or the specimens have been completely anonymized, there will no longer be a link between the subject's personal information and their specimens. In this situation, the request for specimen destruction cannot be processed.

7.1.5.2 Blinding/Unblinding

This is an open label trial; there is no blinding for this trial.

Section 5.8 outlines the criteria for allowing subjects who are discontinued from treatment to continue to be monitored in the trial.

7.1.5.3 Calibration of Critical Equipment

The investigator or qualified designee has the responsibility to ensure that any critical device or instrument used for a clinical evaluation/test during a clinical trial that provides important information about inclusion/exclusion criteria and/or safety or efficacy parameters shall be suitably calibrated and maintained to ensure that the data obtained is reliable and/or reproducible. Documentation of equipment calibration must be retained as source documentation at the trial site.

Critical Equipment for this trial includes:

- Laboratory equipment – as required for inclusion labs and trial assessments
- Imaging equipment – as required for study objectives

See protocol-specified guidance in the Trial Administrative Binder, Procedures Manual, and Site Imaging Manual.

7.1.6 Visit Requirements

Visit requirements are outlined in Section 6.0 - Trial Flow Chart. Specific procedure-related details are provided above in Section 7.1 - Trial Procedures.

7.1.6.1 Screening

Approximately 28 days prior to treatment allocation, potential subjects will be evaluated to determine that they fulfill the entry requirements as set forth in Section 5.1. Screening procedures may be repeated.

Subjects may be rescreened after initially failing to meet the inclusion/exclusion criteria. Results from assessments performed during the initial screening period are acceptable in lieu of repeat screening test if performed within the specified time frame and the inclusion/exclusion criteria is met. Subjects who are rescreened will retain their original screening number. Results of a test performed prior to the subject signing consent as part of routine clinical management are acceptable in lieu of a screening test if performed within the specified time frame.

Screening procedures are to be completed within 28 days prior to the first dose of trial treatment except for the following:

- Laboratory tests and ECOG performance status (PS) are to be performed within 7 days prior to the first dose of trial treatment. An exception is hepatitis and thyroid testing which may be done up to 28 days prior to the first dose of trial treatment.
- For women of reproductive potential, a urine or serum pregnancy test will be performed within 72 hours prior to the first dose of trial treatment.

7.1.6.2 Treatment Period

Visit requirements are outlined in the Trial Flow Chart (Section 6.0). Specific procedure-related details are provided above in Trial Procedures (Section 7.0).

7.1.6.2.1 Second Course Phase (Retreatment Period)

Subjects who stop pembrolizumab with stable disease (SD) or better may be eligible for up to 17 additional trial treatments (approximately 1 year) if they progress after stopping trial treatments. Retreatment with pembrolizumab is termed the Second Course Phase and is only available if the trial remains open and the subject meets the following conditions:

- **Either**
 - Stopped initial treatment with pembrolizumab after attaining an investigator-determined CR according to RECIST 1.1
 - Was treated with at least 8 trial treatments (approximately 6 months) with pembrolizumab before discontinuing therapy
 - Received at least two treatments with pembrolizumab beyond the date when the initial CR was declared

OR

- Had SD, PR or CR and stopped pembrolizumab after 35 trial treatments (approximately 2 years) for reasons other than disease progression or intolerance

• **And**

- Experienced an investigator-determined confirmed radiographic disease progression after stopping their initial treatment with pembrolizumab, and
 - Did not receive any anti-cancer treatment since the last dose of pembrolizumab.
 - Has a performance status of 0 or 1 on the ECOG Performance Scale.
 - Demonstrates adequate organ function as detailed in Section 5.1.2.
 - The subject meets all of the inclusion criteria and none of the safety parameters listed in the exclusion criteria.
 - Female subject of childbearing potential should have a negative serum or urine pregnancy test within 72 hours prior to receiving retreatment with study medication (Day 1).
 - Female subjects of childbearing potential must be willing to use an adequate method of contraception as outlined in Section 5.7.2 – Contraception, for the course of the study through 120 days after the last dose of study medication.
 - *Note: Abstinence is acceptable if this is the usual lifestyle and preferred contraception for the subject.*
 - Male subjects of child bearing potential must agree to use an adequate method of contraception as outlined in Section 5.7.2 – Contraception, and not to donate sperm starting with the first dose of study therapy through 120 days after the last dose of study therapy.
 - *Note: Abstinence is acceptable if this is the usual lifestyle and preferred contraception for the subject.*
 - Does not have a history or current evidence of any condition, therapy, or laboratory abnormality that might interfere with the subject's participation for the full duration of the trial or is not in the best interest of the subject to participate, in the opinion of the treating investigator.
 - The trial is ongoing.

Subjects who enter the Second Course Phase will be retreated at the same dose frequency as when they last received pembrolizumab. Pembrolizumab will be administered for up to an additional 17 trial treatments (approximately 1 year).

Visit requirements for the second course phase are outlined in the Second Course Phase Trial Flow Chart (Section 6.2).

7.1.6.3 Post-Treatment Visits

7.1.6.3.1 Safety Follow-up Visits

The mandatory Safety Follow-up Visit should be conducted approximately 30 days after the last dose of trial treatment or before the initiation of a new anti-cancer treatment, whichever comes first.

Subjects who are eligible for retreatment with pembrolizumab may have up to two safety follow-up visits, one after the Initial Treatment Period and one after the Second Course Treatment Phase.

7.1.6.3.2 Follow-up Visits

Subjects who discontinue trial treatment for reasons other than disease progression will move into the Follow-up Phase and should be assessed Q12W by radiologic imaging to monitor disease status. Every effort should be made to collect information regarding disease status until the start of a new anti-cancer therapy, disease progression, death, or the end of the study (or if the subject begins retreatment with pembrolizumab as detailed in Section 7.1.6.2.1).

Information regarding post-study anti-cancer treatment will be collected if new treatment is initiated.

Subjects who are eligible to receive retreatment with pembrolizumab according to the criteria in Section 7.1.4.1.4 will move from the Follow-up Phase to the Second Course Phase when they experience disease progression. Details are provided in the Trial Flow Chart (Section 6.0) for retreatment with pembrolizumab.

7.1.6.3.3 Survival Follow Up

Subjects, who experience confirmed disease progression (by site assessment) or start a new anti-cancer therapy, will move into the Survival Follow-up Phase. Subjects should be contacted (eg, by telephone or visit) approximately every 12 weeks to assess for survival status until death, withdrawal of consent, or the end of the study, whichever occurs first. Post-study anti-cancer therapy will be collected during survival follow up.

7.1.6.4 Survival Status

To ensure current and complete survival data are available at the time of database locks, updated survival status may be requested during the course of the study by the Sponsor. For example, updated survival status may be requested prior to but not limited to an eDMC review, interim and/or final analysis. Upon Sponsor notification, all participants who do not/will not have a scheduled study visit or study contact during the Sponsor-defined time period will be contacted for their survival status (excluding participants that have a previously recorded death event in the collection tool).

7.2 Assessing and Recording Adverse Events

An adverse event is defined as any untoward medical occurrence in a patient or clinical investigation subject administered a pharmaceutical product and which does not necessarily have to have a causal relationship with this treatment. An adverse event can therefore be any unfavourable and unintended sign (including an abnormal laboratory finding, for example), symptom, or disease temporally associated with the use of a medicinal product or protocol-specified procedure, whether or not considered related to the medicinal product or protocol-specified procedure. Any worsening (i.e., any clinically significant adverse change in frequency and/or intensity) of a preexisting condition that is temporally associated with the use of the Sponsor's product, is also an adverse event.

Changes resulting from normal growth and development that do not vary significantly in frequency or severity from expected levels are not to be considered adverse events. Examples of this may include, but are not limited to, teething, typical crying in infants and children and onset of menses or menopause occurring at a physiologically appropriate time.

Sponsor's product includes any pharmaceutical product, biological product, device, diagnostic agent or protocol-specified procedure, whether investigational (including placebo or active comparator medication) or marketed, manufactured by, licensed by, provided by or distributed by the Sponsor for human use.

Adverse events may occur during clinical trials, or as prescribed in clinical practice, from overdose (whether accidental or intentional), from abuse and from withdrawal.

Progression of the cancer under study is not considered an adverse event.

All adverse events that occur after the consent form is signed but before treatment allocation/randomization must be reported by the investigator if they cause the subject to be excluded from the trial, or are the result of a protocol-specified intervention, including but not limited to washout or discontinuation of usual therapy, diet, placebo treatment or a procedure. From the time of treatment allocation/randomization through 30 days following cessation of treatment, all adverse events must be reported by the investigator. Such events will be recorded at each examination on the Adverse Event case report forms/worksheets. The reporting timeframe for adverse events meeting any serious criteria is described in section 7.2.3.1. The investigator will make every attempt to follow all subjects with non-serious adverse events for outcome.

Electronic reporting procedures can be found in the Electronic Data Capture (EDC) data entry guidelines. Paper reporting procedures can be found in the Investigator Trial File Binder (or equivalent).

7.2.1 Definition of an Overdose for This Protocol and Reporting of Overdose to the Sponsor

In this trial, an overdose is any dose higher than ≥ 1000 mg (5 times the protocol defined dose) of pembrolizumab. No specific information is available on the treatment of over dose of pembrolizumab. In the event of overdose, trial treatment should be discontinued and the subject should be observed closely for signs of toxicity. Appropriate supportive treatment should be provided if clinically indicated.

If an adverse event(s) is associated with (“results from”) the overdose of Sponsor's product or vaccine, the adverse event(s) is reported as a serious adverse event, even if no other seriousness criteria are met.

If a dose of Sponsor's product or vaccine meeting the protocol definition of overdose is taken without any associated clinical symptoms or abnormal laboratory results, the overdose is reported as a non-serious Event of Clinical Interest (ECI), using the terminology “accidental or intentional overdose without adverse effect.”

All reports of overdose with and without an adverse event must be reported by the investigator within 24 hours to the Sponsor either by electronic media or paper. Electronic reporting procedures can be found in the EDC data entry guidelines. Paper reporting procedures can be found in the Investigator Trial File Binder (or equivalent).

7.2.2 Reporting of Pregnancy and Lactation to the Sponsor

Although pregnancy and lactation are not considered adverse events, it is the responsibility of investigators or their designees to report any pregnancy or lactation in a subject (spontaneously reported to them) that occurs during the trial.

Pregnancies and lactations that occur after the consent form is signed but before treatment allocation/randomization must be reported by the investigator if they cause the subject to be excluded from the trial, or are the result of a protocol-specified intervention, including but not limited to washout or discontinuation of usual therapy, diet, placebo treatment or a procedure. Pregnancies and lactations that occur from the time of treatment allocation/randomization through 120 days following cessation of Sponsor's product, or 30 days following cessation of treatment if the subject initiates new anticancer therapy, whichever is earlier, must be reported by the investigator. All reported pregnancies must be followed to the completion/termination of the pregnancy. Pregnancy outcomes of spontaneous abortion, missed abortion, benign hydatidiform mole, blighted ovum, fetal death, intrauterine death, miscarriage and stillbirth must be reported as serious events (Important Medical Events). If the pregnancy continues to term, the outcome (health of infant) must also be reported.

Such events must be reported within 24 hours to the Sponsor either by electronic media or paper. Electronic reporting procedures can be found in the EDC data entry guidelines. Paper reporting procedures can be found in the Investigator Trial File Binder (or equivalent).

7.2.3 Immediate Reporting of Adverse Events to the Sponsor

7.2.3.1 Serious Adverse Events

A serious adverse event is any adverse event occurring at any dose or during any use of Sponsor's product that:

- Results in death;
- Is life threatening;
- Results in persistent or significant disability/incapacity;
- Results in or prolongs an existing inpatient hospitalization;

- Is a congenital anomaly/birth defect;
- Is an other important medical event.

Note: In addition to the above criteria, adverse events meeting either of the below criteria, although not serious per ICH definition, are reportable to the Sponsor in the same timeframe as SAEs to meet certain local requirements. Therefore, these events are considered serious by the Sponsor for collection purposes.

- Is a new cancer (that is not a condition of the study);
- Is associated with an overdose.

Refer to [Table 8](#) for additional details regarding each of the above criteria.

For the time period beginning when the consent form is signed until treatment allocation/randomization, any serious adverse event, or follow up to a serious adverse event, including death due to any cause, other than progression of the cancer under study (reference Section 7.2.3.3 for additional details), that occurs to any subject must be reported within 24 hours to the Sponsor if it causes the subject to be excluded from the trial, or is the result of a protocol-specified intervention, including but not limited to washout or discontinuation of usual therapy, diet, placebo treatment or a procedure.

For the time period beginning at treatment allocation/randomization through 90 days following cessation of treatment, or 30 days following cessation of treatment if the subject initiates new anticancer therapy, whichever is earlier, any serious adverse event, or follow up to a serious adverse event, including death due to any cause other than progression of the cancer under study (reference Section 7.2.3.3 for additional details), whether or not related to the Sponsor's product, must be reported within 24 hours to the Sponsor either by electronic media or paper. Electronic reporting procedures can be found in the EDC data entry guidelines. Paper reporting procedures can be found in the Investigator Trial File Binder (or equivalent).

Additionally, any serious adverse event, considered by an investigator who is a qualified physician to be related to the Sponsor's product that is brought to the attention of the investigator at any time following consent through the end of the specified safety follow-up period specified in the paragraph above, or at any time outside of the time period specified in the previous paragraph also must be reported immediately to the Sponsor.

All subjects with serious adverse events must be followed up for outcome.

7.2.3.2 Events of Clinical Interest

Selected non-serious and serious adverse events are also known as Events of Clinical Interest (ECI) and must be reported to the Sponsor.

For the time period beginning when the consent form is signed until treatment allocation/randomization, any ECI, or follow up to an ECI, that occurs to any subject must be reported within 24 hours to the Sponsor if it causes the subject to be excluded from the trial, or is the result of a protocol-specified intervention, including but not limited to washout or discontinuation of usual therapy, diet, placebo treatment or a procedure.

For the time period beginning at treatment allocation/randomization through 30 days following cessation of treatment, any ECI, or follow up to an ECI, whether or not related to the Sponsor's product, must be reported within 24 hours to the Sponsor, either by electronic media or paper. Electronic reporting procedures can be found in the EDC data entry guidelines. Paper reporting procedures can be found in the Investigator Trial File Binder (or equivalent).

Events of clinical interest for this trial include:

1. an overdose of Sponsor's product, as defined in Section 7.2.1 - Definition of an Overdose for This Protocol and Reporting of Overdose to the Sponsor, that is not associated with clinical symptoms or abnormal laboratory results.
2. Hepatic ECIs include any of the following events.

Cohort 1:

All of these events will require holding pembrolizumab treatment, notification of the event(s) to the Sponsor within 24 hours via electronic media or paper, and a hepatology consultation. For dose interval modification, refer to Section 5.2.1.2. For guidance related to the diagnosis and management of hepatic ECIs, refer to Section 5.2.1.3.

- a. ALT:
 - i. Among subjects with baseline ALT $<2 \times \text{ULN}$: ALT $\geq 5 \times \text{ULN}$
 - ii. Among subjects with baseline ALT $\geq 2 \times \text{ULN}$: ALT $>3 \times$ the baseline level
 - iii. ALT $>500 \text{ U/L}$ regardless of baseline level
- b. AST:
 - i. Among subjects with baseline AST $<2 \times \text{ULN}$: AST $\geq 5 \times \text{ULN}$
 - ii. Among subjects with baseline AST $\geq 2 \times \text{ULN}$: AST $>3 \times$ the baseline level
 - iii. AST $>500 \text{ U/L}$ regardless of baseline level
- c. Total Bilirubin:
 - i. Among subjects with baseline levels $<1.5 \text{ mg/dL}$: a value of $>2.0 \text{ mg/dL}$
 - ii. Among subjects with baseline levels that are $\geq 1.5 \text{ mg/dL}$: a value $\geq 2 \times$ the baseline level
 - iii. Total bilirubin $>3.0 \text{ mg/dL}$ regardless of baseline level
- d. Regardless of laboratory values, hepatic decompensation diagnosed clinically, including:
 - i. New onset clinically detectable ascites
 - ii. Gastrointestinal bleeding suggestive of portal hypertension (eg, esophageal or gastric varices)

iii. Encephalopathy

Cohort 2:

Hepatic ECIs include any of the following events if the events are NOT considered due to disease progression, as judged by the investigator. All of these events will require holding study treatment, notification of the event(s) to the Sponsor within 24 hours after awareness via electronic media or paper.

a. ALT:

- i. Among subjects with baseline $ALT < 2 \times ULN$: $ALT \geq 5 \times ULN$
- ii. Among subjects with baseline $ALT \geq 2 \times ULN$: $ALT > 3 \times$ the baseline level
- iii. $ALT > 500$ U/L regardless of baseline level

b. Total Bilirubin:

- i. Total bilirubin > 3.0 mg/dL regardless of baseline level
- c. Regardless of laboratory values, hepatic decompensation diagnosed clinically, including:
 - i. New onset clinically detectable ascites requiring intervention for > 3 days
 - ii. Hepatic Encephalopathy

7.2.3.3 Protocol-Specific Exceptions to Serious Adverse Event Reporting

Efficacy endpoints as outlined will not be reported to the Sponsor as described in Section 7.2.3 - Immediate Reporting of Adverse Events to the Sponsor.

Specifically, the suspected/actual events covered in this exception include any event that is disease progression of the cancer under study.

The Sponsor will monitor safety data to ensure the safety of the subjects in the trial. Any suspected endpoint which upon review is not progression of the cancer under study will be forwarded to global safety as a SAE within 24 hours of determination that the event is not progression of the cancer under study.

7.2.4 Evaluating Adverse Events

An investigator who is a qualified physician will evaluate all adverse events according to the NCI Common Terminology for Adverse Events (CTCAE), version 4.0. Any adverse event which changes CTCAE grade over the course of a given episode will have each change of grade recorded on the adverse event case report forms/worksheets.

All adverse events regardless of CTCAE grade must also be evaluated for seriousness.

Table 8 Evaluating Adverse Events

An investigator who is a qualified physician, will evaluate all adverse events as to:

V4.0 CTCAE Grading	Grade 1	Mild; asymptomatic or mild symptoms; clinical or diagnostic observations only; intervention not indicated.
	Grade 2	Moderate; minimal, local or noninvasive intervention indicated; limiting age-appropriate instrumental ADL.
	Grade 3	Severe or medically significant but not immediately life-threatening; hospitalization or prolongation or hospitalization indicated; disabling; limiting self-care ADL.
	Grade 4	Life threatening consequences; urgent intervention indicated.
	Grade 5	Death related to AE
Seriousness	A serious adverse event is any adverse event occurring at any dose or during any use of Sponsor's product that:	
	†Results in death; or	
	†Is life threatening; or places the subject, in the view of the investigator, at immediate risk of death from the event as it occurred (Note: This does not include an adverse event that, had it occurred in a more severe form, might have caused death.); or	
	†Results in a persistent or significant disability/incapacity (substantial disruption of one's ability to conduct normal life functions); or	
	†Results in or prolongs an existing inpatient hospitalization (hospitalization is defined as an inpatient admission, regardless of length of stay, even if the hospitalization is a precautionary measure for continued observation. (Note: Hospitalization for an elective procedure to treat a pre-existing condition that has not worsened is not a serious adverse event. A pre-existing condition is a clinical condition that is diagnosed prior to the use of an MSD product and is documented in the patient's medical history.); or	
	†Is a congenital anomaly/birth defect (in offspring of subject taking the product regardless of time to diagnosis); or	
	Is a new cancer (that is not a condition of the study) (although not serious per ICH definition, is reportable to the Sponsor within 24 hours to meet certain local requirements); or	
	Is an overdose (whether accidental or intentional). Any adverse event associated with an overdose is considered a serious adverse event for collection purposes. An overdose that is not associated with an adverse event is considered a non-serious event of clinical interest and must be reported within 24 hours.	
	Other important medical events that may not result in death, not be life threatening, or not require hospitalization may be considered a serious adverse event when, based upon appropriate medical judgment, the event may jeopardize the subject and may require medical or surgical intervention to prevent one of the outcomes listed previously (designated above by a †).	
Duration	Record the start and stop dates of the adverse event. If less than 1 day, indicate the appropriate length of time and units	
Action taken	Did the adverse event cause the Sponsor's product to be discontinued?	
Relationship to Sponsor's Product	Did the Sponsor's product cause the adverse event? The determination of the likelihood that the Sponsor's product caused the adverse event will be provided by an investigator who is a qualified physician. The investigator's signed/dated initials on the source document or worksheet that supports the causality noted on the AE form, ensures that a medically qualified assessment of causality was done. This initialed document must be retained for the required regulatory time frame. The criteria below are intended as reference guidelines to assist the investigator in assessing the likelihood of a relationship between the test drug and the adverse event based upon the available information.	
	The following components are to be used to assess the relationship between the Sponsor's product and the AE; the greater the correlation with the components and their respective elements (in number and/or intensity), the more likely the Sponsor's product caused the adverse event (AE):	
	Exposure	Is there evidence that the subject was actually exposed to the Sponsor's product such as: reliable history, acceptable compliance assessment (pill count, diary, etc.), expected pharmacologic effect, or measurement of drug/metabolite in bodily specimen?
	Time Course	Did the AE follow in a reasonable temporal sequence from administration of the Sponsor's product? Is the time of onset of the AE compatible with a drug-induced effect (applies to trials with investigational medicinal product)?
	Likely Cause	Is the AE not reasonably explained by another etiology such as underlying disease, other drug(s)/vaccine(s), or other host or environmental factors

Relationship to Sponsor's Product (continued)	The following components are to be used to assess the relationship between the test drug and the AE: (continued)	
	Dechallenge	Was the Sponsor's product discontinued or dose/exposure/frequency reduced? If yes, did the AE resolve or improve? If yes, this is a positive dechallenge. If no, this is a negative dechallenge. (Note: This criterion is not applicable if: (1) the AE resulted in death or permanent disability; (2) the AE resolved/improved despite continuation of the Sponsor's product; or (3) the trial is a single-dose drug trial); or (4) Sponsor's product(s) is/are only used one time.)
	Rechallenge	Was the subject re-exposed to the Sponsor's product in this study? If yes, did the AE recur or worsen? If yes, this is a positive rechallenge. If no, this is a negative rechallenge. (Note: This criterion is not applicable if: (1) the initial AE resulted in death or permanent disability, or (2) the trial is a single-dose drug trial); or (3) Sponsor's product(s) is/are used only one time). NOTE: IF A RECHALLENGE IS PLANNED FOR AN ADVERSE EVENT WHICH WAS SERIOUS AND WHICH MAY HAVE BEEN CAUSED BY THE SPONSOR'S PRODUCT, OR IF REEXPOSURE TO THE SPONSOR'S PRODUCT POSES ADDITIONAL POTENTIAL SIGNIFICANT RISK TO THE SUBJECT, THEN THE RECHALLENGE MUST BE APPROVED IN ADVANCE BY THE SPONSOR CLINICAL DIRECTOR AS PER DOSE MODIFICATION GUIDELINES IN THE PROTOCOL.
		The assessment of relationship will be reported on the case report forms /worksheets by an investigator who is a qualified physician according to his/her best clinical judgment, including consideration of the above elements.
Record one of the following		Use the following scale of criteria as guidance (not all criteria must be present to be indicative of a Sponsor's product relationship).
Yes, there is a reasonable possibility of Sponsor's product relationship.	There is evidence of exposure to the Sponsor's product. The temporal sequence of the AE onset relative to the administration of the Sponsor's product is reasonable. The AE is more likely explained by the Sponsor's product than by another cause.	
No, there is not a reasonable possibility of Sponsor's product relationship	Subject did not receive the Sponsor's product OR temporal sequence of the AE onset relative to administration of the Sponsor's product is not reasonable OR the AE is more likely explained by another cause than the Sponsor's product. (Also entered for a subject with overdose without an associated AE.)	

7.2.5 Sponsor Responsibility for Reporting Adverse Events

All Adverse Events will be reported to regulatory authorities, IRB/IECs and investigators in accordance with all applicable global laws and regulations, i.e., per ICH Topic E6 (R1) Guidelines for Good Clinical Practice.

7.3 TRIAL GOVERNANCE AND OVERSIGHT

7.3.1 Scientific Advisory Committee

This trial was developed in collaboration with both Sponsor and non-Sponsor scientific experts who provide input with respect to the trial design, interpretation of trial results and subsequent peer-reviewed scientific publications.

7.3.2 Executive Oversight Committee

The Executive Oversight Committee (EOC) comprises members of Sponsor Senior Management. The EOC will receive and decide upon any recommendations made by the eDMC regarding the trial.

7.3.3 Data Monitoring Committee

Cohort 1 only

To supplement the routine trial monitoring outlined in this protocol, an eDMC will monitor the interim data from this trial. The voting members of the committee are external to the Sponsor. The voting members of the eDMC must not be involved with the trial in any other way (eg, they cannot be trial investigators) and must have no competing interests that could affect their roles with respect to the trial.

The eDMC will make recommendations to the EOC regarding steps to ensure both subject safety and the continued ethical integrity of the trial. Also, the DMC will review interim trial results, consider the overall risk and benefit to trial participants (see Section 8.7 - Interim Analyses) and recommend to the EOC if the trial should continue in accordance with the protocol.

Specific details regarding composition, responsibilities, and governance, including the roles and responsibilities of the various members and the Sponsor protocol team; meeting facilitation; the trial governance structure; and requirements for and proper documentation of eDMC reports, minutes, and recommendations will be described in a separate charter that is reviewed and approved by the eDMC. The eDMC will monitor the trial at an appropriate frequency, as described in the detailed eDMC charter. The eDMC will also make recommendations to the sponsor protocol team regarding steps to ensure both subject safety and the continued ethical integrity of the trial.

8.0 STATISTICAL ANALYSIS PLAN

This section outlines the statistical analysis strategy and procedures for the study. If, after the study has begun, but prior to any final database lock, changes made to primary and/or key secondary hypotheses, or the statistical methods related to those hypotheses, then the

protocol will be amended (consistent with International Conference on Harmonisation (ICH) Guideline E-9). Changes to exploratory or other non-confirmatory analyses made after the protocol has been finalized, but prior to final database lock, will be documented in a supplemental statistical analysis plan (SAP [sSAP]) and referenced in the Clinical Study Report (CSR) for the study. There will be a separate biomarker and PK analysis plan. Post hoc exploratory analyses will be clearly identified in the CSR.

8.1 Statistical Analysis Plan Summary

Key elements of the statistical analysis plan are summarized below. The same statistical analysis plan and endpoints will apply to Cohort 1 and Cohort 2; the analyses will be done separately. The comprehensive plan is provided in Sections 8.2 to 8.12.

Study Design Overview	A Phase 2 Study of Pembrolizumab (MK-3475) as Monotherapy in Subjects with Previously Systemically Treated Advanced Hepatocellular Carcinoma
Treatment Assignment	This is a single arm open-label study.
Analysis Populations	Efficacy: All Subjects as Treated (ASaT) Safety: All Subjects as Treated (ASaT)
Primary Endpoints	Objective Response Rate (ORR) based on RECIST 1.1 assessed by the central imaging vendor
Statistical Methods for Key Efficacy Analyses	The estimate of the ORR, along with its 95% confidence interval (CI) based on the Clopper-Pearson method [51], will be provided.
Statistical Methods for Key Safety Analyses	Counts and percentages of subjects with AEs will be provided.
Interim Analysis	For cohort 1 only, an interim analysis of the safety and efficacy data from the first 20 patients enrolled will be performed to inform planning of other studies in the pembrolizumab development program. This analysis will be performed by the Clinical Biostatistics department of the Sponsor.
Multiplicity	No multiplicity adjustment is planned in this Phase 2 study.
Sample Size and Power	The planned sample size is 100 subjects for Cohort 1 and 50 subjects for Cohort 2. Section 8.9 provides the precision of the ORR estimates for Cohort 1.

8.2 Responsibility for Analyses

The statistical analysis of the data obtained from this study will be the responsibility of the Clinical Biostatistics department of the Sponsor.

This trial is being conducted as a non-randomized, open-label study, ie, subjects, investigators, and Sponsor personnel will be aware of subject treatment assignments after each subject is enrolled and treatment is assigned.

Except for the one interim analysis of the first 20 subjects enrolled to inform the pembrolizumab development program for Cohort 1, no other interim analysis is planned. Any other interim analysis will be documented.

8.3 Hypotheses/Estimation

Objectives and hypotheses of the study are stated in Section 3.0.

8.4 Analysis Endpoints

Efficacy and safety endpoints that will be evaluated are listed below.

8.4.1 Efficacy Endpoints

8.4.1.1 Primary Efficacy Endpoint

- Objective Response Rate**

ORR is defined as the proportion of the subjects in the analysis population who have a CR or PR. Responses are based on assessments by the blinded central imaging vendor per RECIST 1.1.

8.4.1.2 Secondary Efficacy Endpoints

- Duration of Response**

For subjects who demonstrate CR or PR, based on assessments by the central imaging vendor per RECIST 1.1, DOR is defined as the time from first documented evidence of CR or PR until disease progression or death due to any cause, whichever occurs first.

- Disease Control Rate**

DCR is defined as the percentage of subjects who have achieved CR, PR, or SD based on assessments by the central imaging vendor per RECIST 1.1.

- Time To Progression**

TTP is defined as the time from the first day of trial treatment to the first documented disease progression per RECIST 1.1 based on assessments by the central imaging vendor.

- Progression-Free Survival**

PFS is defined as the time from the first day of trial treatment to the first documented disease progression per RECIST 1.1 based on assessments by the central imaging vendor or death due to any cause, whichever occurs first.

- Overall Survival (OS)**

OS is defined as the time from first dose of study medication to death due to any cause.

8.4.1.3 Exploratory Efficacy Endpoints

The exploratory endpoints listed in Section 3.3, ie, ORR, DOR, DCR, TTP, and PFS per irRECIST and mRECIST, are defined in the same way as in Section 8.4.1.1 and Section 8.4.1.2, except that disease progression will be assessed, and then confirmed (4 weeks later), by the central imaging vendor per irRECIST and by the central imaging vendor per mRECIST, instead of per RECIST 1.1.

8.4.2 Safety Endpoints

Safety endpoints are described in Section 4.2.3.3 and Section 7.2.

8.5 Analysis Populations

Eligible subjects enter the study when the treatment allocation number is centrally assigned using IVRS/IWRS (see Section 5.3).

8.5.1 Efficacy Analysis Populations

The All Subjects as Treated (ASaT) population will be used for the analysis of ORR, DCR, TTP, PFS, and OS. The ASaT population consists of all allocated subjects who received at least one dose of trial treatment.

The analysis population for DOR consists of responders (PR and CR).

Details on the approach to handling missing data are provided in [Table 9](#).

8.5.2 Safety Analysis Populations

The ASaT population will be used for the analysis of safety data in this study. The ASaT population consists of all allocated subjects who received at least one dose of trial treatment.

At least one laboratory or vital sign measurement obtained subsequent to at least one dose of trial treatment is required for inclusion in the analysis of each specific parameter. To assess change from baseline, a baseline measurement is also required.

8.6 Statistical Methods

8.6.1 Statistical Methods for Efficacy Analyses

This section describes the statistical methods that address the primary and secondary objectives.

For the primary efficacy endpoint of ORR, the point estimate and 95% confidence interval will be provided using the exact binomial method proposed by Clopper and Pearson (1934) [51]. Subjects in the primary analysis population (ASaT) without ORR data will be counted as non-responders.

For DOR, Kaplan-Meier (KM) curves and median estimates from the KM curves will be provided if sample size permits.

For DCR, the point estimate and 95% confidence interval will be provided using exact binomial method proposed by Clopper and Pearson (1934) [51]. Subjects in the analysis population (ASaT) with missing DCR data are considered as subjects whose disease is not under control.

For TTP, PFS, and OS endpoints, KM curves and median estimates from the KM curves will be provided as appropriate.

The efficacy analysis is summarized in [Table 9](#).

Table 9 Analysis Strategy for Efficacy Variables

Endpoint/Variable (Description, Time Point)	Statistical Method	Analysis Population	Missing Data Approach
Primary Endpoint			
ORR – RECIST 1.1 by central imaging vendor review	Exact method based on binomial distribution (Clopper-Pearson method)	ASaT	Subjects with missing data are considered non-responders
Key Secondary Endpoints			
DOT – RECIST 1.1 by central imaging vendor review	Summary statistics using Kaplan-Meier method, if sample size permits	All responders	Non-responders are excluded from analysis. Responders are censored according to the censoring rules listed in Table 10 .
DCR – RECIST 1.1 by central imaging vendor review	Exact method based on binomial distribution (Clopper-Pearson method)	ASaT	Subjects with missing data are considered as subjects with disease not under control
TTP – RECIST 1.1 by central imaging vendor review	Summary statistics using Kaplan-Meier method	ASaT	Censored at last assessment
PFS – RECIST 1.1 by central imaging vendor review	Summary statistics using Kaplan-Meier method	ASaT	Censored at last assessment
OS	Summary statistics using Kaplan-Meier method	ASaT	Censored at last known alive date
Abbreviations: ASaT=all subjects as treated; DCR=disease control rate; DOT=duration of response; ORR=overall response rate; OS=overall survival; PFS=progression-free survival; RECIST=Response Evaluation Criteria in Solid Tumors; TTP=time to progression.			

Table 10 Censoring Rules for DOR

Situation	Date of Progression or Censoring	Outcome
No progression nor death, no new anti-cancer therapy initiated	Last adequate disease assessment	Censor (non-event)
No progression nor death, new anti-cancer therapy initiated	Last adequate disease assessment before new anti-cancer therapy initiated	Censor (non-event)
Death or progression after ≥ 2 consecutive missed adequate disease assessments	Last adequate disease assessment prior to the after ≥ 2 consecutive missed adequate disease assessments	Censor (non-event)
Death or progression after ≤ 1 missed adequate disease assessments	PD or death	End of response (Event)
Subjects are considered to have an ongoing response if censored, alive, have not progressed, have not started a new anti-cancer therapy and have not been determined to be lost to follow up. Abbreviations: DOR=duration of response; PD=progressive disease		

8.6.2 Statistical Methods for Safety Analyses

Safety and tolerability will be assessed by clinical review of all relevant parameters including AEs, laboratory tests, and vital signs.

Counts and percentages of subjects with AEs will be provided.

8.6.3 Demographic and Baseline Characteristics

The number and percentage of subjects screened, allocated, the primary reasons for screening failure, and the primary reasons for discontinuation will be displayed. Demographic variables (eg, age, gender), baseline characteristics, primary and secondary diagnoses, and prior and concomitant therapies will be summarized either by descriptive statistics or categorical tables for all enrolled subjects.

8.7 Interim Analyses

An interim analysis of the safety and efficacy data from the first 20 patients enrolled in Cohort 1 will be performed after they finish their 9-week imaging scan or discontinued to inform planning of other studies in the pembrolizumab development program. This analysis will be performed by the Clinical Biostatistics department of the Sponsor.

8.8 Multiplicity

No multiplicity adjustment is planned in this study.

8.9 Sample Size

In this study, approximately 100 subjects will be enrolled in Cohort 1 and 50 subjects will be enrolled in Cohort 2. [Table 11](#) shows the two-sided 95% confidence interval (CI) of ORR with 100 subjects for different observed response rates.

Table 11 Two-sided 95% Confidence Interval of ORR with 100 Subjects (Cohort 1)

Number of Observed Responders	ORR Estimates (%)	95% CI of ORR (%)
15	15	(8.6, 23.5)
17	17	(10.2, 25.8)
20	20	(12.7, 29.2)
25	25	(16.9, 34.7)
30	30	(21.2, 40.0)
35	35	(25.7, 45.2)

8.10 Subgroup Analyses and Effect of Baseline Factors

The estimate of the treatment effect for the primary endpoint will be estimated within each category of the following classification variables:

- Age category (≤ 65 vs. > 65 years)
- Sex (female vs. male)
- Region (US vs non-US)
- Etiology (uninfected vs. infected (HCV or HBV positive))
- Macrovascular invasion (yes vs. no)
- ECOG PS (0 vs. 1)
- Alpha fetoprotein (AFP) (> 200 IU/mL vs. ≤ 200 IU/mL)
- Extrahepatic disease (yes vs. no)
- Sorafenib intolerance versus progression (Cohort 1 only)

8.11 Compliance (Medication Adherence)

Drug accountability data for pembrolizumab will be collected during the study. Any deviation from protocol-directed administration will be reported.

8.12 Extent of Exposure

Extent of Exposure for a subject is defined as number of cycles in which the subject receives the study medication infusion. Summary statistics will be provided on Extent of Exposure for the ASaT population.

9.0 LABELING, PACKAGING, STORAGE AND RETURN OF CLINICAL SUPPLIES

9.1 Investigational Product

The investigator shall take responsibility for and shall take all steps to maintain appropriate records and ensure appropriate supply, storage, handling, distribution and usage of

investigational product in accordance with the protocol and any applicable laws and regulations.

Clinical Supplies will be provided by the Sponsor as summarized in [Table 12](#).

Clinical supplies will be packaged to support enrollment and replacement subjects as required. When a replacement subject is required, the Sponsor or designee needs to be contacted prior to dosing the replacement supplies.

Table 12 Product Descriptions

Product Name & Potency	Dosage Form	Source/Additional Information
Pembrolizumab 50 mg/vial	Lyophilized powder for injection	Provided centrally by the Sponsor
Pembrolizumab 100 mg/4 mL	Solution for infusion	Provided centrally by the Sponsor*

*Pembrolizumab 100 mg/4 mL solution will not be supplied at the initiation of the trial. It is considered a back-up if there are supply issues with the pembrolizumab 50 mg/vial lyophilized powder.

9.2 Packaging and Labeling Information

Clinical supplies will be affixed with a clinical label in accordance with regulatory requirements.

Site Pharmacies will receive open label vials of study drug. Pembrolizumab will be provided as non-kitted single vials.

9.3 Clinical Supplies Disclosure

This trial is open-label; therefore, the subject, the trial site personnel, the Sponsor and/or designee are not blinded. Treatment (name, strength or potency) is included in the label text; random code/disclosure envelopes or lists are not provided.

Section 5.8 outlines the criteria for allowing subjects who are discontinued from treatment to continue to be monitored in the trial.

9.4 Storage and Handling Requirements

Clinical supplies must be stored in a secure, limited-access location under the storage conditions specified on the label.

Receipt and dispensing of trial medication must be recorded by an authorized person at the trial site.

Clinical supplies may not be used for any purpose other than that stated in the protocol.

9.5 Discard/Destruction>Returns and Reconciliation

The investigator is responsible for keeping accurate records of the clinical supplies received from the Sponsor or designee, the amount dispensed to and returned by the subjects and the amount remaining at the conclusion of the trial. For all trial sites, the local country Sponsor personnel or designee will provide appropriate documentation that must be completed for

drug accountability and return, or local discard and destruction if appropriate. Where local discard and destruction is appropriate, the investigator is responsible for ensuring that a local discard/destruction procedure is documented.

9.6 Standard Policies

Trial site personnel will have access to a central electronic treatment allocation/randomization system (IVRS/IWRS system) to allocate subjects, to assign treatment to subjects and to manage the distribution of clinical supplies. Each person accessing the IVRS system must be assigned an individual unique PIN. They must use only their assigned PIN to access the system, and they must not share their assigned PIN with anyone.

10.0 ADMINISTRATIVE AND REGULATORY DETAILS

10.1 Confidentiality

10.1.1 Confidentiality of Data

By signing this protocol, the investigator affirms to the Sponsor that information furnished to the investigator by the Sponsor will be maintained in confidence, and such information will be divulged to the institutional review board, ethics review committee (IRB/ERC) or similar or expert committee; affiliated institution and employees, only under an appropriate understanding of confidentiality with such board or committee, affiliated institution and employees. Data generated by this trial will be considered confidential by the investigator, except to the extent that it is included in a publication as provided in the Publications section of this protocol.

10.1.2 Confidentiality of Subject Records

By signing this protocol, the investigator agrees that the Sponsor (or Sponsor representative), IRB/ERC, or regulatory authority representatives may consult and/or copy trial documents in order to verify worksheet/case report form data. By signing the consent form, the subject agrees to this process. If trial documents will be photocopied during the process of verifying worksheet/case report form information, the subject will be identified by unique code only; full names/initials will be masked prior to transmission to the Sponsor.

By signing this protocol, the investigator agrees to treat all subject data used and disclosed in connection with this trial in accordance with all applicable privacy laws, rules and regulations.

10.1.3 Confidentiality of Investigator Information

By signing this protocol, the investigator recognizes that certain personal identifying information with respect to the investigator, and all subinvestigators and trial site personnel, may be used and disclosed for trial management purposes, as part of a regulatory submissions, and as required by law. This information may include:

1. name, address, telephone number and e-mail address;
2. hospital or clinic address and telephone number;

3. curriculum vitae or other summary of qualifications and credentials; and
4. other professional documentation.

Consistent with the purposes described above, this information may be transmitted to the Sponsor, and subsidiaries, affiliates and agents of the Sponsor, in your country and other countries, including countries that do not have laws protecting such information. Additionally, the investigator's name and business contact information may be included when reporting certain serious adverse events to regulatory authorities or to other investigators. By signing this protocol, the investigator expressly consents to these uses and disclosures.

If this is a multicenter trial, in order to facilitate contact between investigators, the Sponsor may share an investigator's name and contact information with other participating investigators upon request.

10.1.4 Confidentiality of IRB/IEC Information

The Sponsor is required to record the name and address of each IRB/IEC that reviews and approves this trial. The Sponsor is also required to document that each IRB/IEC meets regulatory and ICH GCP requirements by requesting and maintaining records of the names and qualifications of the IRB/IEC members and to make these records available for regulatory agency review upon request by those agencies.

10.2 Compliance with Financial Disclosure Requirements

Financial Disclosure requirements are outlined in the US Food and Drug Administration Regulations, Financial Disclosure by Clinical Investigators (21 CFR Part 54). It is the Sponsor's responsibility to determine, based on these regulations, whether a request for Financial Disclosure information is required. It is the investigator's/subinvestigator's responsibility to comply with any such request.

The investigator/subinvestigator(s) agree, if requested by the Sponsor in accordance with 21 CFR Part 54, to provide his/her financial interests in and/or arrangements with the Sponsor to allow for the submission of complete and accurate certification and disclosure statements. The investigator/subinvestigator(s) further agree to provide this information on a Certification/Disclosure Form, commonly known as a financial disclosure form, provided by the Sponsor. The investigator/subinvestigator(s) also consent to the transmission of this information to the Sponsor in the United States for these purposes. This may involve the transmission of information to countries that do not have laws protecting personal data.

10.3 Compliance with Law, Audit and Debarment

By signing this protocol, the investigator agrees to conduct the trial in an efficient and diligent manner and in conformance with this protocol; generally accepted standards of Good Clinical Practice (e.g., International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use Good Clinical Practice: Consolidated Guideline and other generally accepted standards of good clinical practice); and all applicable federal, state and local laws, rules and regulations relating to the conduct of the clinical trial.

The Code of Conduct, a collection of goals and considerations that govern the ethical and scientific conduct of clinical investigations sponsored by MSD, is provided in Section 12.1 - Code of Conduct for Clinical Trials.

The investigator also agrees to allow monitoring, audits, IRB/ERC review and regulatory authority inspection of trial-related documents and procedures and provide for direct access to all trial-related source data and documents.

The investigator agrees not to seek reimbursement from subjects, their insurance providers or from government programs for procedures included as part of the trial reimbursed to the investigator by the Sponsor.

The investigator shall prepare and maintain complete and accurate trial documentation in compliance with Good Clinical Practice standards and applicable federal, state and local laws, rules and regulations; and, for each subject participating in the trial, provide all data, and, upon completion or termination of the clinical trial, submit any other reports to the Sponsor as required by this protocol or as otherwise required pursuant to any agreement with the Sponsor.

Trial documentation will be promptly and fully disclosed to the Sponsor by the investigator upon request and also shall be made available at the trial site upon request for inspection, copying, review and audit at reasonable times by representatives of the Sponsor or any regulatory authorities. The investigator agrees to promptly take any reasonable steps that are requested by the Sponsor as a result of an audit to cure deficiencies in the trial documentation and worksheets/case report forms.

The investigator must maintain copies of all documentation and records relating to the conduct of the trial in compliance with all applicable legal and regulatory requirements. This documentation includes, but is not limited to, the protocol, worksheets/case report forms, advertising for subject participation, adverse event reports, subject source data, correspondence with regulatory authorities and IRBs/ERCs, consent forms, investigator's curricula vitae, monitor visit logs, laboratory reference ranges, laboratory certification or quality control procedures and laboratory director curriculum vitae. By signing this protocol, the investigator agrees that documentation shall be retained until at least 2 years after the last approval of a marketing application in an ICH region or until there are no pending or contemplated marketing applications in an ICH region or until at least 2 years have elapsed since the formal discontinuation of clinical development of the investigational product. Because the clinical development and marketing application process is variable, it is anticipated that the retention period can be up to 15 years or longer after protocol database lock. The Sponsor will determine the minimum retention period and notify the investigator when documents may be destroyed. The Sponsor will determine the minimum retention period and upon request, will provide guidance to the investigator when documents no longer need to be retained. The sponsor also recognizes that documents may need to be retained for a longer period if required by local regulatory requirements. All trial documents shall be made available if required by relevant regulatory authorities. The investigator must consult with and obtain written approval by the Sponsor prior to destroying trial and/or subject files.

ICH Good Clinical Practice guidelines recommend that the investigator inform the subject's primary physician about the subject's participation in the trial if the subject has a primary physician and if the subject agrees to the primary physician being informed.

The investigator will promptly inform the Sponsor of any regulatory authority inspection conducted for this trial.

Persons debarred from conducting or working on clinical trials by any court or regulatory authority will not be allowed to conduct or work on this Sponsor's trials. The investigator will immediately disclose in writing to the Sponsor if any person who is involved in conducting the trial is debarred or if any proceeding for debarment is pending or, to the best of the investigator's knowledge, threatened.

In the event the Sponsor prematurely terminates a particular trial site, the Sponsor will promptly notify that trial site's IRB/IEC.

According to European legislation, a Sponsor must designate an overall coordinating investigator for a multi-center trial (including multinational). When more than one trial site is open in an EU country, MSD, as the Sponsor, will designate, per country, a national principal coordinator (Protocol CI), responsible for coordinating the work of the principal investigators at the different trial sites in that Member State, according to national regulations. For a single-center trial, the Protocol CI is the principal investigator. In addition, the Sponsor must designate a principal or coordinating investigator to review the trial report that summarizes the trial results and confirm that, to the best of his/her knowledge, the report accurately describes the conduct and results of the trial [Clinical Study Report (CSR) CI]. The Sponsor may consider one or more factors in the selection of the individual to serve as the Protocol CI and or CSR CI (e.g., availability of the CI during the anticipated review process, thorough understanding of clinical trial methods, appropriate enrollment of subject cohort, timely achievement of trial milestones). The Protocol CI must be a participating trial investigator.

10.4 Compliance with Trial Registration and Results Posting Requirements

Under the terms of the Food and Drug Administration Amendments Act (FDAAA) of 2007, and the European Medicines Agency (EMA) clinical trial Directive 2001/20/EC, the Sponsor of the trial is solely responsible for determining whether the trial and its results are subject to the requirements for submission to <http://www.clinicaltrials.gov>, www.clinicaltrialregister.eu or other local registries. MSD, as Sponsor of this trial, will review this protocol and submit the information necessary to fulfill these requirements. MSD entries are not limited to FDAAA or the EMA clinical trials directive mandated trials. Information posted will allow subjects to identify potentially appropriate trials for their disease conditions and pursue participation by calling a central contact number for further information on appropriate trial locations and trial site contact information.

By signing this protocol, the investigator acknowledges that the statutory obligations under FDAAA, the EMA clinical trials directive or other locally mandated registries are that of the Sponsor and agrees not to submit any information about this trial or its results to those registries.

10.5 Quality Management System

By signing this protocol, the Sponsor agrees to be responsible for implementing and maintaining a quality management system with written development procedures and functional area standard operating procedures (SOPs) to ensure that trials are conducted and

data are generated, documented, and reported in compliance with the protocol, accepted standards of Good Clinical Practice, and all applicable federal, state, and local laws, rules and regulations relating to the conduct of the clinical trial.

10.6 Data Management

The investigator or qualified designee is responsible for recording and verifying the accuracy of subject data. By signing this protocol, the investigator acknowledges that his/her electronic signature is the legally binding equivalent of a written signature. By entering his/her electronic signature, the investigator confirms that all recorded data have been verified as accurate.

Detailed information regarding Data Management procedures for this protocol will be provided separately.

10.7 Publications

This trial is intended for publication, even if terminated prematurely. Publication may include any or all of the following: posting of a synopsis online, abstract and/or presentation at a scientific conference, or publication of a full manuscript. The Sponsor will work with the authors to submit a manuscript describing trial results within 12 months after the last data become available, which may take up to several months after the last subject visit in some cases such as vaccine trials. However, manuscript submission timelines may be extended on OTC trials. For trials intended for pediatric-related regulatory filings, the investigator agrees to delay publication of the trial results until the Sponsor notifies the investigator that all relevant regulatory authority decisions on the trial drug have been made with regard to pediatric-related regulatory filings. MSD will post a synopsis of trial results for approved products on www.clinicaltrials.gov by 12 months after the last subject's last visit for the primary outcome, 12 months after the decision to discontinue development, or product marketing (dispensed, administered, delivered or promoted), whichever is later.

These timelines may be extended for products that are not yet marketed, if additional time is needed for analysis, to protect intellectual property, or to comply with confidentiality agreements with other parties. Authors of the primary results manuscript will be provided the complete results from the Clinical Study Report, subject to the confidentiality agreement. When a manuscript is submitted to a biomedical journal, the Sponsor's policy is to also include the protocol and statistical analysis plan to facilitate the peer and editorial review of the manuscript. If the manuscript is subsequently accepted for publication, the Sponsor will allow the journal, if it so desires, to post on its website the key sections of the protocol that are relevant to evaluating the trial, specifically those sections describing the trial objectives and hypotheses, the subject inclusion and exclusion criteria, the trial design and procedures, the efficacy and safety measures, the statistical analysis plan, and any amendments relating to those sections. The Sponsor reserves the right to redact proprietary information.

For multicenter trials, subsequent to the multicenter publication (or after public disclosure of the results online at www.clinicaltrials.gov if a multicenter manuscript is not planned), an investigator and his/her colleagues may publish their data independently. In most cases, publication of individual trial site data does not add value to complete multicenter results, due to statistical concerns. In rare cases, publication of single trial site data prior to the main

paper may be of value. Limitations of single trial site observations in a multicenter trial should always be described in such a manuscript.

Authorship credit should be based on 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published. Authors must meet conditions 1, 2 and 3. Significant contributions to trial execution may also be taken into account to determine authorship, provided that contributions have also been made to all three of the preceding authorship criteria. Although publication planning may begin before conducting the trial, final decisions on authorship and the order of authors' names will be made based on participation and actual contributions to the trial and writing, as discussed above. The first author is responsible for defending the integrity of the data, method(s) of data analysis and the scientific content of the manuscript.

The Sponsor must have the opportunity to review all proposed abstracts, manuscripts or presentations regarding this trial 45 days prior to submission for publication/presentation. Any information identified by the Sponsor as confidential must be deleted prior to submission; this confidentiality does not include efficacy and safety results. Sponsor review can be expedited to meet publication timelines.

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12.0 APPENDICES

12.1 Code of Conduct for Clinical Trials

Merck Sharp & Dohme LLC, Rahway, NJ, USA (MSD)

Code of Conduct for Interventional Clinical Trials

I. Introduction

A. Purpose

MSD, through its subsidiaries, conducts clinical trials worldwide to evaluate the safety and effectiveness of our products. As such, we are committed to designing, implementing, conducting, analyzing, and reporting these trials in compliance with the highest ethical and scientific standards. Protection of participants in clinical trials is the overriding concern in the design and conduct of clinical trials. In all cases, MSD clinical trials will be conducted in compliance with local and/or national regulations (including all applicable data protection laws and regulations), and International Council for Harmonisation Good Clinical Practice (ICH-GCP), and also in accordance with the ethical principles that have their origin in the Declaration of Helsinki.

B. Scope

Highest ethical and scientific standards shall be endorsed for all clinical interventional investigations sponsored by MSD irrespective of the party (parties) employed for their execution (e.g., contract research organizations, collaborative research efforts). This Code is not intended to apply to trials that are observational in nature, or which are retrospective. Further, this Code does not apply to investigator-initiated trials, which are not under the full control of MSD.

II. Scientific Issues

A. Trial Conduct

1. Trial Design

Except for pilot or estimation trials, clinical trial protocols will be hypothesis-driven to assess safety, efficacy and/or pharmacokinetic or pharmacodynamic indices of MSD or comparator products. Alternatively, MSD may conduct outcomes research trials, trials to assess or validate various endpoint measures, or trials to determine patient preferences, etc.

The design (i.e., participant population, duration, statistical power) must be adequate to address the specific purpose of the trial and shall respect the data protection rights of all participants, trial site staff and, where applicable, third parties. All trial protocols are and will be assessed for the need and capability to enroll underrepresented groups. Participants must meet protocol entry criteria to be enrolled in the trial.

2. Site Selection

MSD's clinical trials are conducted globally in many different countries and in diverse populations, including people of varying age, race, ethnicity, gender, and accounting for other potential disease related factors. MSD selects investigative sites based on medical expertise, access to appropriate participants, adequacy of facilities and staff, previous performance in clinical trials, as well as budgetary considerations. Prior to trial initiation, sites are evaluated by MSD personnel (or individuals acting on behalf of MSD) to assess the ability to successfully conduct the trial.

Where appropriate, and in accordance with regulatory authority guidance, MSD will make concerted efforts to raise awareness of clinical trial opportunities in various communities. MSD will seek to engage underrepresented groups and those disproportionately impacted by the disease under study. MSD will support clinical trial investigators to enroll underrepresented groups and expand access to those who will ultimately use the products under investigation.

3. Site Monitoring/Scientific Integrity

Investigative trial sites are monitored to assess compliance with the trial protocol and Good Clinical Practice (GCP). MSD reviews clinical data for accuracy, completeness, and consistency. Data are verified versus source documentation according to standard operating procedures. Per MSD policies and procedures, if potential fraud, scientific/research misconduct, privacy incidents/breaches or Clinical Trial-related Significant Quality Issues are reported, such matters are investigated. When necessary, appropriate corrective and/or preventative actions are defined and regulatory authorities and/or ethics review committees are notified.

B. Publication and Authorship

Regardless of trial outcome, MSD commits to publish the primary and secondary results of its registered trials of marketed products in which treatment is assigned, according to the pre-specified plans for data analysis. To the extent scientifically appropriate, MSD seeks to publish the results of other analyses it conducts that are important to patients, physicians, and payers. Some early phase or pilot trials are intended to be hypothesis-generating rather than hypothesis testing; in such cases, publication of results may not be appropriate since the trial may be underpowered and the analyses complicated by statistical issues such as multiplicity.

MSD's policy on authorship is consistent with the recommendations published by the International Committee of Medical Journal Editors (ICMJE). In summary, authorship should reflect significant contribution to the design and conduct of the trial, performance or interpretation of the analysis, and/or writing of the manuscript. All named authors must be able to defend the trial results and conclusions. MSD funding of a trial will be acknowledged in publications.

III. Participant Protection

A. Regulatory Authority and Ethics Committee Review (Institutional Review Board [IRB]/Independent Ethics Committee [IEC])

All protocols and protocol amendments will be submitted by MSD for regulatory authority acceptance/authorization prior to implementation of the trial or amendment, in compliance with local and/or national regulations.

The protocol, protocol amendment(s), informed consent form, investigator's brochure, and other relevant trial documents must be reviewed and approved by an IRB/IEC before being implemented at each site, in compliance with local and/or national regulations. Changes to the protocol that are required urgently to eliminate an immediate hazard and to protect participant safety may be enacted in anticipation of ethics committee approval. MSD will inform regulatory authorities of such new measures to protect participant safety, in compliance with local and/or national regulations.

B. Safety

The guiding principle in decision-making in clinical trials is that participant welfare is of primary importance. Potential participants will be informed of the risks and benefits of, as well as alternatives to, trial participation. At a minimum, trial designs will take into account the local standard of care.

All participation in MSD clinical trials is voluntary. Participants enter the trial only after informed consent is obtained. Participants may withdraw from an MSD trial at any time, without any influence on their access to, or receipt of, medical care that may otherwise be available to them.

C. Confidentiality

MSD is committed to safeguarding participant confidentiality, to the greatest extent possible, as well as all applicable data protection rights. Unless required by law, only the investigator, Sponsor (or individuals acting on behalf of MSD), ethics committee, and/or regulatory authorities will have access to confidential medical records that might identify the participant by name.

D. Genomic Research

Genomic research will only be conducted in accordance with a protocol and informed consent authorized by an ethics committee.

IV. Financial Considerations

A. Payments to Investigators

Clinical trials are time- and labor-intensive. It is MSD's policy to compensate investigators (or the sponsoring institution) in a fair manner for the work performed in support of MSD trials. MSD does not pay incentives to enroll participants in its trials. However, when enrollment is particularly challenging, additional payments may be made to compensate for the time spent in extra recruiting efforts.

MSD does not pay for participant referrals. However, MSD may compensate referring physicians for time spent on chart review and medical evaluation to identify potentially eligible participants.

B. Clinical Research Funding

Informed consent forms will disclose that the trial is sponsored by MSD, and that the investigator or sponsoring institution is being paid or provided a grant for performing the trial. However, the local ethics committee may wish to alter the wording of the disclosure statement to be consistent with financial practices at that institution. As noted above, all publications resulting from MSD trials will indicate MSD as a source of funding.

C. Funding for Travel and Other Requests

Funding of travel by investigators and support staff (e.g., to scientific meetings, investigator meetings, etc.) will be consistent with local guidelines and practices.

V. Investigator Commitment

Investigators will be expected to review MSD's Code of Conduct as an appendix to the trial protocol, and in signing the protocol, agree to support these ethical and scientific standards

12.2 Collection and Management of Specimens for Future Biomedical Research

1. Definitions

- a. Biomarker: A biological molecule found in blood, other body fluids, or tissues that is a sign of a normal or abnormal process or of a condition or disease. A biomarker may be used to see how well the body responds to a treatment for a disease or condition.¹
- b. Pharmacogenomics: The investigation of variations of DNA and RNA characteristics as related to drug/vaccine response.²
- c. Pharmacogenetics: A subset of pharmacogenomics, pharmacogenetics is the influence of variations in DNA sequence on drug/vaccine response.²
- d. DNA: Deoxyribonucleic acid.
- e. RNA: Ribonucleic acid.

2. Scope of Future Biomedical Research

The specimens collected in this trial as outlined in Section 7.1.3.7 – Future Biomedical Research Sample Collection will be used to study various causes for how subjects may respond to a drug/vaccine. Future biomedical research specimen(s) will be stored to provide a resource for future trials conducted by the Sponsor focused on the study of biomarkers responsible for how a drug/vaccine enters and is removed by the body, how a drug/vaccine works, other pathways a drug/vaccine may interact with, or other aspects of disease. The specimen(s) may be used for future assay development and/or drug/vaccine development.

It is now well recognized that information obtained from studying and testing clinical specimens offers unique opportunities to enhance our understanding of how individuals respond to drugs/vaccines, enhance our understanding of human disease and ultimately improve public health through development of novel treatments targeted to populations with the greatest need. All specimens will be used by the Sponsor or those working for or with the Sponsor.

3. Summary of Procedures for Future Biomedical Research

a. Subjects for Enrollment

All subjects enrolled in the clinical trial will be considered for enrollment in the Future Biomedical Research sub-trial.

b. Informed Consent

Informed consent for specimens (i.e., DNA, RNA, protein, etc.) will be obtained during screening for protocol enrollment from all subjects or legal guardians, at a trial visit by the investigator or his or her designate. Informed consent for Future Biomedical Research should be presented to the subjects on Visit 1. If delayed, present consent at next possible Subject Visit. Informed consent must be obtained prior to collection of all Future Biomedical Research specimens. Consent forms signed by the subject will be kept at the clinical trial site under secure storage for regulatory reasons.

A template of each trial site's approved informed consent will be stored in the Sponsor's clinical document repository. Each consent will be assessed for appropriate specimen permissions.

c. eCRF Documentation for Future Biomedical Research Specimens

Documentation of subject consent for Future Biomedical Research will be captured in the electronic Case Report Forms (eCRFs). Any specimens for which such an informed consent cannot be verified will be destroyed.

d. Future Biomedical Research Specimen Collections

Collection of specimens for Future Biomedical Research will be performed as outlined in the trial flow chart. In general, if additional blood specimens are being collected for Future Biomedical Research, these will usually be obtained at a time when the subject is having blood drawn for other trial purposes.

4. Confidential Subject Information for Future Biomedical Research

In order to optimize the research that can be conducted with Future Biomedical Research specimens, it is critical to link subject' clinical information with future test results. In fact little or no research can be conducted without connecting the clinical trial data to the specimen. The clinical data allow specific analyses to be conducted. Knowing subject characteristics like gender, age, medical history and treatment outcomes are critical to understanding clinical context of analytical results.

To maintain privacy of information collected from specimens obtained for Future Biomedical Research, the Sponsor has developed secure policies and procedures. All specimens will be single-coded per ICH E15 guidelines as described below.

At the clinical trial site, unique codes will be placed on the Future Biomedical Research specimens for transfer to the storage facility. This first code is a random number which does not contain any personally identifying information embedded within it. The link (or key) between subject identifiers and this first unique code will be held at the trial site. No personal identifiers will appear on the specimen tube.

5. Biorepository Specimen Usage

Specimens obtained for the MSD Biorepository will be used for analyses using good scientific practices. Analyses utilizing the Future Biomedical Research specimens may be performed by the Sponsor, or an additional third party (e.g., a university investigator) designated by the Sponsor. The investigator conducting the analysis will follow the Sponsor's privacy and confidentiality requirements. Any contracted third party analyses will conform to the specific scope of analysis outlined in this sub-trial. Future Biomedical Research specimens remaining with the third party after specific analysis is performed will be reported to the Sponsor.

6. Withdrawal From Future Biomedical Research

Subjects may withdraw their consent for Future Biomedical Research and have their specimens and all derivatives destroyed. Subjects may withdraw consent at any time by contacting the principal investigator for the main trial. If medical records for the main trial are still available, the investigator will contact the Sponsor using the designated mailbox

(clinical.specimen.management@MSD.com) and a form will be provided to obtain appropriate information to complete specimen withdrawal. Subsequently, the subject's specimens will be removed from the biorepository and be destroyed. Documentation will be sent to the investigator confirming the destruction. It is the responsibility of the investigator to inform the subject of completion of destruction. Any analyses in progress at the time of request for destruction or already performed prior to the request being received by the Sponsor will continue to be used as part of the overall research trial data and results. No new analyses would be generated after the request is received.

In the event that the medical records for the main trial are no longer available (e.g., if the investigator is no longer required by regulatory authorities to retain the main trial records) or the specimens have been completely anonymized, there will no longer be a link between the subject's personal information and their specimens. In this situation, the request for specimen destruction can not be processed.

7. Retention of Specimens

Future Biomedical Research specimens will be stored in the biorepository for potential analysis for up to 20 years from the end of the main study. Specimens may be stored for longer if a regulatory or governmental authority has active questions that are being answered. In this special circumstance, specimens will be stored until these questions have been adequately addressed.

Specimens from the trial site will be shipped to a central laboratory and then shipped to the Sponsor-designated biorepository. If a central laboratory is not utilized in a particular trial, the trial site will ship directly to the Sponsor-designated biorepository. The specimens will be stored under strict supervision in a limited access facility which operates to assure the integrity of the specimens. Specimens will be destroyed according to Sponsor policies and procedures and this destruction will be documented in the biorepository database.

8. Data Security

Databases containing specimen information and test results are accessible only to the authorized Sponsor representatives and the designated trial administrator research personnel and/or collaborators. Database user authentication is highly secure, and is accomplished using network security policies and practices based on international standards (e.g., ISO17799) to protect against unauthorized access.

9. Reporting of Future Biomedical Research Data to Subjects

No information obtained from exploratory laboratory studies will be reported to the subject, family, or physicians. Principle reasons not to inform or return results to the subject include: Lack of relevance to subject health, limitations of predictive capability, and concerns regarding misinterpretation.

If any exploratory results are definitively associated with clinical significance for subjects while the clinical trial is still ongoing, investigators will be contacted with information. After the clinical trial has completed, if any exploratory results are definitively associated with clinical significance, the Sponsor will endeavor to make such results available through appropriate mechanisms (e.g., scientific publications and/or presentations). Subjects will not

be identified by name in any published reports about this study or in any other scientific publication or presentation.

10. Future Biomedical Research Study Population

Every effort will be made to recruit all subjects diagnosed and treated on Sponsor clinical trials for Future Biomedical Research.

11. Risks Versus Benefits of Future Biomedical Research

For future biomedical research, risks to the subject have been minimized. No additional risks to the subject have been identified as no additional specimens are being collected for FBR (ie, only leftover samples are being retained).

The Sponsor has developed strict security, policies and procedures to address subject data privacy concerns. Data privacy risks are largely limited to rare situations involving possible breach of confidentiality. In this highly unlikely situation there is risk that the information, like all medical information, may be misused.

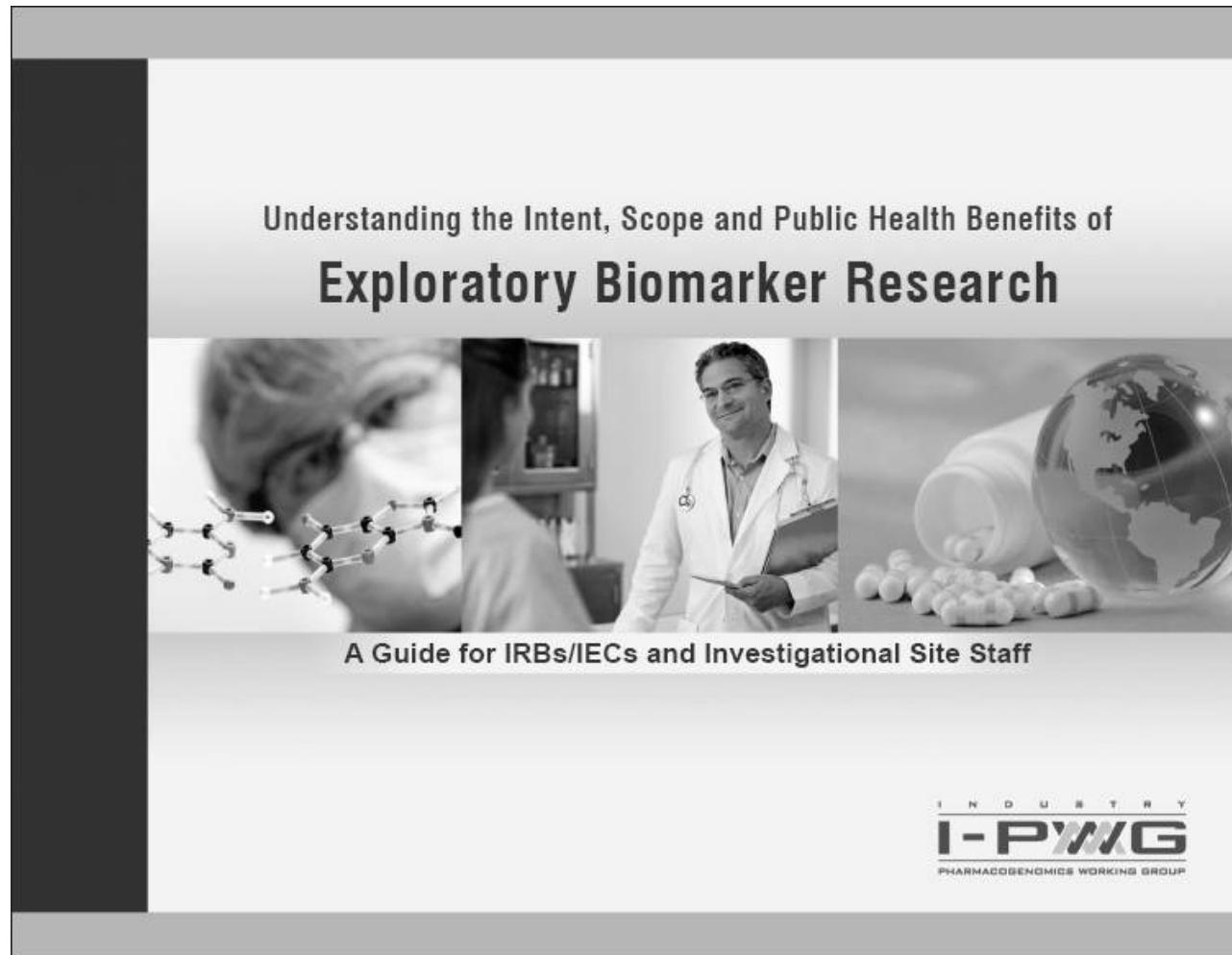
12. Questions

Any questions related to the future biomedical research should be e-mailed directly to clinical.specimen.management@MSD.com.

13. References

1. National Cancer Institute: <http://www.cancer.gov/dictionary/?searchTxt=biomarker>
2. International Conference on Harmonization: DEFINITIONS FOR GENOMIC BIOMARKERS, PHARMACOGENOMICS, PHARMACOGENETICS, GENOMIC DATA AND SAMPLE CODING CATEGORIES - E15; <http://www.ich.org/LOB/media/MEDIA3383.pdf>

12.3 Understanding the Intent, Scope and Public Health Benefits of Exploratory Biomarker Research: A Guide for IRBs/IECs and Investigational Site Staff



This informational brochure is intended for IRBs/IECs and Investigational Site Staff. The brochure addresses issues relevant to specimen collection for biomarker research in the context of pharmaceutical drug and vaccine development.

Developed by
The Industry Pharmacogenomics Working Group (I-PWG)
www.i-pwg.org

1. What is a Biomarker and What is Biomarker Research?

A biomarker is a "characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention".¹

Biomarker research, including research on pharmacogenomic biomarkers, is a tool used to improve the development of pharmaceuticals and understanding of disease. It involves the analysis of biomolecules (such as DNA, RNA, proteins, and lipids), or other measurements (such as blood pressure or brain images) in relation to clinical endpoints of interest. Biomarker research can be influential across all phases of drug development, from drug discovery and preclinical evaluations to clinical development and post-marketing studies. This brochure focuses on biomarker research involving analysis of biomolecules from biological samples collected in clinical trials. Please refer to I-PWG Pharmacogenomic Informational Brochure² and ICH Guidance E15³ for additional information specific to pharmacogenomic biomarkers.

2. Why is Biomarker Research Important?

Importance to Patients and Public Health
Biomarker research is helping to improve our ability to predict, detect, and monitor diseases and improve our understanding of how individuals respond to drugs. This research underlies personalized medicine: a tailored approach to patient treatment based on the molecular analysis of genes, proteins, and metabolites.⁴ The goal of biomarker research is to aid clinical decision-making toward safer and more efficacious courses of treatment, improved patient outcomes, and overall cost-savings. It also allows for the continued development and availability of drugs that are effective in certain sub-populations when they otherwise might not have been developed due to insufficient efficacy in the broader population.

Recent advances in biomedical technology, including genetic and molecular medicine, have greatly increased the power and precision of analytical tools used in health research and have accelerated the drive toward personalized medicine. In some countries, highly focused initiatives have been created to promote biomarker research (e.g., in the US: www.fda.gov/oc/initiatives/criticalpath/; in the EU: www.imi.europa.eu/index_en.html).

Importance to Drug Development
Biomarker research is being used by the pharmaceutical industry to streamline the drug development process. Some biomarkers are used as substitutes or "surrogates" for safety or efficacy endpoints in clinical trials particularly where clinical outcomes or events cannot practically or ethically be measured (e.g., cholesterol as a surrogate for cardiovascular disease).⁵ By using biomarkers to assess patient response, ineffective drug candidates may be terminated earlier in the development process in favor of more promising drug candidates. Biomarkers are being used to optimize clinical trial designs and outcomes by identifying patient populations that are more likely to respond to a drug therapy or to avoid specific adverse events.

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Biomarker research is also being used to enhance scientific understanding of the mechanisms of both treatment response and disease processes, which can help to identify future targets for drug development. Depending on the clinical endpoints in a clinical trial, biomarker sample collection may either be a required or optional component of the trial. However, both mandatory and optional sample collections are important for drug development.

3. Importance of Biomarkers to Regulatory Authorities

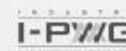
Regulatory health authorities are increasingly aware of the benefits of biomarkers and how they may be used for drug approval, clinical trial design, and clinical care. Biomarkers have been used to establish risk:benefit profiles. For example, the FDA has modified the US warfarin (Coumadin®) label to include the analysis of CYP2C9 and VKORC1 genes to guide dosing regimens. Health authorities such as the FDA (USA), EMEA (European Union), MHLW (Japan), and ICH (International) are playing a key role in advancing this scientific field as it applies to pharmaceutical development by creating the regulatory infrastructure to facilitate this research. Numerous regulatory guidances and concept papers have already been issued, many of which are available through www.i-pwg.org. Global regulatory authorities have highlighted the importance of biomarker research and the need for the pharmaceutical industry to take the lead in this arena.^{3,6-24}

4. How are Biomarkers Being Used in Drug/Vaccine Development?

Biomarker research is currently being used in drug/vaccine development to:

- Explain variability in response among participants in clinical trials
- Better understand the mechanism of action or metabolism of investigational drugs
- Obtain evidence of pharmacodynamic activity (i.e., how the drug affects the body) at the molecular level
- Address emerging clinical issues such as unexpected adverse events
- Determine eligibility for clinical trials to optimize trial design
- Optimize dosing regimens to minimize adverse reactions and maximize efficacy
- Develop drug-linked diagnostic tests to identify patients who are more likely or less likely to benefit from treatment or who may be at risk of experiencing adverse events
- Provide better understanding of mechanisms of disease
- Monitor clinical trial participant response to medical interventions

Biomarker research, including research on banked samples, should be recognized as an important public health endeavor for the overall benefit of society, whether by means of advancement of medical science or by development of safer and more effective therapies.⁷ Since the value of collected samples may increase over time as scientific discoveries are made, investment in long-term sample repositories is a key component of biomarker research.



5. Biomarkers are Already a Reality in Health Care

A number of drugs now have biomarker information included in their labels.²⁶ Biomarker tests are already being used in clinical practice to serve various purposes:

Predictive biomarkers (efficacy) – In clinical practice, predictive efficacy biomarkers are used to predict which patients are most likely to respond, or not respond, to a particular drug. Examples include: i) *Her2/neu* overexpression analysis required for prescribing trastuzumab (Herceptin[®]) to breast cancer patients, ii) *c-kit* expression analysis prior to prescribing imatinib mesylate (Gleevec[®]) to gastrointestinal stromal tumor patients, and iii) *KRAS* mutational status testing prior to prescribing panitumumab (Vectibix[®]) or cetuximab (Erbitux[®]) to metastatic colorectal cancer patients.

Predictive biomarkers (safety) – In clinical practice, predictive safety biomarkers are used to select the proper drug dose or to evaluate the appropriateness of continued therapy in the event of a safety concern. Examples include: i) monitoring of blood potassium levels in patients receiving spironolone and ethinyl estradiol (Yasmin[®]) together with daily long-term drug regimens that may increase serum potassium, and ii) prospective *HLA-B*5701* screening to identify those at increased risk for hypersensitivity to abacavir (Ziagen[®]).

Surrogate biomarkers – In clinical practice, surrogate biomarkers may be used as alternatives to measures such as survival or irreversible morbidity. Surrogate biomarkers are measures that are reasonably likely, based on epidemiologic, therapeutic, pathophysiologic, or other evidence, to predict clinical benefit. Examples include: i) LDL level as a surrogate for risk of cardiovascular diseases in patients taking lipid-lowering agents such as atorvastatin calcium (Lipitor[®]), ii) blood glucose as a surrogate for clinical outcomes in patients taking anti-diabetic agents, and iii) HIV plasma viral load and CD4 cell counts as sur-

rogates for time-to-clinical-events and overall survival in patients receiving antiretroviral therapy for HIV disease.

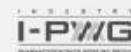
Prognostic biomarkers – Biomarkers can also help predict clinical outcomes independent of any treatment modality. Examples of prognostic biomarkers used in clinical practice include: i) CellSearchTM to predict progression-free survival in breast cancer, ii) anti-CCP (cyclic citrullinated protein) for the severity of rheumatoid arthritis, iii) estrogen receptor status for breast cancer, and iv) anti-dsDNA for the severity of systemic lupus erythematosus.

6. Biomarker Samples from Clinical Trials: An Invaluable Resource

Adequate sample sizes and high-quality data from controlled clinical trials are key to advancements in biomarker research. Samples collected in clinical trials create the opportunity for investigation of biomarkers related to specific drugs, drug classes, and disease areas. Clinical drug development programs are therefore an invaluable resource and a unique opportunity for highly productive biomarker research. In addition to conducting independent research, pharmaceutical companies are increasingly contributing to consortia efforts by pooling samples, data, and expertise in an effort to conduct rigorous and efficient biomarker research and to maximize the probability of success.²⁶⁻²⁷

7. Informed Consent for Collection & Banking of Biomarker Samples

Collection of biological samples in clinical trials must be undertaken with voluntary informed consent of the participant (or legally-acceptable representative). Policies



and regulations for legally-appropriate informed consent vary on national, state, and local levels, but are generally based on internationally recognized pillars of ethical conduct for research on human subjects.²⁶⁻³¹

Optional vs. Required Subject Participation
Depending on the relevance of biomarker research to a clinical development program at the time of protocol development, the biomarker research may be a core required component of a trial (e.g., key to elucidating the drug mechanism of action or confirming that the drug is interacting with the target) or may be optional (e.g., to gain valuable knowledge that enhances the understanding of diseases and drugs). Informed consent for the collection of biomarker samples may be presented either in the main clinical informed consent form or as a separate informed consent form, with approaches varying somewhat across pharmaceutical companies. The relevance of biomarker research to a clinical development program may change over time as the science evolves. The samples may therefore increase in value after a protocol is developed.

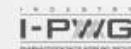
Consent for Future Research Use
While it can be a challenge to specify the details of the research that will be conducted in the future, the I-PWG holds the view that future use of samples collected for exploratory biomarker research in clinical trials should be permissible when i) the research is scientifically sound, ii) participants are informed of the scope of the intended future research, even if this is broadly defined (see potential uses in Section 4 above), iii) autonomy is respected by providing the option to consent separately to future use of samples or by providing the option to terminate further use of samples upon request (consent withdrawal / sample destruction), and iv) industry standards for confidentiality protection per Good Clinical Practice guidelines are met.^{3, 31} Importantly, any research using banked samples should be consistent with the original informed consent, except where otherwise permitted by local law or regulation.

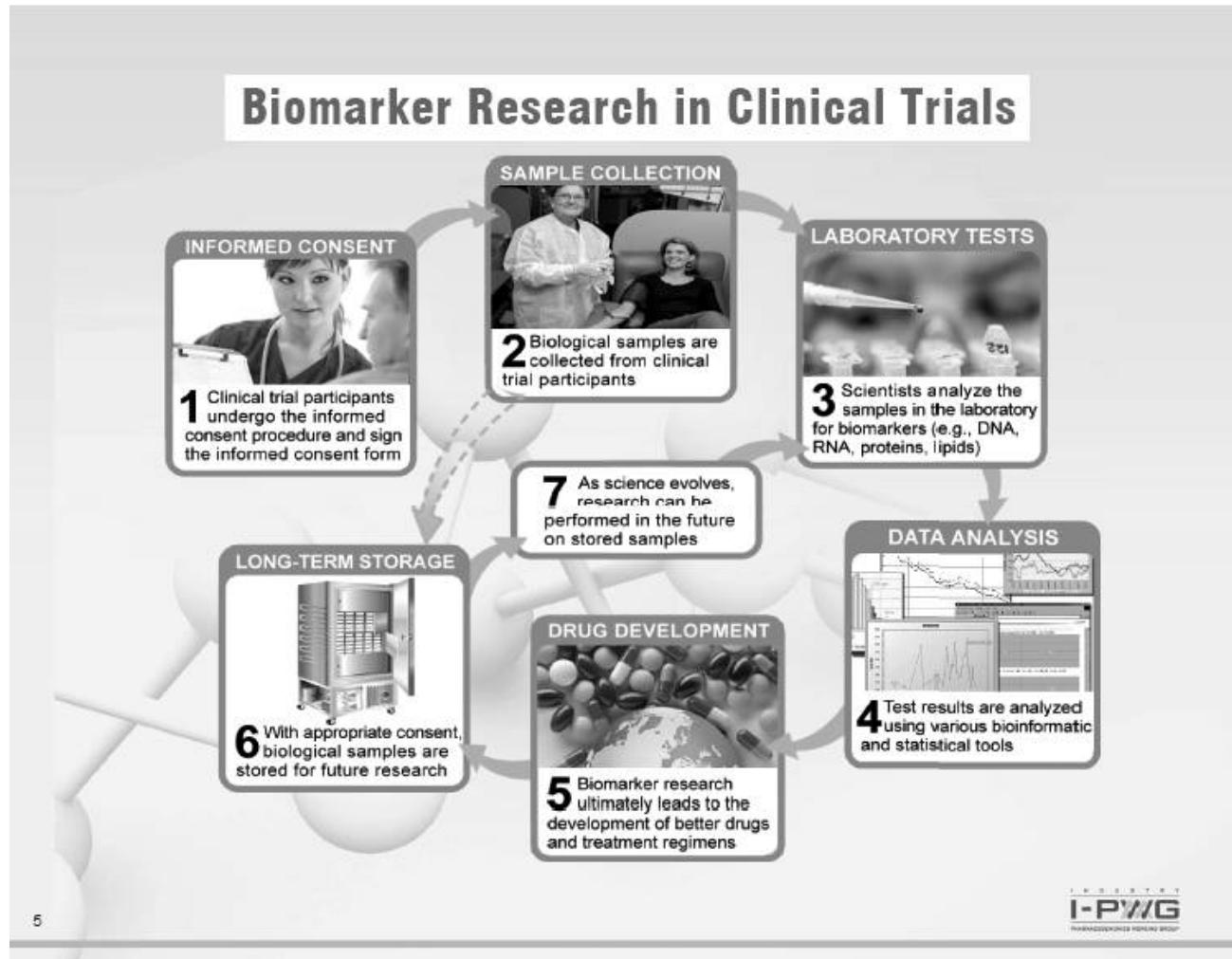
Important elements of informed consent for future use of samples include, but are not limited to:³⁰

The scope of research – Where the scope of the potential future research is broad, participants should be informed of the boundaries of the research. While it may not be possible to describe the exact analytical techniques that will be used, or specific molecules that will be analyzed, it is possible to clearly articulate in reasonable detail the type of research to be conducted and its purpose. Information regarding whether stored samples may be shared with other parties or utilized for commercialization purposes should also be addressed.

Withdrawal of consent / sample destruction – The informed consent form should inform participants of their right to withdraw their consent / request destruction of their samples. This should include the mechanisms for exercising that right and any limitations to exercising that right. For example, participants should be informed that it is not possible to destroy samples that have been anonymized.³ In addition, according to industry standards and regulatory guidance, participants should be informed that data already generated prior to a consent withdrawal request are to be maintained as part of the study data.³⁵

The duration of storage – The permissible duration of storage may vary according to the nature and uses of the samples and may also vary on national, state, and local levels. The intended duration of storage, including indefinite storage, should be specified.





8. Biomarker Sample Collection in Different Countries

Collection of biological samples for biomarker research is straightforward in most jurisdictions. Some countries have specific laws and regulations regarding collection, labeling, storage, export, and/or use of exploratory samples. In addition, some regulations distinguish between DNA and non-DNA samples or between samples used for diagnostic purposes and samples collected for scientific research. Processes for the collection, labeling, storage, export, and/or use of biomarker samples should always adhere to the laws and regulations of the country/region in which those samples are collected.

9. Return of Research Results to Study Participants

Policies for the return of biomarker research results to study participants who request them vary among pharmaceutical companies. There are many considerations that pharmaceutical companies weigh when determining their policy regarding the return of biomarker research results to study participants. These include:

- i) the conditions under which biomarker research results were generated (i.e., exploratory research laboratory versus accredited diagnostic laboratory)
- ii) whether the results will have an impact on the medical care of the participant or on a related person, if applicable
- iii) whether genetic counseling is recommended (for genetic results)
- iv) the ability to accurately link the result to the individual from whom the sample was collected
- v) international, national, and local guidelines, policies, legislation, and regulations regarding participants' rights to access data generated on them

Renegar *et al.* 2006 and Article 29 Data Protection Working Party (an advisory committee to the European Commission on the European Data Protection Directive) have addressed these considerations in detail in relation to pharmacogenomic research data and provided a list of documents addressing the general issue of return of research results.³⁴⁻³⁶

10. Benefits and Risks Associated with Biomarker Research

Benefits

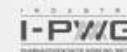
While it may not always directly benefit the study participant who is providing the samples, biomarker research can improve overall understanding of disease and treatment of future patients receiving therapies developed from such research. Patients are now benefiting from retrospective biomarker research conducted on samples collected from clinical trials and stored for exploratory research. One example is the recent label update to the EGFR antibody drugs cetuximab (Erbitux[®]) and panitumumab (Vectibix[®]) which highlights the value of KRAS status as a predictive biomarker for treatment of metastatic colorectal cancer with this class of drug.

The humanitarian benefit of human research is recognized by the Nuremberg Code.^{28,33} Provided that the degree of risk does not exceed that determined by the humanitarian importance of the problem to be solved, research participants should not be denied the right to contribute to the greater common good.^{28,32}

Risks

Risks associated with biomarker research are primarily related to the physical aspects of obtaining the sample and to patient privacy concerns.

Physical risks associated with biomarker sample collection in clinical trials can be characterized in two ways:
i) negligible additional risk when the biomarker sample is collected as part of a procedure conducted to support



other core trial objectives, and ii) some added risk where the sampling procedure would otherwise have not been performed as a core component of a trial. Risks are also determined by the invasiveness of the sample collection procedure.

Privacy risks are generally those associated with the inappropriate disclosure and misuse of data. Pharmaceutical companies have policies and procedures for confidentiality protection to minimize this risk for all data collected and generated in clinical trials. These may vary across companies, but are based on industry standards of confidentiality and privacy protection highlighted in the following section. Importantly, privacy risks inherent to biomarker data are no greater than other data collected in a clinical trial.

11. Privacy, Confidentiality, and Patient Rights

Maintaining the privacy of study participants and the confidentiality of information relating to them is of paramount concern to industry researchers, regulators, and patients. Good Clinical Practice (GCP), the standard adhered to in pharmaceutical clinical research, is a standard that

“...provides assurance that the data and reported results are credible and accurate, and that the rights, integrity, and confidentiality of trial subjects are protected”,

where confidentiality is defined as, *“The prevention of disclosure, to other than authorized individuals, of a sponsor’s proprietary information or of a subject’s identity.”*

This standard dictates that *“the confidentiality of records that could identify subjects should be protected, respecting the privacy and confidentiality rules in accordance with applicable regulatory requirements.”*³¹

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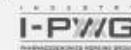
Exploratory biomarker research in pharmaceutical development is commonly conducted in research laboratories that are not accredited to perform diagnostic tests used for healthcare decision-making. Therefore, results from exploratory biomarker research usually are not appropriate for use in making decisions about a trial participant’s health. In addition, exploratory research data should not be included as part of a participant’s medical record accessible for use by insurance companies. Legislation and policies to protect individuals against discrimination based on genetic information continually evolve based on social, ethical, and legal considerations. Examples of such legislation include the Human Tissue Act 2004 (UK) and the Genetic Information Nondiscrimination Act (GINA) 2008 (USA).³⁶⁻³⁷

12. Where to Get More Information?

Educational resources related to biomarker and pharmacogenomic research that caters to health care professionals, IRBs/IECs, scientists, and patients are continually being created and are publicly available. Links to many of these resources are available through the I-PWG website: www.i-pwg.org.

13. What is I-PWG?

The Industry Pharmacogenomics Working Group (I-PWG) (formerly the Pharmacogenetics Working Group) is a voluntary association of pharmaceutical companies engaged in pharmacogenomic research. The Group’s activities focus on non-competitive educational, informational, ethical, legal, and regulatory topics. The Group provides information and expert opinions on these topics and sponsors educational/informational programs to promote better understanding of pharmacogenomic and other biomarker research for key stakeholders. The I-PWG interacts with regulatory author-



ities and policy groups to ensure alignment. More information about the I-PWG is available at: www.i-pwg.org.

14. Contributing authors

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www.i-pwg.org



12.4 Hepatitis B Definitions and Treatment Considerations

Table 13 describes the various definitions of hepatitis B as well as the treatment considerations for subjects with hepatitis B.

Table 13 Hepatitis B Definitions and Treatment Considerations

Test	Patient Status	Eligible for KN-0224?	Any HBV Treatment Needed?
HBsAg (-) Total anti-HBc (+) HBsAb (+)	Immune after natural infection	Yes	No
HBsAg (-) Total anti-HBc (-) HBsAb (+)	Immune after vaccination	Yes	No
HBsAg (+) Total anti-HBc (+) IgM anti-HBc (+) HBsAb (-)	Acute infection	No	—
HBsAg (+) Total anti-HBc (+) IgM anti-HBc (-) HBsAb (-)	Chronic infection	Yes	Yes, need to be on a HBV treatment for at least 12 weeks prior to start of pembrolizumab <u>Exclude if:</u> (a) <12 weeks of therapy; (b) HBV viral load not under control during this time frame (c) Documented HBV flare in the past 12 weeks
HBsAg (-) Total anti-HBc (+) IgM anti-HBc (-) HBsAb (-) HBV viral load (negative)	Unclear. Could be: (1) Resolved infection (2) False positive anti-HBc (3) Low level infection (4) Resolving Acute infection	Yes	No
HBsAg (-) Total anti-HBc (+) IgM anti-HBc (-) HBsAb (-) HBV viral load (+)	(1) Low level infection (2) Resolving acute infection	Yes	Yes (as above)

HBc = HBsAb = HBsAg = HBV = IgM =

12.5 ECOG Performance Status

GRADE	ECOG PERFORMANCE STATUS
0	Fully active, able to carry on all pre-disease performance without restriction
1	Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature, e.g., light house work, office work
2	Ambulatory and capable of all selfcare but unable to carry out any work activities; up and about more than 50% of waking hours
3	Capable of only limited selfcare; confined to bed or chair more than 50% of waking hours
4	Completely disabled; cannot carry on any selfcare; totally confined to bed or chair
5	Dead

*Oken M, Creech R, Tormey D, et al. Toxicity and response criteria of the Eastern Cooperative Oncology Group. *Am J Clin Oncol.* 1982;5:649-655.

<http://ecog-acrin.org/resources/ecog-performance-status>

12.6 Common Terminology Criteria for Adverse Events

The descriptions and grading scales found in the revised NCI Common Terminology Criteria for Adverse Events (CTCAE) version 4.0 will be utilized for adverse event reporting. (<http://ctep.cancer.gov/reporting/ctc.html>).

12.7 Child-Pugh Score

The Child-Pugh score is used to assess the prognosis of chronic liver disease, mainly cirrhosis. Although it was originally used to predict mortality during surgery, it is now used to determine the prognosis, as well as the required strength of treatment and the necessity of liver transplantation.

Scoring

The score employs five clinical measures of liver disease. Each measure is scored from 1 to 3, with 3 indicating most severe derangement.

Measure	1 point	2 points	3 points
<u>Total bilirubin</u> ¹ (mg/dL)	<2.0	2.0 to 3.0	>3.0
<u>Serum albumin</u> (g/dL)	>3.5	2.8 to 3.5	<2.8
<u>INR</u> ² <u>Or</u> <u>Prothrombin time, prolongation (secs)</u>	<1.7 <4.0	1.7 to 2.3 4.0-6.0	> 2.3 >6.0
<u>Ascites</u>	None	Mild (easily controlled by medication)	Moderate to Severe (poorly controlled)
<u>Hepatic encephalopathy</u> ³	None	Grade I-II (mild or moderate)	Grade III-IV (severe or coma)

¹In primary sclerosing cholangitis and primary biliary cirrhosis, the bilirubin references are changed to reflect the fact that these diseases feature high conjugated bilirubin levels. The upper limit for 1 point is 68 µmol/L (4 mg/dL) and the upper limit for 2 points is 170 µmol/L (10 mg/dL).

² Different textbooks and publications use different measures. Some older reference works substitute PT prolongation for INR

³ Hepatic encephalopathy graded according to West Haven Criteria for Semi-quantitative Grading of Mental Status: *Adapted from: Conn H, Lieberthal M. The hepatic coma syndromes and lactulose. Baltimore: Williams & Wilkins; 1979.*

- **Grade I:** Trivial lack of awareness; euphoria or anxiety; shortened attention span; impaired performance of addition or subtraction
- **Grade II:** Lethargy or apathy, minimal disorientation for time or place; subtle personality change; inappropriate behavior
- **Grade III:** Somnolence to semi-stupor, but responsive to verbal stimuli
Confusion; Gross disorientation

- **Grade IV:** Coma (unresponsive to verbal or noxious stimuli)

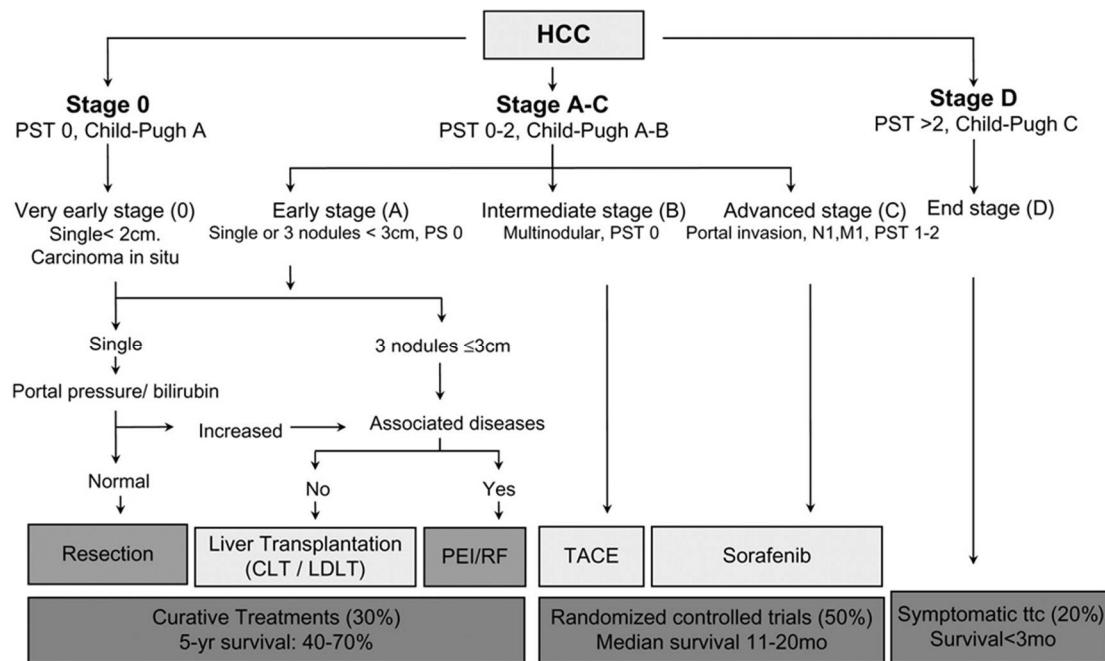
Interpretation

Chronic liver disease is classified into Child-Pugh class A to C, employing the added score from above.

Points	Class	One year survival	Two year survival
5-6	A	100%	85%
7-9	B	81%	57%
10-15	C	45%	35%

12.8 Barcelona Clinic Liver Cancer Staging System

The Barcelona Clinic Liver Cancer staging system is shown in [Figure 3](#) below [52].



CLT = cadaveric liver transplantation; LDLT = living donor liver transplantation; PEI = percutaneous ethanol injection; RF = radio frequency (ablation); TACE = transarterial chemoembolization.

Figure 3 Barcelona Clinic Liver Cancer Staging System

12.9 List of Abbreviations

Abbreviation/Term	Definition
1L	First line
2L	Second line
ADA	Anti-drug antibodies
AE	Adverse event
AFP	Alpha fetoprotein
ALC1	Antibodies to liver cytosol antigen
ALKM-1	Antibodies to liver/kidney microsomes
ALT	Alanine aminotransferase
ANA	Antibodies to nuclei
aPTT	Activated partial thromboplastin time
ASaT	All subjects as treated
ASMA	Antibodies to smooth muscle
AST	Aspartate aminotransferase
BCG	Bacille of Calmette-Guerin Vaccine (Tuberculosis Vaccine)
BCLC	Barcelona Clinic Liver Cancer scale
β-HCG	Beta Human Chorionic Gonadotropin
BID	Twice daily
CI	Confidence interval
CL	Clearance
C _{max}	Serum maximum concentration
CNS	Central nervous system
CR	Complete response
CRF	Case Report Form
CRP	C-Reactive protein
CSR	Clinical Study Report
CT	Computed tomography
CTCAE	Common Toxicity Criteria for Adverse Events
CTFG	Clinical Trial Facilitation Group
C _{trough}	Serum minimum concentration
Dbil	Direct bilirubin
DCR	Disease control rate
DNA	Deoxyribonucleic acid
DO.R	Duration of response
ECG	Electrocardiogram
ECI	Events of clinical interest
ECOG	Eastern Cooperative Oncology Group
EDC	Electronic data capture
eDMC	External data monitoring committee
ELISA	Enzyme-linked immunosorbent assay
EOC	Executive Oversight Committee
EPO	Erythropoietin
ERC	Ethics review committee
FBR	Future biomedical research
FDA	Food and Drug Administration
FDAAA	Food and Drug Administration Amendments Act
FDAMA	Food and Drug Administration Modernization Act
FFPE	Formalin-fixed, paraffin-embedded
FNA	Fine needle aspirate
FOLFOX	Chemotherapy regimen containing: folinic acid, 5-fluorouracil, and oxaliplatin

Abbreviation/Term	Definition
FSH	Follicle-stimulating hormone
GCP	Good Clinical Practice
GEP	Gene expression profile
Anti-HBc	Hepatitis B core antibody, Total
Anti-HBc, IgM	Hepatitis B core antibody, IgM
HBeAg	Hepatitis B early antigen
Anti-HBe	Hepatitis B early antibody
Anti-HBs	Hepatitis B surface antibody
HBsAg	Hepatitis B surface antigen
HBV	Hepatitis B virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C virus
HDV	Hepatitis D virus
Anti-HDV	Hepatitis D antibody
HIV	Human immunodeficiency virus
IB	Investigator's Brochure
ICF	Informed consent form
ICH	International Conference on Harmonisation
IHC	Immunohistochemistry
INR	International normalized ratio
irAE	Immune-related adverse event
irPD	radiographic progression of disease
IRB	Institutional Review Board
ITIM	Immunoreceptor tyrosine-based inhibition motif
ITSM	Immunoreceptor tyrosine-based switch motif
IUD	Intrauterine device
IUS	Intrauterine hormone-releasing system (IUS)
IV	Intravenous
IVRS	Interactive voice response system
IWRS	Integrated web response system
KM	Kaplan-Meier
mAb	Monoclonal antibody
mRECIST	Modified RECIST for HCC
miRNA	Micro RNA
MRI	Magnetic resonance imaging
MTD	Maximum tolerated dose
NCI	National Cancer Institute
NSCLC	Non-small cell lung cancer
ORR	Objective response rate
OS	Overall survival
OTC	Over-the-counter
PBMC	Peripheral blood mononuclear cell
PD	Progressive disease
PD-1	Programmed cell death 1
PD-L1	Programmed death ligand 1
PD-L2	Programmed death ligand 2
PFS	Progression-free survival
PI	Principal investigator
PK	Pharmacokinetic
PR	Partial response
PT	Prothrombin time
PS	Performance status

Abbreviation/Term	Definition
RECIST	Response Evaluation Criteria in Solid Tumors
Q2W	Every 2 weeks
Q3W	Every 3 weeks
Q9W	Every 9 weeks
Q12W	Every 12 weeks
QD	Once daily
RNA	Ribonucleic acid
SAE	Serious adverse events
SAP	Statistical analysis plan
SD	Stable disease
SIM	Site Imaging Manual
SOP	Standard operating procedures
sSAP	Supplemental SAP
SVR 12	Sustained virologic response for 12 weeks
SVR 24	Sustained virologic response for 24 weeks
TACE	Transcatheter chemoembolization
TAE	Transarterial embolization
Tbil	Total bilirubin
TIL	Tumor infiltrating lymphocytes
TTP	Time to progression
ULN	Upper limit of normal
V	Volume of distribution

13.0 SIGNATURES

13.1 Sponsor's Representative

TYPED NAME	
TITLE	
SIGNATURE	
DATE SIGNED	

13.2 Investigator

I agree to conduct this clinical trial in accordance with the design outlined in this protocol and to abide by all provisions of this protocol (including other manuals and documents referenced from this protocol). I agree to conduct the trial in accordance with generally accepted standards of Good Clinical Practice. I also agree to report all information or data in accordance with the protocol and, in particular, I agree to report any serious adverse events as defined in Section 7.0 – TRIAL PROCEDURES (Assessing and Recording Adverse Events). I also agree to handle all clinical supplies provided by the Sponsor and collect and handle all clinical specimens in accordance with the protocol. I understand that information that identifies me will be used and disclosed as described in the protocol, and that such information may be transferred to countries that do not have laws protecting such information. Since the information in this protocol and the referenced Investigator's Brochure is confidential, I understand that its disclosure to any third parties, other than those involved in approval, supervision, or conduct of the trial is prohibited. I will ensure that the necessary precautions are taken to protect such information from loss, inadvertent disclosure or access by third parties.

TYPED NAME	
TITLE	
SIGNATURE	
DATE SIGNED	