

# Crizotinib

Xalkori®

200 mg and 250 mg Capsule

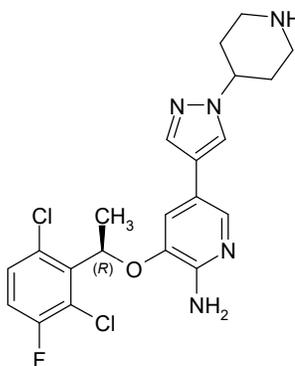


## 1.0 PHARMACOLOGIC CATEGORY

Tyrosine Kinase Inhibitor

## 2.0 DESCRIPTION

Crizotinib is an oral receptor tyrosine kinase inhibitor. The molecular formula for crizotinib is  $C_{21}H_{22}Cl_2FN_5O$ . The molecular weight is 450.34 Daltons. Crizotinib is described chemically as (*R*)-3-[1-(2,6-Dichloro-3-fluorophenyl)ethoxy]-5-[1-(piperidin-4-yl)-1*H*-pyrazol-4-yl]pyridin-2-amine. The chemical structure of crizotinib is shown below:



Crizotinib is a white to pale yellow powder with a pKa of 9.4 (piperidinium cation) and 5.6 (pyridinium cation). The solubility of crizotinib in aqueous media decreases over the range pH 1.6 to pH 8.2 from greater than 10 mg/mL to less than 0.1 mg/mL. The log of the distribution coefficient (octanol/water) at pH 7.4 is 1.65.

## 3.0 FORMULATION

Crizotinib (Xalkori®) 200 mg capsule: Each capsule contains 200 mg Crizotinib.

Crizotinib (Xalkori®) 250 mg capsule: Each capsule contains 250 mg Crizotinib.

## 4.0 CLINICAL PARTICULARS

### 4.1 Therapeutic Indications

Crizotinib is indicated for the treatment of anaplastic lymphoma kinase (ALK)-positive advanced non-small cell lung cancer (NSCLC).

Crizotinib is indicated for the treatment of ROS1-positive advanced NSCLC.

## 4.2 Dosage and Method of Administration

### ALK and ROS1 Testing

Detection of ALK-positive NSCLC and ROS1-positive NSCLC is necessary for selection of patients for treatment with crizotinib because these are the only patients for whom benefit has been shown. Assessment for ALK-positive NSCLC and ROS1-positive NSCLC should be performed by laboratories with demonstrated proficiency in the specific technology being utilized. Improper assay performance can lead to unreliable test results.

### Recommended Dosing

#### *Adult Patients with ALK-Positive or ROS1-Positive Advanced NSCLC*

The recommended starting dose schedule of crizotinib is 250 mg taken orally twice daily. Continue treatment as long as the patient is deriving clinical benefit from therapy.

### Dose Modification

Dosing interruption and/or dose reduction may be required based on individual safety and tolerability.

For adult patients if a dose reduction is necessary for patients treated with crizotinib 250 mg orally twice daily, then the dose of crizotinib should be reduced as below:

- First dose reduction: Crizotinib (Xalkori<sup>®</sup>) 200 mg taken orally twice daily
- Second dose reduction: Crizotinib (Xalkori<sup>®</sup>) 250 mg taken orally once daily
- Permanently discontinue if unable to tolerate Crizotinib (Xalkori<sup>®</sup>) 250 mg taken orally once daily

Dose reduction guidelines for hematologic and non-hematologic toxicities are provided in Table 1 and Table 2. For adult patients treated with a lower than the recommended crizotinib starting dose, use the recommendations in Table 1 and Table 2 accordingly.

| <b>Table 1. Crizotinib Dose Modification – Hematologic Toxicities<sup>a</sup></b>  |   |
|--|---|
| <b>CTCAE<sup>b</sup> Grade</b>   | <b>Crizotinib Dosing</b>  |
| Grade 3  | Withhold until recovery to Grade $\leq 2$ , then resume at the same dose schedule             |
| Grade 4  | Withhold until recovery to Grade $\leq 2$ , then resume at the next lower dose <sup>c,d</sup> |
| a. Except lymphopenia (unless associated with clinical events, e.g., opportunistic infections).<br>b. National Cancer Institute (NCI) Common Terminology Criteria for Adverse Events.<br>c. In case of recurrence, withhold until recovery to Grade $\leq 2$ , then resume at 250 mg, once daily for adults. Permanently discontinue in case of further Grade 4 recurrence.<br>d. For adult patients treated with 250 mg once daily or whose dose was reduced to 250 mg once daily, discontinue during evaluation. |   |

| <b>Table 2. Crizotinib Dose Modification – Non-hematologic Toxicities</b> |                          |
|---|--------------------------|
| <b>CTCAE<sup>a</sup> Grade</b>  | <b>Crizotinib Dosing</b> |

|  |   |
|--|---|
| Grade 3 or 4 alanine aminotransferase (ALT) or aspartate aminotransferase (AST) elevation with Grade $\leq 1$ total bilirubin  | Withhold until recovery to Grade $\leq 1$ or baseline, then resume at the next lower dose <sup>b,c</sup>  |
| Grade 2, 3 or 4 ALT or AST elevation with concurrent Grade 2, 3 or 4 total bilirubin elevation (in the absence of cholestasis or hemolysis)  | Permanently discontinue   |
| Any Grade interstitial lung disease/pneumonitis <sup>d</sup>   | Permanently discontinue   |
| Grade 3 QTc prolongation   | Withhold until recovery to Grade $\leq 1$ , then resume at the next lower dose <sup>b,c</sup>   |
| Grade 4 QTc prolongation   | Permanently discontinue   |
| Grade 2, 3 bradycardia <sup>e</sup> (symptomatic, may be severe and medically significant, medical intervention indicated)   | <p>Adult patients:<br/>Withhold until recovery to Grade <math>\leq 1</math> or to heart rate of 60 bpm or above</p> <p>Evaluate concomitant medications known to cause bradycardia, as well as antihypertensive medications</p> <p>If contributing concomitant medication is identified and discontinued, or its dose is adjusted, resume at previous dose upon recovery to Grade <math>\leq 1</math> or to heart rate of 60 bpm or above</p> <p>If no contributing concomitant medication is identified, or if contributing concomitant medications are not discontinued or dose modified, resume at reduced dose<sup>c</sup> upon recovery to Grade <math>\leq 1</math> or to heart rate of 60 bpm or above</p> |
| Grade 4 bradycardia <sup>e,f</sup> (life-threatening consequences, urgent intervention indicated)  | <p>Adult patients:<br/>Permanently discontinue if no contributing concomitant medication is identified</p> <p>If contributing concomitant medication is identified and discontinued, or its dose is adjusted, resume at 250 mg once daily<sup>c</sup> upon recovery to Grade <math>\leq 1</math> or to heart rate of 60 bpm or above, with frequent monitoring</p>  |
| <p>a. NCI Common Terminology Criteria for Adverse Events.</p> <p>b. In case of recurrence, withhold until recovery to Grade <math>\leq 1</math>, then resume at 250 mg, once daily for adults. Permanently discontinue in case of further Grade <math>\geq 3</math> recurrence.</p> <p>c. For adult patients treated with 250 mg once daily or whose dose was reduced to 250 mg once daily, discontinue during evaluation.</p> <p>d. Not attributable to NSCLC progression, other pulmonary disease, infection, or radiation effect.</p> <p>e. Adult patients: Heart rate less than 60 beats per minute (bpm).</p> <p>f. Permanently discontinue for recurrence.</p> |   |

*Hepatic impairment:* Crizotinib is extensively metabolized in the liver. Treatment with crizotinib should be used with caution in patients with hepatic impairment (see Table 2 and Sections 4.4 Special Warnings and Precautions for Use and 5.2 Pharmacokinetic Properties).

A clinical study was conducted in patients with advanced cancer and varying degrees of hepatic impairment, based on National Cancer Institute (NCI) classification, who received multiple doses of crizotinib to evaluate the effect of hepatic impairment on the pharmacokinetics and safety of crizotinib. No starting dose adjustment of crizotinib is recommended for patients with mild hepatic impairment (either AST >Upper Limit of Normal (ULN) and total bilirubin  $\leq$ ULN or any AST and total bilirubin >ULN but  $\leq 1.5 \times$ ULN), as the systemic crizotinib exposure was comparable to that from patients with normal hepatic function receiving the same crizotinib dose of 250 mg twice daily. The starting crizotinib dose for patients with moderate hepatic impairment (any AST and total bilirubin  $> 1.5 \times$ ULN and  $\leq 3 \times$ ULN) is recommended to be 200 mg twice daily, as the systemic crizotinib exposure increased compared to that from patients with normal hepatic function receiving the same dose of 200 mg twice daily, but was comparable to that from patients with normal hepatic function receiving 250 mg twice daily. The starting crizotinib dose for patients with severe hepatic impairment (any AST and total bilirubin  $> 3 \times$ ULN) is recommended to be 250 mg once daily, as crizotinib doses greater than 250 mg once daily have not been studied in patients with severe hepatic impairment and may result in increases of systemic crizotinib exposure to supra-therapeutic levels.

*Renal impairment:* No starting dose adjustment is needed for patients with mild ( $60 \leq$  creatinine clearance [ $CL_{cr}$ ]  $< 90$  mL/min) or moderate ( $30 \leq CL_{cr} < 60$  mL/min) renal impairment, since the population pharmacokinetic analysis indicated no clinically meaningful changes in steady-state crizotinib exposure in these patients. Crizotinib plasma concentrations may be increased in patients with severe renal impairment ( $CL_{cr} < 30$  mL/min). The crizotinib dose should be adjusted to 250 mg taken orally once daily in patients with severe renal impairment not requiring peritoneal dialysis or hemodialysis. The dose may be increased to 200 mg twice daily based on individual safety and tolerability after at least 4 weeks of treatment (see Sections 4.4 Special Warnings and Precautions for Use and 5.2 Pharmacokinetic Properties).

*Pediatric patients:* The safety and efficacy of crizotinib in pediatric patients has not been established.

*Elderly:* No starting dose adjustment is required (see Sections 5.1 Pharmacodynamic Properties and 5.2 Pharmacokinetic Properties).

### **Method of administration**

Crizotinib may be taken with or without food (see Section 5.2 Pharmacodynamic Properties). Capsules should be swallowed whole. If a dose of crizotinib is missed, then it should be taken as soon as the patient or care giver remembers unless it is less than 6 hours until the next dose, in which case the patient should not take the missed dose. Patients should not take 2 doses at the same time to make up for a missed dose.

### **4.3 Contraindications**

Use of crizotinib is contraindicated in patients with hypersensitivity to crizotinib or to any of the excipients such as colloidal silicon dioxide, microcrystalline cellulose, anhydrous dibasic calcium phosphate, sodium starch glycolate, magnesium stearate, and hard gelatin capsule shells.

### **4.4 Special Warnings and Precautions for Use**

#### **Hepatotoxicity**

Drug-induced hepatotoxicity with fatal outcome occurred in 0.1% of 1,722 patients treated with crizotinib across clinical trials. Concurrent elevations in ALT and/or AST  $\geq 3 \times \text{ULN}$  and total bilirubin  $\geq 2 \times \text{ULN}$  without significant elevations of alkaline phosphatase ( $\leq 2 \times \text{ULN}$ ) have been observed in less than 1% of patients treated with crizotinib. Increases to Grade 3 or 4 ALT or AST elevations were observed in 187 (11%) and 95 (6%) of patients, respectively. Seventeen (1%) patients required permanent discontinuation from treatment associated with elevated transaminases, suggesting that these events were generally manageable by dosing modifications as defined in Table 2 (see Section 4.2 Dosage and Method of Administration). Transaminase elevations generally occurred within the first 2 months of treatment. Liver function tests including ALT, AST and total bilirubin should be monitored every 2 weeks during the first 2 months of treatment, then once a month and as clinically indicated, with more frequent repeat testing for Grades 2, 3 or 4 elevations. For patients who develop transaminase elevations, see Dose Modification section (see Section 4.2 Dosage and Method of Administration).

#### **Interstitial Lung Disease (Pneumonitis)**

Crizotinib has been associated with severe, life-threatening, or fatal interstitial lung disease (ILD)/pneumonitis in clinical trials at a frequency of 26 (2%) of 1722 patients treated with crizotinib. These cases generally occurred within 3 months after the initiation of treatment. Patients should be monitored for pulmonary symptoms indicative of ILD/pneumonitis. Other potential causes of ILD/pneumonitis should be excluded. Crizotinib should be permanently discontinued in patients diagnosed with treatment-related ILD/pneumonitis (see Section 4.2 Dosage and Method of Administration).

## **QT Interval Prolongation**

Automated machine-read QTc prolongation without accompanying arrhythmia has been observed. Crizotinib should be administered with caution to patients who have a history of or predisposition for QTc prolongation, or who are taking medications that are known to prolong the QT interval. When using crizotinib in these patients, periodic monitoring with electrocardiograms and electrolytes should be considered. For patients who develop QTc prolongation, see Dose Modification section (see Sections 4.2 Dosage and Method of Administration and 5.2 Pharmacokinetic Properties).

## **Bradycardia**

Bradycardia has been reported in clinical studies, and it was usually asymptomatic. The full effect of crizotinib on pulse rate may not develop until several weeks after start of treatment. Avoid using crizotinib in combination with other bradycardic agents (e.g., beta-blockers, non-dihydropyridine calcium channel blockers, such as verapamil and diltiazem, clonidine, digoxin) to the extent possible, due to the increased risk of symptomatic bradycardia (syncope, dizziness, hypotension). Monthly monitoring of pulse rate and blood pressure is recommended. Dose modification is not required in cases of asymptomatic bradycardia. In cases of symptomatic bradycardia, crizotinib should be held and the use of concomitant medications should be re-evaluated. For management of patients who develop symptomatic bradycardia, see Dose Modification and Undesirable Effects sections (see Sections 4.2 Dosage and Method of Administration and 4.8 Undesirable Effects).

## **Renal Impairment**

If patients have severe renal impairment not requiring peritoneal dialysis or hemodialysis, the dose of crizotinib should be adjusted (see Sections 4.2 Dosage and Method of Administration and 5.2 Pharmacokinetic Properties).

## 4.5 Interaction with Other Medicinal Products and Other Forms of Interaction

Crizotinib is a substrate of CYP3A4/5 and also a moderate inhibitor of CYP3A. *In vitro* studies in human liver microsomes demonstrated that crizotinib is a time-dependent inhibitor of CYP3A.

### Agents that may increase crizotinib plasma concentrations

Coadministration of crizotinib with strong CYP3A inhibitors may increase crizotinib plasma concentrations (see Section 5.2 Pharmacokinetic Properties). The concomitant use of strong CYP3A inhibitors, including but not limited to atazanavir, clarithromycin, indinavir, itraconazole, ketoconazole, nefazodone, nelfinavir, ritonavir, saquinavir, telithromycin, troleanomycin, and voriconazole, should be avoided. Grapefruit or grapefruit juice may also increase plasma concentrations of crizotinib and should be avoided.

### Agents that may decrease crizotinib plasma concentrations

Coadministration of crizotinib with strong CYP3A inducers may decrease crizotinib plasma concentrations (see Section 5.2 Pharmacokinetic Properties). The concurrent use of strong CYP3A inducers, including but not limited to carbamazepine, phenobarbital, phenytoin, rifabutin, rifampin, and St. John's wort, should be avoided.

### Agents whose plasma concentrations may be altered by crizotinib

Crizotinib has been identified as an inhibitor of CYP3A both *in vitro* and *in vivo* (see Section 5.2 Pharmacokinetic Properties). Caution should be exercised in administering crizotinib in combination with drugs that are predominantly metabolized by CYP3A, particularly those CYP3A substrates that have narrow therapeutic indices, including but not limited to alfentanil, cyclosporine, fentanyl, quinidine, sirolimus, and tacrolimus.

Coadministration of crizotinib should be avoided with CYP3A substrates that have narrow therapeutic indices and are associated with life-threatening arrhythmias, including but not limited to dihydroergotamine, ergotamine, and pimozide.

## 4.6 Fertility, Pregnancy and Lactation

### Fertility

Based on nonclinical safety findings, male and female fertility may be compromised by treatment with crizotinib (see Section 5.3 Preclinical Safety Data).

### Pregnancy

Crizotinib may cause fetal harm when administered to a pregnant woman. Crizotinib was not shown to be teratogenic in pregnant rats or rabbits. Reduced fetal body weights were considered adverse effects in the rat and rabbit at 200 and 60 mg/kg/day, respectively (approximately equivalent to human clinical exposure based on area under the plasma concentration-time curve [AUC]).

There are no adequate and well-controlled studies in pregnant women using crizotinib. Women of childbearing potential should be advised to avoid becoming pregnant while receiving crizotinib. Women of childbearing potential who are receiving this drug, or partners of women of childbearing potential receiving this drug, should use adequate contraceptive methods during therapy and for at least 90 days after completing therapy.

Female patients taking crizotinib during pregnancy or who become pregnant while taking crizotinib should be apprised of the potential hazard to a fetus. Male patients taking crizotinib should also be apprised of the potential hazard to a fetus if their partner is or should become pregnant.

### **Lactation**

It is not known whether crizotinib and its metabolites are excreted in human milk. Because many drugs are excreted in human milk, and because of the potential for serious adverse reactions in nursing infants from exposure to crizotinib, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

### **4.7 Effects on Ability to Drive and Use Machines**

No studies on the effect of crizotinib on the ability to drive and use machines have been performed. However, caution should be exercised when driving or operating machinery by patients who experience vision disorder, dizziness, or fatigue while taking crizotinib (see Section 4.8 Undesirable Effects).

### **4.8 Undesirable Effects**

#### Summary of Safety Profile in Adult Patients with ALK-Positive or ROS1-Positive Advanced NSCLC

The data described below reflect exposure to crizotinib in 1669 patients with ALK-positive advanced NSCLC who participated in randomized Phase 3 Studies 1007 or 1014 or in single-arm Studies 1001 or 1005, and in 53 patients with ROS1-positive advanced NSCLC who participated in single-arm Study 1001, for a total of 1722 patients (see Section 5.1 Pharmacodynamic Properties). These patients received a starting oral dose of 250 mg twice daily continuously. In Study 1014, the median duration of study treatment was 47 weeks for patients in the crizotinib arm (N=171); the median duration of treatment was 23 weeks for patients who crossed over from the chemotherapy arm to receive crizotinib treatment (N=109). In Study 1007, the median duration of study treatment was 48 weeks for patients in the crizotinib arm (N=172). For ALK-positive NSCLC patients in Studies 1001 (N=154) and 1005 (N=1063), the median duration of treatment was 57 and 45 weeks, respectively. For ROS1-positive NSCLC patients in Study 1001 (N=53), the median duration of treatment was 101 weeks.

The most serious adverse reactions in 1722 patients with either ALK-positive or ROS1-positive advanced NSCLC were hepatotoxicity, ILD/pneumonitis, and QT interval prolongation (see Section 4.4 Special Warnings and Precautions for Use). The most common adverse reactions ( $\geq 25\%$ ) in patients with either ALK-positive or ROS1-positive

NSCLC were vision disorder, nausea, diarrhea, vomiting, edema, constipation, elevated transaminases, fatigue, decreased appetite, dizziness, and neuropathy.

In 1722 patients with either ALK-positive or ROS1-positive NSCLC treated with crizotinib, all-causality adverse events associated with dosing interruptions or dose reductions occurred in 763 (44%) and 259 (15%) patients, respectively. All-causality adverse events associated with permanent treatment discontinuation occurred in 302 (18%) patients.

Table 3 presents adverse drug reactions for crizotinib within each system organ class (SOC) by decreasing medical seriousness or clinical importance.

**Table 3. Adverse Drug Reactions for Crizotinib**

**Adverse Drug Reaction Table**

| <b>System Organ Class</b>                            | <b>Adverse Drug Reactions</b>  |
|--|--|
| Blood and lymphatic system disorders                 | Neutropenia <sup>a</sup><br>Leukopenia <sup>b</sup>  |
| Metabolism and nutrition disorders                   | Decreased appetite   |
| Nervous system disorders                             | Neuropathy <sup>c</sup><br>Dizziness <sup>d</sup><br>Dysgeusia                                 |
| Eye disorders  | Vision disorder <sup>e</sup>   |
| Cardiac disorders                                    | Electrocardiogram QT prolonged<br>Syncope<br>Bradycardia <sup>f</sup>                          |
| Respiratory, thoracic and mediastinal disorders      | Interstitial lung disease <sup>g</sup>   |
| Gastrointestinal disorders                           | Esophagitis <sup>h</sup><br>Vomiting<br>Diarrhea<br>Nausea<br>Constipation<br>Dyspepsia        |
| Hepatobiliary disorders                              | Hepatic failure<br>Elevated transaminases <sup>i</sup><br>Blood alkaline phosphatase increased |
| Skin and subcutaneous tissue disorders               | Rash   |
| Renal and urinary disorders                          | Renal cyst <sup>j</sup><br>Blood creatinine increased <sup>k</sup>                             |
| General disorders and administration site conditions | Edema <sup>l</sup><br>Fatigue  |
| Investigations                                       | Blood testosterone decreased <sup>m</sup><br>Blood creatine phosphokinase increased            |

Event terms that represent the same medical concept or condition were grouped together and reported as a single adverse drug reaction in the table above. Terms actually reported in the studies up to the data cutoff date and contributing to the relevant adverse drug reaction are indicated in parentheses, as listed below.

- a. Neutropenia (Febrile neutropenia, Neutropenia, Neutrophil count decreased).
- b. Leukopenia (Leukopenia, White blood cell count decreased).
- c. Neuropathy (Burning sensation, Dysesthesia, Formication, Gait disturbance, Hyperesthesia, Hypoesthesia, Hypotonia, Motor dysfunction, Muscle atrophy, Muscular weakness, Neuralgia, Neuritis, Neuropathy peripheral, Neurotoxicity, Paresthesia, Peripheral motor neuropathy, Peripheral sensorimotor neuropathy, Peripheral sensory neuropathy, Peroneal nerve palsy, Polyneuropathy, Sensory disturbance, Skin burning sensation).
- d. Dizziness (Balance disorder, Dizziness, Dizziness postural, Presyncope).
- e. Vision Disorder (Diplopia, Halo vision, Photophobia, Photopsia, Vision blurred, Visual acuity reduced, Visual brightness, Visual impairment, Visual perseveration, Vitreous floaters).
- f. Bradycardia (Bradycardia, Heart rate decreased, Sinus bradycardia).
- g. Interstitial Lung Disease (Acute respiratory distress syndrome, Alveolitis, Interstitial lung disease, Pneumonitis).
- h. Esophagitis (Esophagitis, Esophageal ulcer).
- i. Elevated Transaminases (Alanine aminotransferase increased, Aspartate aminotransferase increased, Gamma-glutamyltransferase increased, Hepatic enzyme increased, Hepatic function abnormal, Liver function test abnormal, Transaminases increased).
- j. Renal Cyst (Renal abscess, Renal cyst, Renal cyst hemorrhage, Renal cyst infection).
- k. Blood creatinine increased (Blood creatinine increased, Creatinine renal clearance decreased).
- l. Edema (Face edema, Generalized edema, Local swelling, Localized edema, Edema, Edema peripheral, Periorbital edema).
- m. Blood testosterone decreased (Blood testosterone decreased, Hypogonadism, Secondary hypogonadism).

### Description of Selected Adverse Reactions in Adult Patients with ALK-Positive or ROS1-Positive Advanced NSCLC

#### **Visual Effects**

In clinical trials of patients with either ALK-positive or ROS1-positive advanced NSCLC, all-causality vision disorder, most commonly visual impairment, photopsia, vision blurred, and vitreous floaters, was experienced by 1084 (63%) of 1722 patients treated with crizotinib. Of the 1084 patients who experienced vision disorder, 95% had events that were mild in severity. Ophthalmological evaluation should be considered if vision disorder persists or worsens in severity. Seven (0.4%) patients had temporary treatment discontinuation and 2 (0.1%) patients had a dose reduction associated with vision disorder. There were no permanent discontinuations associated with vision disorder for any of the 1722 patients treated with crizotinib.

Based on the Visual Symptom Assessment Questionnaire (VSAQ-ALK), patients treated with crizotinib in Study 1007 and Study 1014 reported a higher incidence of visual disturbances compared to patients treated with chemotherapy. The onset of vision disorder generally occurred during the first week of drug administration. The majority of patients in the crizotinib arms in Study 1007 and Study 1014 (>50%) reported visual disturbances, which occurred at a frequency of 4 to 7 days each week, lasted up to 1 minute, and had mild or no impact (scores 0 to 3 out of a maximum score of 10) on daily activities as captured by the VSAQ-ALK questionnaire.

## **Gastrointestinal Effects**

Nausea (57%), diarrhea (54%), vomiting (51%), and constipation (43%) were the most commonly reported all-causality gastrointestinal events. Most events were mild to moderate in severity. Median times to onset for nausea and vomiting were 3 days, and these events declined in frequency after 3 weeks of treatment. Supportive care should include the use of antiemetic medications. In clinical trials, the most commonly used antiemetic medications were ondansetron and prochlorperazine. Median times to onset for diarrhea and constipation were 13 and 17 days, respectively. Supportive care for diarrhea and constipation should include the use of standard antidiarrheal and laxative medications, respectively.

## **Nervous System Effects**

All-causality neuropathy as defined in Table 3, was experienced by 435 (25%) of 1722 patients treated with crizotinib, and was primarily Grade 1 or 2 in severity. Dizziness and dysgeusia were also very commonly reported and were primarily Grade 1 in severity.

## **Bradycardia**

In clinical trials of patients with either ALK-positive or ROS1-positive advanced NSCLC, all-causality bradycardia was experienced by 219 (13%) of 1722 patients treated with crizotinib. Most events were mild in severity. A total of 259 (16%) of 1666 patients with at least 1 postbaseline vital sign assessment had a pulse rate <50 bpm. The use of concomitant medications associated with bradycardia should be carefully evaluated. Patients who develop symptomatic bradycardia should be managed as recommended in the Dose Modification and Warnings and Precautions sections (see Sections 4.2 Dosage and Method of Administration and 4.4 Special Warnings and Precautions for Use).

## **Renal Cyst**

All-causality complex renal cysts were experienced by 52 (3%) of 1722 patients treated with crizotinib. There were no reports of clinically relevant abnormal urinalyses or renal impairment in these cases, although local cystic invasion beyond the kidney was observed in some patients. Periodic monitoring with imaging and urinalysis should be considered in patients who develop renal cysts.

## **Laboratory Abnormalities/Testing**

### *Hematologic Laboratory Abnormalities*

In clinical studies of crizotinib in patients with either ALK-positive or ROS1-positive advanced NSCLC, shifts to Grade 3 or 4 decreases in leukocytes and neutrophils were observed in 64 (4%) and 226 (13%) patients, respectively. Complete blood counts including differential white blood cell counts should be monitored as clinically indicated, with more frequent repeat testing if Grade 3 or 4 abnormalities are observed, or if fever or infection occurs. In patients who develop hematologic laboratory abnormalities, see Dose Modification section (see Section 4.2 Dosage and Method of Administration).

### *Hepatic Laboratory Abnormalities*

In clinical studies of crizotinib in patients with either ALK-positive or ROS1-positive advanced NSCLC, shifts to Grade 3 or 4 ALT, AST, and alkaline phosphatase were observed in 187 (11%), 95 (6%), and 33 (2%) patients, respectively. Patients should be monitored for hepatotoxicity and managed as recommended in Warnings and Precautions section (see Section 4.4 Special Warnings and Precautions for Use).

### *Renal Laboratory Abnormalities*

In clinical studies of crizotinib in patients with ALK-positive advanced NSCLC, the estimated glomerular filtration rate (eGFR) decreased from a baseline median of 96.42 mL/min/1.73 m<sup>2</sup> (n=1681) to a median of 80.23 mL/min/1.73 m<sup>2</sup> at 2 weeks of treatment (n=1499). Median eGFR appeared to be relatively stable from 12 weeks of treatment (78.06 mL/min/1.73 m<sup>2</sup>, n=1338) through 104 weeks of treatment (75.45 mL/min/1.73 m<sup>2</sup>, n=315) and increased to 83.02 mL/min/1.73 m<sup>2</sup> at 28 days after the last dose of crizotinib (n=123).

Shifts to eGFR Grade 4 (15 to <30 mL/min/1.73 m<sup>2</sup>) or to eGFR Grade 5 (<15 mL/min/1.73 m<sup>2</sup>) were observed in 3% and <1% of patients, respectively.

## **4.9 Overdose and Treatment**

Treatment of overdose with crizotinib should consist of general supportive measures. There is no antidote for crizotinib.

## **5.0 PHARMACOLOGICAL PROPERTIES**

### **5.1 Pharmacodynamic Properties**

Crizotinib is a selective small-molecule inhibitor of the ALK receptor tyrosine kinase (RTK) and its oncogenic variants (i.e., ALK fusion events and selected ALK mutations). Crizotinib is also an inhibitor of the Hepatocyte Growth Factor Receptor (HGFR, c-Met) RTK, ROS1 (c-ros), and Recepteur d'Origine Nantais (RON) RTKs. Crizotinib demonstrated concentration-dependent inhibition of the kinase activity of ALK, ROS1, and c-Met in biochemical assays and inhibited phosphorylation and modulated kinase-dependent phenotypes in cell-based assays. Crizotinib demonstrated potent and selective growth inhibitory activity and induced apoptosis in tumor cell lines exhibiting ALK fusion events (including echinoderm microtubule-associated protein-like 4 [EML4]-ALK and nucleophosmin [NPM]-ALK), ROS1 fusion events, or exhibiting amplification of the *ALK* or *MET* gene locus.

Crizotinib demonstrated antitumor efficacy, including marked cytoreductive antitumor activity, in mice bearing tumor xenografts that expressed ALK fusion proteins. The antitumor efficacy of crizotinib was dose-dependent and correlated to pharmacodynamic inhibition of phosphorylation of ALK fusion proteins (including EML4-ALK and NPM-ALK) in tumors *in vivo*. Crizotinib also demonstrated marked antitumor activity in mouse xenograft studies, where tumors were generated using a panel of NIH-3T3 cell lines engineered to express key ROS1 fusions identified in human tumors. The antitumor

efficacy of crizotinib was dose-dependent and demonstrated a correlation with inhibition of ROS1 phosphorylation *in vivo*.

### **Pediatric Population**

The safety and efficacy of crizotinib in pediatric patients has not been established. Decreased bone formation in growing long bones was observed in immature rats at 150 mg/kg/day following once daily dosing for 28 days (approximately 3 times human clinical exposure based on AUC). Other toxicities of potential concern to pediatric patients have not been evaluated in juvenile animals.

### **Clinical Studies**

#### **Previously Untreated ALK-positive Advanced NSCLC – Randomized Phase 3 Study 1014**

The use of single-agent crizotinib for the first-line treatment of ALK-positive advanced NSCLC in patients with or without brain metastases was investigated in a multicenter, multinational, randomized, open-label Phase 3 Study 1014. The primary objective of this study was to demonstrate that crizotinib was superior to first-line standard-of-care platinum-based chemotherapy (pemetrexed-cisplatin or pemetrexed-carboplatin) in prolonging Progression-Free Survival (PFS) as assessed by independent radiology review (IRR) in patients with ALK-positive advanced NSCLC who had not received previous systemic treatment for advanced disease. Secondary objectives were to compare measures of clinical efficacy including Objective Response Rate (ORR) as assessed by IRR, Duration of Response (DR), Overall Survival (OS), Intracranial Time to Progression (IC-TTP) as assessed by IRR, and Patient-Reported Outcomes (PRO).

The full analysis population for Study 1014 included 343 patients with ALK-positive advanced NSCLC as identified by Fluorescence In Situ Hybridization (FISH) prior to randomization. One hundred seventy-two (172) patients were randomized to the crizotinib arm (171 patients received crizotinib 250 mg orally twice daily) and 171 patients were randomized to the chemotherapy arm (169 patients received chemotherapy; 91 patients were treated with pemetrexed/cisplatin and 78 patients were treated with pemetrexed/carboplatin). Chemotherapy consisted of pemetrexed 500 mg/m<sup>2</sup> in combination with cisplatin 75 mg/m<sup>2</sup> or carboplatin at a dose calculated to produce an AUC of 5 or 6 mg • min/mL. Chemotherapy was given by intravenous infusion every 3 weeks for up to 6 cycles. The median duration of study treatment was 47 weeks in the crizotinib arm and 18 weeks in the chemotherapy arm. Patients could continue crizotinib treatment beyond the time of Response Evaluation Criteria in Solid Tumors (RECIST)-defined disease progression, as assessed by IRR, at the discretion of the investigator if the patient was still experiencing clinical benefit. Patients in the chemotherapy arm who completed 6 cycles were to continue in the study without further treatment, but have ongoing tumor assessments until RECIST-defined disease progression as determined by IRR. Patients in the chemotherapy arm who had RECIST-defined progression of disease as assessed by IRR had the option to receive crizotinib. One hundred forty-four (84%) patients received crizotinib after the randomization phase (128 patients through the crossover process and 16 patients as follow-up therapy).

Randomization was stratified by Eastern Cooperative Oncology Group (ECOG) performance status (0-1 vs. 2), race (Asian vs. non-Asian), and brain metastases (present vs. absent).

Baseline demographic and disease characteristics were similar between the crizotinib and chemotherapy treatment arms with regard to gender (female: 61% vs. 63% for crizotinib vs. chemotherapy, respectively), median age (52 years vs. 54 years), race (White: 53% vs. 50%, and Asian: 45% vs. 47%); smoking status (current smokers: 6% vs. 3%, former smokers: 33% vs. 32%, and never smokers: 62% vs. 65%), metastatic disease (98% in both treatment arms), tumor histology (adenocarcinoma: 92% vs. 93%), performance status (ECOG 0 or 1: 94% vs. 95%, and ECOG 2: 6% vs. 5%), and brain metastases (present 26% vs. 28%).

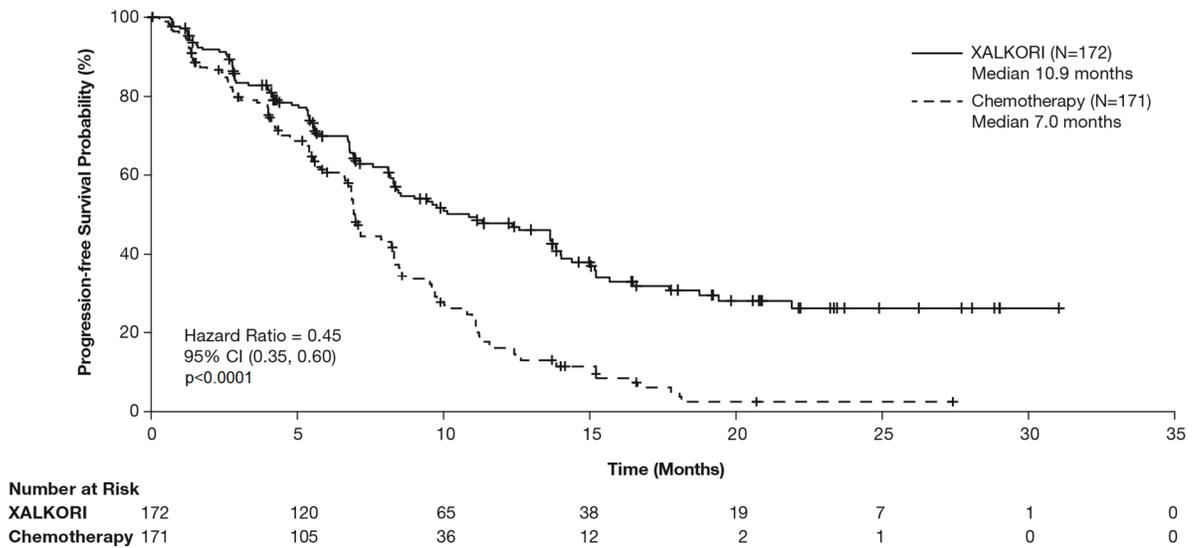
Crizotinib significantly prolonged PFS compared to chemotherapy as assessed by IRR. There was a numerical improvement in OS in the patients treated with crizotinib, although this improvement was not statistically significant. Efficacy data from randomized Phase 3 Study 1014 are summarized in Table 4, and the Kaplan-Meier curves for PFS and OS are shown in Figures 1 and 2, respectively.

**Table 4. Efficacy Results from Randomized Phase 3 Study 1014 (Full Analysis Population) in Patients with Previously Untreated ALK-positive Advanced NSCLC**

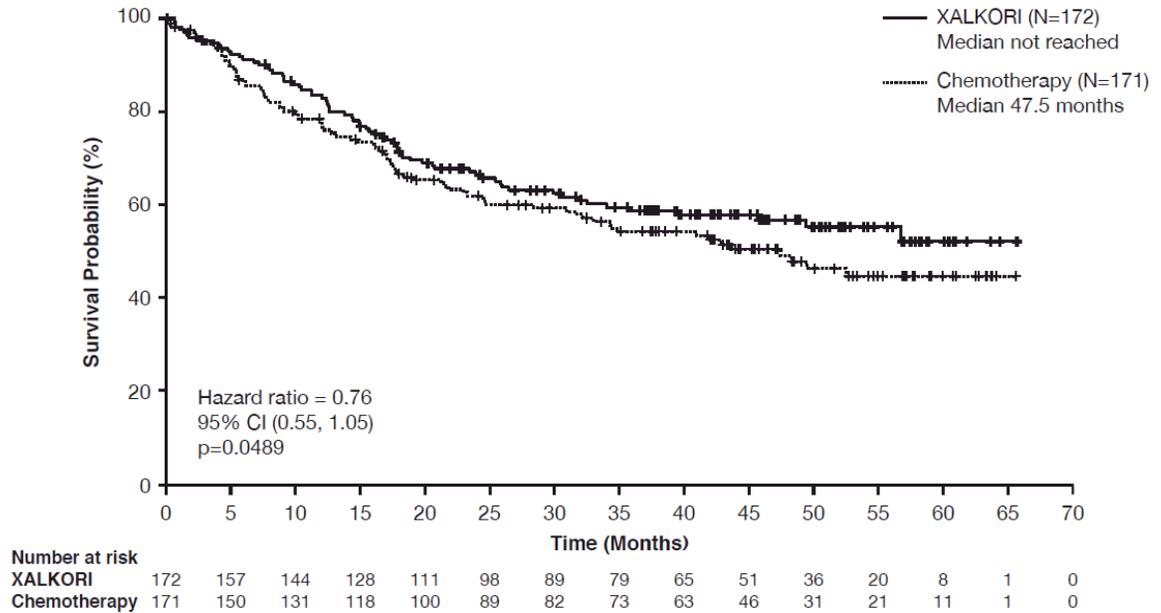
| <b>Response Parameter</b>   | <b>Crizotinib<br/>(N=172)</b> | <b>Chemotherapy<br/>(N=171)</b> |
|---|-------------------------------|---------------------------------|
| <b>Progression-free Survival (Based on IRR)</b>   |                               |                                 |
| Number with event, n (%)  | 100 (58%)                     | 137 (80%)                       |
| Median PFS in months (95% CI)   | 10.9 (8.3, 13.9)              | 7.0 <sup>a</sup> (6.8, 8.2)     |
| HR (95% CI) <sup>b</sup>  | 0.45 (0.35, 0.60)             |                                 |
| p-value <sup>c</sup>  | <0.0001                       |                                 |
| <b>Overall Survival<sup>d</sup></b>   |                               |                                 |
| Number of deaths, n (%)   | 71 (41%)                      | 81 (47%)                        |
| Median OS in months (95% CI)  | NR (45.8, NR)                 | 47.5 (32.2, NR)                 |
| HR (95% CI) <sup>b</sup>  | 0.76 (0.55, 1.05)             |                                 |
| p-value <sup>c</sup>  | 0.0489                        |                                 |
| 12-Month survival probability, <sup>d</sup><br>% (95% CI)   | 83.5 (77.0, 88.3)             | 78.4 (71.3, 83.9)               |
| 18-Month survival probability, <sup>d</sup><br>% (95% CI)   | 71.5 (64.0, 77.7)             | 66.6 (58.8, 73.2)               |
| 48-Month survival probability, <sup>d</sup><br>% (95% CI)   | 56.6 (48.3, 64.1)             | 49.1 (40.5, 57.1)               |
| <b>Objective Response Rate (based on IRR)</b>   |                               |                                 |
| Objective Response Rate % (95% CI)  | 74% (67, 81)                  | 45% <sup>e</sup> (37, 53)       |
| p-value <sup>f</sup>  | <0.0001                       |                                 |
| <b>Duration of Response</b>   |                               |                                 |
| Months <sup>g</sup> (95% CI)  | 11.3 (8.1, 13.8)              | 5.3 (4.1, 5.8)                  |
| Abbreviations: N/n=number of patients; CI=confidence interval; HR=hazard ratio; IRR=independent radiology review; NR=not reached; PFS=progression-free survival; OS=overall survival. |                               |                                 |

- \* PFS, Objective Response Rate and Duration of Response are based on the data cutoff date of 30 November 2013; OS is based on the last patient last visit date of 30 November 2016, and is based on a median follow up of approximately 46 months.
- Median PFS times were 6.9 months (95% CI: 6.6, 8.3) for pemetrexed/cisplatin (HR=0.49; p-value <0.0001 for crizotinib compared with pemetrexed/cisplatin) and 7.0 months (95% CI: 5.9, 8.3) for pemetrexed/carboplatin (HR=0.45; p-value <0.0001 for crizotinib compared with pemetrexed/carboplatin).
  - Based on the Cox proportional hazards stratified analysis.
  - Based on the stratified log-rank test (1-sided).
  - Updated based on final OS analysis. OS analysis was not adjusted for the potentially confounding effects of cross over (144 [84%] patients in the chemotherapy arm received subsequent crizotinib treatment).
  - ORRs were 47% (95% CI: 37, 58) for pemetrexed/cisplatin (p-value <0.0001 compared with crizotinib) and 44% (95% CI: 32, 55) for pemetrexed/carboplatin (p-value <0.0001 compared with crizotinib).
  - Based on the stratified Cochran-Mantel-Haenszel test (2-sided).
  - Estimated using the Kaplan-Meier method.

**Figure 1. Kaplan-Meier Curves for Progression-free Survival (Based on IRR) by Treatment Arm in Randomized Phase 3 Study 1014 (Full Analysis Population) in Patients with Previously Untreated ALK-positive Advanced NSCLC**



**Figure 2. Kaplan-Meier Curves for Overall Survival by Treatment Arm in Randomized Phase 3 Study 1014 (Full Analysis Population) in Patients with Previously Untreated ALK-positive Advanced NSCLC**



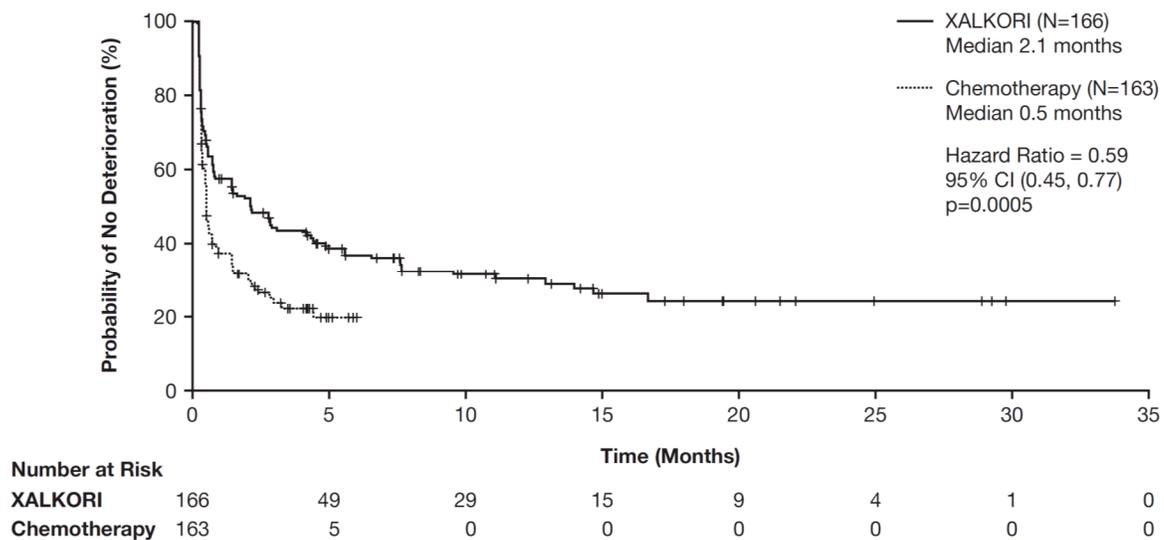
Based on IRR assessment, a total of 9 (23.1%) of the 39 patients in the crizotinib arm and 12 (30.0%) of the 40 patients in the chemotherapy arm with previously treated baseline brain metastases experienced progression of intracranial lesions or developed new intracranial lesions. For patients with previously treated baseline brain metastases, the median intracranial TTP (IC-TTP) was 15.7 months in the crizotinib arm and 12.5 months in the chemotherapy arm (HR=0.45 [95% CI: 0.19, 1.07]; 1-sided p-value=0.0315). A total of 16 (12.1%) of the 132 patients in the crizotinib arm and 14 (10.7%) of the 131 patients in the chemotherapy arm without baseline brain metastases developed new intracranial lesions. For patients without baseline brain metastases, the median IC-TTP was not reached in either the crizotinib or the chemotherapy arms (HR=0.69 [95% CI: 0.33, 1.45]; 1-sided p-value=0.1617).

Patient-reported symptoms and global QOL was collected using the EORTC QLQ-C30 and its lung cancer module (EORTC QLQ-LC13) at baseline (Day 1), Day 7 and Day 15 of Cycle 1, and Day 1 of each subsequent treatment cycle. A total of 166 patients in the crizotinib arm and 163 patients in the chemotherapy arm had completed the EORTC QLQ-C30 and LC-13 questionnaires at baseline and at least 1 postbaseline visit.

Time to Deterioration (TTD) was pre-specified as the time from randomization to the first occurrence of a  $\geq 10$ -point increase in scores from baseline in symptoms of pain (EORTC QLQ-LC13 pain in chest), cough (EORTC QLQ-LC13 cough), or dyspnea (EORTC QLQ-LC13 dyspnea). The median TTD in patient-reported pain in chest, dyspnea, or cough as a composite endpoint was 2.1 months (95% CI: 0.8 months, 4.2 months) in the crizotinib arm compared to 0.5 months (95% CI: 0.4 months, 0.7 months) in the chemotherapy arm. Treatment with crizotinib was associated with a significantly longer TTD in the symptoms of pain in chest, dyspnea, or cough compared

to chemotherapy (hazard ratio 0.59; 95% CI: 0.45, 0.77; Hochberg-adjusted log-rank 2-sided p-value=0.0005).

**Figure 3. Kaplan-Meier Plot of Time to Deterioration in Pain (in Chest), Dyspnea, or Cough (Composite Endpoint) by Treatment Arm (Patient-reported Outcome Evaluable Population) in Patients with Previously Untreated ALK-positive Advanced NSCLC**



The change from baseline scores was found to be significantly different between the 2 treatment arms, with a significantly greater improvement observed in global quality of life in the crizotinib arm compared to the chemotherapy arm (overall difference in change from baseline scores 13.8; p-value <0.0001).

### Previously Treated ALK-positive Advanced NSCLC – Randomized Phase 3 Study 1007

The use of single-agent crizotinib in the treatment of ALK-positive advanced NSCLC with or without brain metastases was investigated in a multicenter, multinational, randomized, open-label Phase 3 study (Study 1007). The primary objective of this study was to demonstrate that crizotinib 250 mg orally twice daily was superior to standard-of-care chemotherapy (pemetrexed 500 mg/m<sup>2</sup> or docetaxel 75 mg/m<sup>2</sup>) intravenously (IV) every 21 days in prolonging Progression-Free Survival (PFS) in patients with ALK-positive advanced NSCLC who had received 1 prior chemotherapy regimen. Patients were required to have ALK-positive NSCLC as identified by Fluorescence *In Situ* Hybridization (FISH) prior to randomization. Patients randomized to chemotherapy could cross over to receive crizotinib in Study 1005 upon RECIST-defined disease progression confirmed by independent radiology review (IRR). The primary efficacy endpoint was PFS with disease progression events determined by IRR. Secondary endpoints included ORR as determined by IRR, DR, OS, and PRO. The full analysis population for Study 1007 included 347 patients with ALK-positive advanced NSCLC. One hundred seventy-three (173) patients were randomized to the crizotinib arm (172 patients received crizotinib) and 174 patients were randomized to the chemotherapy arm (99 [58%] patients received pemetrexed and 72 [42%] patients received docetaxel). Randomization was stratified by ECOG performance status (0-1, 2), brain metastases

(present, absent), and prior EGFR tyrosine kinase inhibitor treatment (yes, no). The median duration of study treatment was 31 weeks in the crizotinib arm as compared to 12 weeks in the chemotherapy arm.

Patients could continue treatment as assigned beyond the time of RECIST-defined disease progression, as assessed by IRR, at the discretion of the investigator if the patient was still experiencing clinical benefit. Fifty eight of 84 (69%) patients treated with crizotinib and 17 of 119 (14%) patients treated with chemotherapy continued treatment for at least 3 weeks after objective disease progression.

Baseline demographic and disease characteristics for patients in this study were similar between the crizotinib and chemotherapy arms with regard to gender (female: 57% vs 55% for crizotinib vs chemotherapy, respectively), median age (51 years vs 49 years), race (White: 52% in both treatment arms, and Asian: 46% vs 45%), smoking status (current smokers: 3% vs 5%, former smokers: 34% vs 31%, and never smokers: 62% vs 64%), metastatic disease (95% vs 91%), tumor histology (adenocarcinoma: 94% vs 92%), performance status (ECOG 0 or 1: 89% vs 91%, ECOG 2: 11% vs 9%), and brain metastases (present: 35% in both treatment arms).

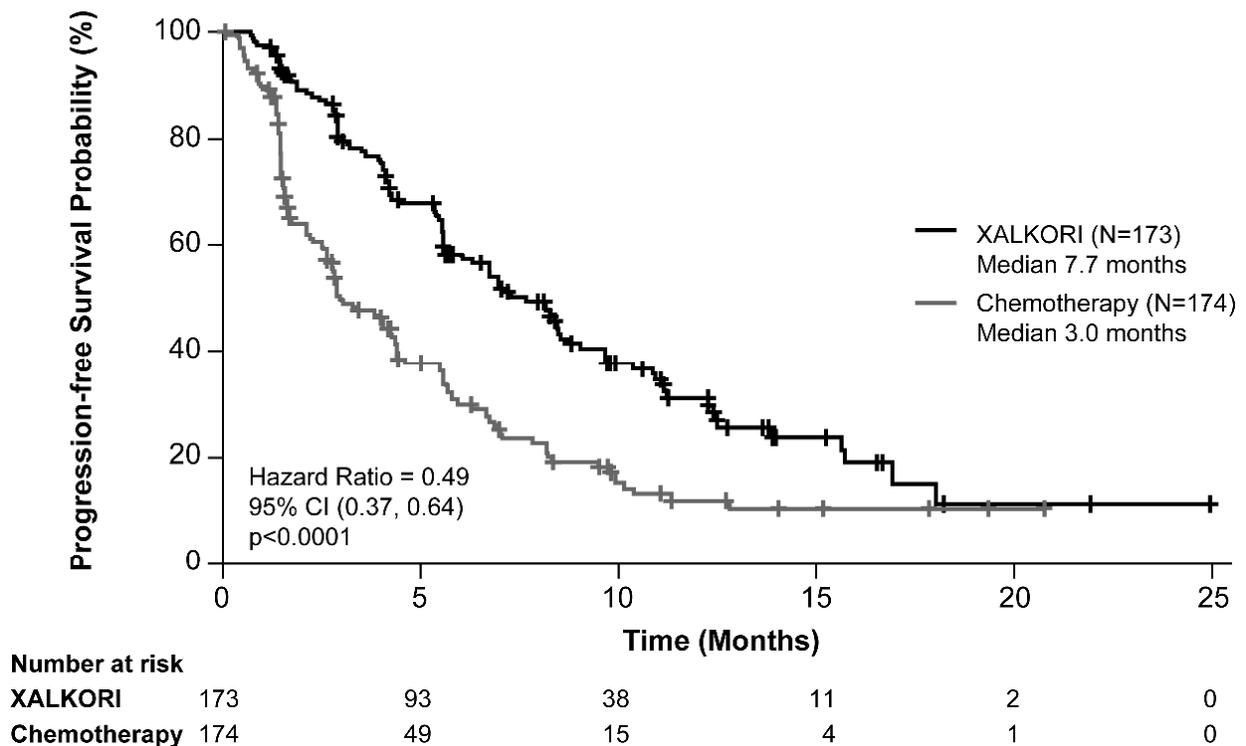
Crizotinib significantly prolonged PFS compared to chemotherapy as assessed by IRR. Efficacy data from randomized Phase 3 Study 1007 are summarized in Table 5, and the Kaplan-Meier curve for PFS is shown in Figure 4.

**Table 5. Efficacy Results from Randomized Phase 3 Study 1007 (Full Analysis Population) in Patients with Previously Treated ALK-positive Advanced NSCLC\***

| <b>Response Parameter</b>   | <b>Crizotinib<br/>(N=173)</b> | <b>Chemotherapy<br/>(N=174)</b> |
|---|-------------------------------|---------------------------------|
| <b>Progression-free Survival (Based on IRR)</b>   |                               |                                 |
| Number with event, n (%)  | 100 (58%)                     | 127 (73%)                       |
| Median PFS in months (95% CI)   | 7.7 (6.0, 8.8)                | 3.0 <sup>a</sup> (2.6, 4.3)     |
| HR (95% CI) <sup>b</sup>  | 0.49 (0.37, 0.64)             |                                 |
| p-value <sup>c</sup>  | <0.0001                       |                                 |
| <b>Overall Survival<sup>d</sup></b>   |                               |                                 |
| Number of deaths, n (%)   | 116 (67%)                     | 126 (72%)                       |
| Median OS in months (95% CI)  | 21.7 (18.9, 30.5)             | 21.9 (16.8, 26.0)               |
| HR (95% CI) <sup>b</sup>  | 0.85 (0.66, 1.10)             |                                 |
| p-value <sup>c</sup>  | 0.1145                        |                                 |
| <b>Objective Response Rate (based on IRR)</b>   |                               |                                 |
| Objective Response Rate % (95% CI)  | 65% (58, 72)                  | 20% <sup>e</sup> (14, 26)       |
| p-value <sup>f</sup>  | <0.0001                       |                                 |
| <b>Duration of Response</b>   |                               |                                 |
| Median <sup>g</sup> , months (95% CI)   | 7.4 (6.1, 9.7)                | 5.6 (3.4, 8.3)                  |
| Abbreviations: N/n=number of patients; CI=confidence interval; HR=hazard ratio; IRR=independent radiology review; PFS=progression-free survival; OS=overall survival. |                               |                                 |
| * PFS, Objective Response Rate and Duration of Response are based on the data cutoff date of 30 March 2012; OS is based on the data cutoff date of 31 August 2015.    |                               |                                 |
| a. Median PFS times were 4.2 months (95% CI: 2.8, 5.7) for pemetrexed (HR=0.59; p-value=0.0004 for  |                               |                                 |

- XALKORI<sup>®</sup> compared with pemetrexed) and 2.6 months (95% CI: 1.6, 4.0) for docetaxel (HR=0.30; p-value <0.0001 for XALKORI<sup>®</sup> compared with docetaxel).
- b. Based on the Cox proportional hazards stratified analysis.
- c. Based on the stratified log-rank test (1-sided).
- d. Updated based on final OS analysis. OS analysis was not adjusted for the potentially confounding effects of cross over.
- e. ORRs were 29% (95% CI: 21, 39) for pemetrexed (p-value <0.0001 compared with XALKORI<sup>®</sup>) and 7% (95% CI: 2, 16) for docetaxel (p-value <0.0001 compared with XALKORI<sup>®</sup>).
- f. Based on the stratified Cochran-Mantel-Haenszel test (2-sided).
- g. Estimated using the Kaplan-Meier method.

**Figure 4. Kaplan-Meier Curves for Progression-free Survival (Based on IRR) by Treatment Arm in Randomized Phase 3 Study 1007 (Full Analysis Population) in Patients with Previously Treated ALK-positive Advanced NSCLC**



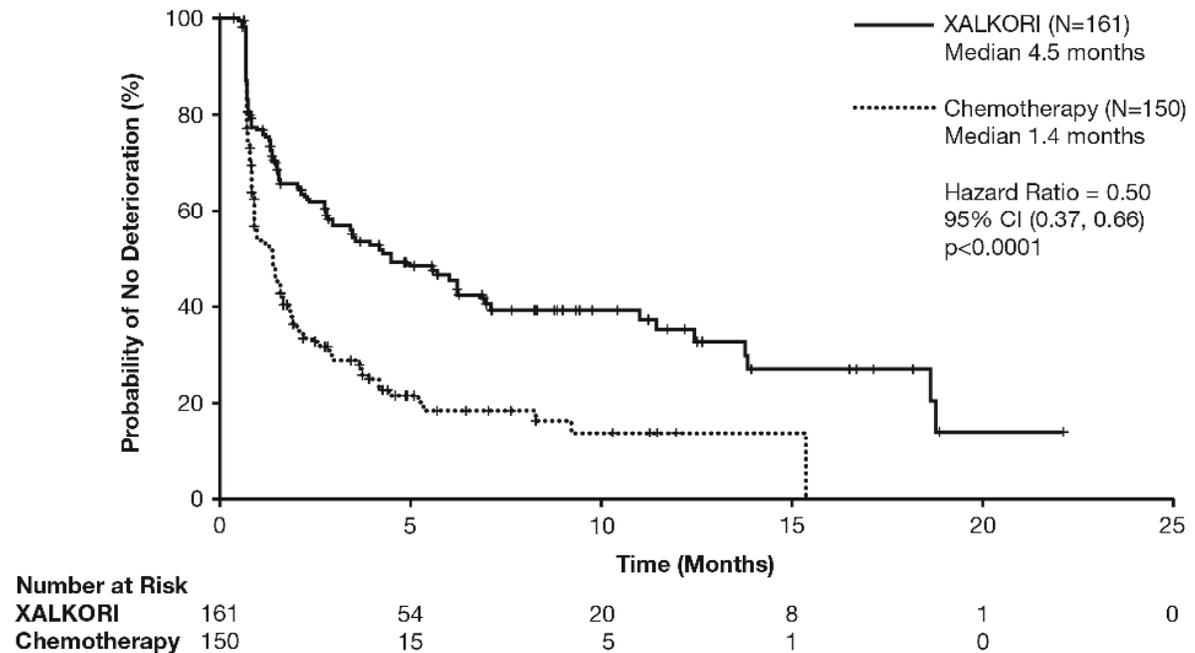
Patient reported symptoms and global QOL was collected using the EORTC QLQ-C30 and its lung cancer module (EORTC QLQ-LC13) at baseline (Day 1 Cycle 1) and Day 1 of each subsequent treatment cycle. A total of 162 patients in the crizotinib arm and 151 patients in the chemotherapy arm had completed the EORTC QLQ-C30 and LC13 questionnaires at baseline and at least 1 postbaseline visit.

TTD was prespecified as the time from randomization to the first occurrence of a  $\geq 10$ -point increase in scores from baseline in symptoms of pain (EORTC QLQ-LC13 pain in chest), cough (EORTC QLQ-LC13 cough), or dyspnea (EORTC QLQ-LC13 dyspnea). The median TTD in patient-reported pain in chest, dyspnea, or cough as a composite endpoint was 4.5 months (95% CI: 3.0 months, 6.9 months) in the crizotinib arm compared to 1.4 months (95% CI: 1.0 months, 1.6 months) in the chemotherapy arm. Treatment with crizotinib was associated with a significantly longer TTD in the

symptoms of pain in chest, dyspnea, or cough compared to chemotherapy (hazard ratio 0.50; 95% CI: 0.37, 0.66; Hochberg-adjusted log-rank p-value <0.0001).

The change from baseline scores was found to be significantly different between the 2 treatment arms, with a significantly greater improvement observed in global quality of life in the crizotinib arm compared to the chemotherapy arm (overall difference in change from baseline scores 9.84; p-value <0.0001).

**Figure 5. Kaplan-Meier Plot of Time to Deterioration in Pain (in Chest), Dyspnea, or Cough (Composite Endpoint) by Treatment Arm (Patient-Reported Outcome Evaluable Population) in Patients with Previously Treated ALK-positive Advanced NSCLC**



### Single-Arm Studies in ALK-positive Advanced NSCLC

The use of single-agent crizotinib in the treatment of ALK-positive advanced NSCLC with or without brain metastases was investigated in 2 multicenter, multinational, single-arm studies (Studies 1001 and 1005). Patients enrolled into these studies had received prior systemic therapy, with the exception of 16 patients in Study 1001 and 3 patients in Study 1005 who had no prior systemic treatment for locally advanced or metastatic disease. The primary efficacy endpoint in both studies was ORR according to RECIST. Secondary endpoints included Time to Tumor Response (TTR), DR, PFS, and OS. Patients received crizotinib 250 mg orally twice daily.

In Study 1001 (N=119), the demographic characteristics were 50% female; median age 51 years; baseline ECOG performance status of 0 or 1 (87%) or 2 (12%), 62% White and 29% Asian; <1% current smokers, 27% former smokers, and 72% never smokers. The disease characteristics were 96% metastatic, 98% adenocarcinoma histology, and 13% with no prior systemic therapy for metastatic disease.

In Study 1005 (N=934), the demographic characteristics were 57% female; median age 53 years; baseline ECOG performance status of 0/1 (82%) or 2/3 (18%), 52% White and 44% Asian; and, 4% current smokers, 30% former smokers, and 66% never smokers. The disease characteristics were 92% metastatic, 94% adenocarcinoma histology.

In Study 1001, patients with advanced NSCLC were required to have ALK-positive tumors prior to entering the clinical trial. ALK-positive NSCLC was identified using a number of local clinical trial assays. One hundred nineteen patients with ALK-positive advanced NSCLC were enrolled into Study 1001 at the time of data cutoff for the PFS and ORR analyses. The median duration of treatment was 32 weeks. There were 2 complete responses and 69 partial responses for an ORR of 61%. The median DR was 48 weeks. Fifty-five percent of objective tumor responses were achieved during the first 8 weeks of treatment. Study 1001 OS data were updated based on 154 ALK-positive advanced NSCLC patients. The median OS at the time of data cutoff was 28.9 months (95% CI: 21.1, 40.1).

In Study 1005, patients with advanced NSCLC were required to have ALK-positive tumors prior to entering the clinical trial. For most patients, ALK-positive NSCLC was identified by FISH. Nine hundred thirty-four patients with ALK-positive advanced NSCLC were treated with crizotinib in Study 1005 at the time of data cutoff for the PFS and ORR analyses. The median duration of treatment for these patients was 23 weeks. Patients could continue treatment as assigned beyond the time of RECIST-defined disease progression at the discretion of the investigator if the benefit/risk assessment justified continuation of treatment. Seventy-seven of 106 patients (73%) continued crizotinib treatment for at least 3 weeks after objective disease progression.

Seven hundred sixty-five patients with ALK-positive advanced NSCLC from Study 1005 were both evaluable for response and identified by the same FISH assay used in randomized Phase 3 Study 1007. There were 8 complete responses and 357 partial responses for an ORR of 48%. The median DR was 47 weeks. Eighty-three percent of objective tumor responses were achieved within the first 12 weeks of treatment. Study 1005 OS data were updated based on 905 ALK-positive advanced NSCLC patients identified by the same FISH assay used in randomized Phase 3 Study 1007. The median OS at the time of data cutoff was 21.5 months (95% CI: 19.3, 23.6).

Efficacy data from Studies 1001 and 1005 are provided in Table 6.

**Table 6. ALK-positive Advanced NSCLC Efficacy Results from Studies 1001 and 1005**

| <b>Efficacy Parameter</b>   | <b>Study 1001</b>        | <b>Study 1005</b>           |
|---|--------------------------|-----------------------------|
|   | <b>N=119<sup>a</sup></b> | <b>N=765<sup>a</sup></b>    |
| ORR <sup>b</sup> [% (95% CI)]   | 61 (52, 70)              | 48 (44, 51)                 |
| TTR [median (range)] weeks  | 7.7 (4, 40)              | 6.1 (3, 49)                 |
| DR <sup>c</sup> [median (95% CI)] weeks   | 48.1 (36, not reached)   | 47.3 (36, 54)               |
| PFS <sup>c</sup> [median (95% CI)] months   | 10.0 (8.2, 14.7)         | 7.8 (6.9, 9.5) <sup>d</sup> |
|   | <b>N=154<sup>e</sup></b> | <b>N=905<sup>e</sup></b>    |
| Number of deaths, n (%)   | 83 (54%)                 | 504 (56%)                   |
| OS <sup>e</sup> [median (95% CI)] months  | 28.9 (21.1, 40.1)        | 21.5 (19.3, 23.6)           |
| Abbreviations: N/n=number of patients; CI=confidence interval; ORR=objective response rate; TTR=time to tumor response; DR=duration of response; PFS=progression-free survival; OS=overall survival.<br>a. Per data cutoff dates 15 September 2010 (Study 1001) and 15 February 2012 (Study 1005).<br>b. Three patients were not evaluable for response in Study 1001, and 42 patients were not evaluable for response in Study 1005.<br>c. Estimated using the Kaplan-Meier method.<br>d. PFS data from Study 1005 included 807 patients in the safety analysis population who were identified by the FISH assay (per data cutoff date 15 February 2012).<br>e. Per data cutoff date 30 November 2013. |                          |                             |

### **ROS1-Positive Advanced NSCLC**

The use of single-agent crizotinib in the treatment of ROS1-positive advanced NSCLC was investigated in multicenter, multinational, single-arm Study 1001. A total of 53 ROS1-positive advanced NSCLC patients were enrolled in the study at the time of data cutoff, including 46 patients with previously treated ROS1-positive advanced NSCLC and 7 patients who had no prior systemic treatment. The primary efficacy endpoint was ORR according to RECIST. Secondary endpoints included TTR, DR, PFS, and OS. Patients received crizotinib 250 mg orally twice daily.

The demographic characteristics were 57% female; median age 55 years; baseline ECOG performance status of 0 or 1 (98%) or 2 (2%), 57% White and 40% Asian; 25% former smokers, and 75% never smokers. The disease characteristics were 94% metastatic, 96% adenocarcinoma histology, and 13% with no prior systemic therapy for metastatic disease.

In Study 1001, patients were required to have ROS1-positive advanced NSCLC prior to entering the clinical trial. For most patients, ROS1-positive NSCLC was identified by FISH. The median duration of treatment was 22.4 months (95% CI: 15.0, 35.9). There were 6 complete responses and 32 partial responses for an ORR of 72% (95% CI: 58%, 83%). The median DR was 24.7 months (95% CI: 15.2, 45.3). Fifty percent of objective tumor responses were achieved during the first 8 weeks of treatment. The median PFS at the time of data cutoff was 19.3 months (95% CI: 15.2, 39.1). The median OS at the time of data cutoff was 51.4 months (95% CI: 29.3, NR).

Efficacy data from ROS1-positive advanced NSCLC patients from Study 1001 are provided in Table 7.

**Table 7. ROS1-Positive Advanced NSCLC Efficacy Results from Study 1001**

| Efficacy Parameter  | Study 1001              |
|---|-------------------------|
|   | <b>N=53<sup>a</sup></b> |
| ORR [% (95% CI)]  | 72 (58, 83)             |
| TTR [median (range)] weeks  | 8 (4, 104)              |
| DR <sup>b</sup> [median (95% CI)] months  | 24.7 (15.2, 45.3)       |
| PFS <sup>b</sup> [median (95% CI)] months   | 19.3 (15.2, 39.1)       |
| OS <sup>b</sup> [median (95% CI)] months  | 51.4 (29.3, NR)         |
| Abbreviations: N=number of patients; CI=confidence interval; ORR=objective response rate; NR=not reached; TTR=time to tumor response; DR=duration of response; OS=overall survival; PFS=progression-free survival.<br>OS is based on a median follow up of approximately 63 months.<br>a. Per data cutoff date 30 June 2018.<br>b. Estimated using the Kaplan-Meier method. |                         |

**Elderly** (see also Sections 4.2 Dosage and Method of Administration and 5.2 Pharmacokinetic Properties)

Of 171 ALK-positive NSCLC patients treated with crizotinib in randomized Phase 3 Study 1014, 22 (13%) were 65 years or older, and of 109 ALK-positive patients treated with crizotinib who crossed over from the chemotherapy arm, 26 (24%) were 65 years or older. Of 172 ALK-positive patients treated with crizotinib in randomized Phase 3 Study 1007, 27 (16%) were 65 years or older. Of 154 and 1063 ALK-positive NSCLC patients in single arm studies 1001 and 1005, 22 (14%) and 173 (16)% were 65 years or older, respectively. In ALK-positive NSCLC patients, the frequency of adverse reactions was generally similar for patients <65 years of age and patients ≥65 years of age with the exception of edema and constipation, which were reported with greater frequency in Study 1014 among patients treated with crizotinib ≥65 years of age. No overall differences in efficacy were observed in comparison with younger patients. Of the 53 ROS1-positive NSCLC patients in single arm Study 1001, 15 (28%) were 65 years of older.

**5.2 Pharmacokinetic Properties**

**Absorption**

Following oral single dose administration in the fasted state, crizotinib is absorbed with median time to achieve peak concentrations of 4 to 6 hours. Following crizotinib 250 mg twice daily, steady state was reached within 15 days and remained stable, with a median accumulation ratio of 4.8. The absolute bioavailability of crizotinib was determined to be 43% (range: 32% to 66%) following the administration of a single 250 mg oral dose.

A high-fat meal reduced crizotinib area under the plasma concentration-time curve from time zero to infinity (AUC<sub>inf</sub>) and maximum observed plasma concentration (C<sub>max</sub>) by approximately 14% when a 250 mg single dose was given to healthy volunteers.

Crizotinib can be administered with or without food (see Section 4.2 Dosage and Method of Administration).

### **Distribution**

The geometric mean volume of distribution ( $V_{ss}$ ) of crizotinib was 1,772 L following intravenous administration of a 50 mg dose, indicating extensive distribution into tissues from the plasma.

Binding of crizotinib to human plasma proteins *in vitro* is 91% and is independent of drug concentration. *In vitro* studies suggested that crizotinib is a substrate for P-glycoprotein (P-gp). The blood-to-plasma concentration ratio is approximately 1.

### **Metabolism**

*In vitro* studies demonstrated that CYP3A4/5 were the major enzymes involved in the metabolic clearance of crizotinib. The primary metabolic pathways in humans were oxidation of the piperidine ring to crizotinib lactam and *O*-dealkylation, with subsequent Phase 2 conjugation of *O*-dealkylated metabolites.

*In vitro* studies in human liver microsomes demonstrated that crizotinib is a time-dependent inhibitor of CYP2B6 and CYP3A.

### **Elimination**

Following single doses of crizotinib, the apparent plasma terminal half-life of crizotinib was 42 hours in patients.

Following the administration of a single 250 mg radiolabeled crizotinib dose to healthy subjects, 63% and 22% of the administered dose was recovered in feces and urine, respectively. Unchanged crizotinib represented approximately 53% and 2.3% of the administered dose in feces and urine, respectively.

The mean apparent clearance (CL/F) of crizotinib was lower at steady state (60 L/hr) after 250 mg twice daily than that after a single 250 mg oral dose (100 L/hr), which was likely due to autoinhibition of CYP3A by crizotinib after multiple dosing.

### **Drug Interactions**

#### *Coadministration of Crizotinib and CYP3A Substrates*

Crizotinib has been identified as an inhibitor of CYP3A both *in vitro* and *in vivo*. Following 28 days of crizotinib dosing at 250 mg taken twice daily in cancer patients, the oral midazolam  $AUC_{inf}$  was 3.7-fold (90% CI: 2.63-5.07) those seen when midazolam was administered alone, suggesting that crizotinib is a moderate inhibitor of CYP3A (see Section 4.5 Interaction with Other Medicinal Products and Other Forms of Interaction).

### *Coadministration of Crizotinib and CYP3A Inhibitors*

Coadministration of crizotinib (250 mg once daily) with itraconazole (200 mg once daily), a strong CYP3A inhibitor, resulted in 57% and 33% increases in crizotinib steady-state area under the plasma concentration-time curve from 0 hour to time tau, the dosing interval ( $AUC_{\tau}$ ) and  $C_{\max}$ , respectively, compared to when crizotinib was given alone (see Section 4.5 Interaction with Other Medicinal Products and Other Forms of Interaction).

### *Coadministration of Crizotinib and CYP3A Inducers*

Co-administration of crizotinib (250 mg twice daily) with rifampin (600 mg once daily), a strong CYP3A inducer, resulted in 84% and 79% decreases in crizotinib steady-state  $AUC_{\tau}$  and  $C_{\max}$ , respectively, compared to when crizotinib was given alone (see Section 4.5 Interaction with other Medicinal Products and Other Forms of Interaction).

### *Coadministration of Crizotinib with Agents that Increase Gastric pH*

The aqueous solubility of crizotinib is pH dependent, with low (acidic) pH resulting in higher solubility. Administration of a single 250 mg crizotinib dose following treatment with esomeprazole 40 mg once daily for 5 days resulted in an approximately 10% decrease in crizotinib total exposure ( $AUC_{\text{inf}}$ ) and no change in peak exposure ( $C_{\max}$ ); the extent of the change in total exposure was not clinically meaningful. Therefore, starting dose adjustment is not required when crizotinib is coadministered with agents that increase gastric pH (such as proton-pump inhibitors, H<sub>2</sub> blockers, or antacids).

### *Coadministration with other CYP Substrates*

*In vitro* studies indicated that clinical drug-drug interactions are unlikely to occur as a result of crizotinib-mediated inhibition of the metabolism of drugs that are substrates for CYP1A2, CYP2C8, CYP2C9, CYP2C19, or CYP2D6.

Crizotinib is an inhibitor of CYP2B6 *in vitro*. Therefore, crizotinib may have the potential to increase plasma concentrations of coadministered drugs that are predominantly metabolized by CYP2B6. *In vitro* studies in human hepatocytes indicated that clinical drug-drug interactions are unlikely to occur as a result of crizotinib-mediated induction of the metabolism of drugs that are substrates for CYP1A2, CYP2B6, CYP2C8, CYP2C9, CYP2C19, or CYP3A.

### *Coadministration with UGT Substrates*

*In vitro* studies indicated that clinical drug-drug interactions are unlikely to occur as a result of crizotinib-mediated inhibition of the metabolism of drugs that are substrates for uridine diphosphate glucuronosyltransferase (UGT)1A1, UGT1A4, UGT1A6, UGT1A9 or UGT2B7.

### *Coadministration with Drugs that are Substrates of Transporters*

Crizotinib is an inhibitor of P-glycoprotein (P-gp) *in vitro*. Therefore, crizotinib may have the potential to increase plasma concentrations of co-administered drugs that are substrates of P-gp.

Crizotinib is an inhibitor of OCT1 and OCT2 *in vitro*. Therefore, crizotinib may have the potential to increase plasma concentrations of coadministered drugs that are substrates of OCT1 or OCT2.

*In vitro*, crizotinib did not inhibit the human hepatic uptake transport proteins organic anion transporting polypeptide (OATP)1B1 or OATP1B3, or the renal uptake transport proteins organic anion transporter (OAT)1 or OAT3 at clinically relevant concentrations. Therefore, clinical drug-drug interactions are unlikely to occur as a result of crizotinib-mediated inhibition of the hepatic or renal uptake of drugs that are substrates for these transporters.

### *Effect on Other Transport Proteins*

*In vitro*, crizotinib is not an inhibitor of BSEP at clinically relevant concentrations.

## **Pharmacokinetics in Special Patient Groups**

*Hepatic Impairment:* Crizotinib is extensively metabolized in the liver. Patients with mild (either AST >ULN and total bilirubin ≤ULN or any AST and total bilirubin >ULN but ≤1.5×ULN), moderate (any AST and total bilirubin >1.5×ULN and ≤3×ULN), or severe (any AST and total bilirubin >3×ULN) hepatic impairment or normal (AST and total bilirubin ≤ULN) hepatic function, who were matched controls for mild or moderate hepatic impairment, were enrolled in an open-label, non-randomized clinical study (Study 1012), based on NCI classification.

Following crizotinib 250 mg twice daily dosing, patients with mild hepatic impairment (N=10) showed similar systemic crizotinib exposure at steady state compared to patients with normal hepatic function (N=8), with geometric mean ratios for area under the plasma concentration-time curve as daily exposure at steady state (AUC<sub>daily</sub>) and C<sub>max</sub> of 91.1% and 91.2%, respectively. No starting dose adjustment is recommended for patients with mild hepatic impairment.

Following crizotinib 200 mg twice daily dosing, patients with moderate hepatic impairment (N=8) showed higher systemic crizotinib exposure compared to patients with normal hepatic function (N=9) at the same dose level, with geometric mean ratios for AUC<sub>daily</sub> and C<sub>max</sub> of 150% and 144%, respectively. However, the systemic crizotinib exposure in patients with moderate hepatic impairment at the dose of 200 mg twice daily was comparable to that observed from patients with normal hepatic function at a dose of 250 mg twice daily, with geometric mean ratios for AUC<sub>daily</sub> and C<sub>max</sub> of 114% and 109%, respectively.

The systemic crizotinib exposure parameters AUC<sub>daily</sub> and C<sub>max</sub> in patients with severe hepatic impairment (N=6) receiving a crizotinib dose of 250 mg once daily were

approximately 64.7% and 72.6%, respectively, of those from patients with normal hepatic function receiving a dose of 250 mg twice daily.

An adjustment of the dose of crizotinib is recommended when administering crizotinib to patients with moderate or severe hepatic impairment (see Sections 4.2 Dosage and Method of Administration and 4.4 Special Warnings and Precautions for Use).

*Renal Impairment:* Patients with mild ( $60 \leq CL_{cr} < 90$  mL/min) and moderate ( $30 \leq CL_{cr} < 60$  mL/min) renal impairment were enrolled in single-arm Studies 1001 and 1005. The effect of renal function, as measured by baseline  $CL_{cr}$  on observed crizotinib steady-state trough concentrations ( $C_{trough, ss}$ ) was evaluated. In Study 1001, the adjusted geometric mean of plasma  $C_{trough, ss}$  in mild (N=35) and moderate (N=8) renal impairment patients were 5.1% and 11% higher, respectively, than those in patients with normal renal function. In Study 1005, the adjusted geometric mean  $C_{trough, ss}$  of crizotinib in mild (N=191) and moderate (N=65) renal impairment groups were 9.1% and 15% higher, respectively, than those in patients with normal renal function. In addition, the population pharmacokinetic analysis from Studies 1001, 1005 and 1007 indicated  $CL_{cr}$  did not have a clinically meaningful effect on the pharmacokinetics of crizotinib. Due to the small size of the increases in crizotinib exposure (5%-15%), no starting dose adjustment is recommended for patients with mild or moderate renal impairment. After a single 250-mg dose in subjects with severe renal impairment ( $CL_{cr} < 30$  mL/min) not requiring peritoneal dialysis or hemodialysis, crizotinib  $AUC_{inf}$  and  $C_{max}$  increased by 79% and 34%, respectively, compared to those with normal renal function. An adjustment of the dose of crizotinib is recommended when administering crizotinib to patients with severe renal impairment not requiring peritoneal dialysis or hemodialysis (see Sections 4.2 Dosage and Method of Administration and 4.4 Special Warnings and Precautions for Use).

*Age:* Based on the population pharmacokinetic analysis from Studies 1001, 1005 and 1007, age has no effect on crizotinib pharmacokinetics (see Sections 4.2 Dosage and Method of Administration and 5.1 Pharmacodynamic Properties).

*Body Weight and Gender:* Based on the population pharmacokinetic analysis from Studies 1001, 1005 and 1007, there was no clinically meaningful effect of body weight or gender on crizotinib pharmacokinetics.

*Ethnicity:* Based on the population pharmacokinetic analysis from Studies 1001, 1005 and 1007, the predicted area under the plasma concentration-time curve at steady state ( $AUC_{ss}$ ) (95% CI) was 23%-37% higher in Asian patients (n=523) than in non-Asian patients (n=691).

## Cardiac Electrophysiology

The QT interval prolongation potential of crizotinib was assessed in patients with either ALK-positive or ROS1-positive NSCLC who received crizotinib 250 mg twice daily. Serial ECGs in triplicate were collected following a single dose and at steady state to evaluate the effect of crizotinib on QT intervals. Thirty-four of 1619 patients (2.1%) with at least 1 postbaseline ECG assessment were found to have QTcF (corrected QT by the Fridericia method)  $\geq 500$  msec, and 79 of 1585 patients (5.0%) with a baseline and at least 1 postbaseline ECG assessment had an increase from baseline QTcF  $\geq 60$  msec by automated machine-read evaluation of ECG (see Section 4.4 Special Warnings and Precautions for Use).

An ECG substudy using blinded manual ECG measurements was conducted in 52 ALK-positive NSCLC patients who received crizotinib 250 mg twice daily. A central tendency analysis indicated that a QTc effect  $\geq 20$  msec can be excluded. A pharmacokinetic/pharmacodynamic analysis suggested a relationship between crizotinib plasma concentration and QTc. In addition, a decrease in heart rate was found to be associated with increasing crizotinib plasma concentration (see Section 4.4 Special Warnings and Precautions for Use).

## 5.3 Preclinical Safety Data

### Genotoxicity

Crizotinib was not mutagenic *in vitro* in the bacterial reverse mutation (Ames) assay. Crizotinib was aneugenic in an *in vitro* micronucleus assay in Chinese Hamster Ovary cells and in an *in vitro* human lymphocyte chromosome aberration assay. Small increases of structural chromosomal aberrations at cytotoxic concentrations were seen in human lymphocytes. In the rat bone marrow *in vivo*, increases in micronuclei were only seen at doses significantly exceeding the expected human exposure. Increases in micronuclei were observed in rats at 250 mg/kg/day (approximately 4 times the AUC at the recommended human dose).

### Carcinogenicity

Carcinogenicity studies with crizotinib have not been performed.

### Fertility

No specific studies with crizotinib have been conducted in animals to evaluate the effect on fertility; however, crizotinib is considered to have the potential to impair reproductive function and fertility in humans based on findings in repeat-dose toxicity studies in the rat. Findings observed in the male reproductive tract included testicular pachytene spermatocyte degeneration in rats given  $\geq 50$  mg/kg/day for 28 days (approximately equivalent to human clinical exposure based on AUC). Findings observed in the female reproductive tract included single-cell necrosis of ovarian follicles of a rat given 500 mg/kg/day for 3 days.

## 6.0 PHARMACEUTICAL PARTICULARS

### 6.1 Shelf-Life

Please see outer package for the expiry date.

## 6.2 Storage Condition

Store at temperatures not exceeding 30°C.

## 6.3 Availability

Crizotinib (Xalkori®) 200 mg Capsule: White opaque HDPE plastic bottle of 60 capsules  
Crizotinib (Xalkori®) 250 mg Capsule: White opaque HDPE plastic bottle of 60 capsules

## 6.4 Incompatibilities

Not applicable.

## 6.5 Special Precautions for Disposal and Other Handling

No special requirements.

Any unused product or waste material should be disposed of in accordance with local requirements.

## 7.0 FDA REGISTRATION NUMBER

Crizotinib (Xalkori®) 200 mg Capsule: DR-XY43853  
Crizotinib (Xalkori®) 250 mg Capsule: DR-XY43852

## 8.0 DATE OF FIRST AUTHORIZATION

Crizotinib (Xalkori®) 200 mg Capsule: 30 October 2014  
Crizotinib (Xalkori®) 250 mg Capsule: 30 October 2014

Keep out of reach of children

**For suspected adverse drug reaction, report to the FDA: [www.fda.gov.ph](http://www.fda.gov/ph)**

**Seek medical attention immediately at the first sign of any adverse drug reaction.**

**CAUTION:** Foods, Drugs, Devices, and Cosmetics Act prohibits dispensing without prescription.

### **Manufactured by:**

Pfizer Manufacturing Deutschland GmbH  
Betriebsstätte, Freiburg  
Mooswaldallee 1  
79090 Freiburg, Baden-Wurtemberg  
Germany

**Marketing Authorization Holder:**

Pfizer, Inc.  
19F – 20F, 8 Rockwell Building  
Hidalgo Drive, Rockwell Center, Poblacion  
Makati City, 1210 Metro Manila  
Philippines

Under Authority of Pfizer, Inc., N.Y., U.S.A.

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