

# SUMMARY OF PRODUCT CHARACTERISTICS

## 1 NAME OF THE MEDICINAL PRODUCT

Adempas 0.5 mg film-coated tablets

## 2 QUALITATIVE AND QUANTITATIVE COMPOSITION

Each film-coated tablet contains 0.5 mg of riociguat.

Excipient with known effect

Each 0.5 mg film-coated tablet contains 37.8 mg lactose (as monohydrate).

For the full list of excipients, see section 6.1.

## 3 PHARMACEUTICAL FORM

Film-coated tablet (tablet).

- *0.5 mg tablet*: white, round, biconvex tablets of 6 mm, marked with the Bayer cross on one side and 0.5 and an “R” on the other side.

## 4 CLINICAL PARTICULARS

### 4.1 Therapeutic indications

Chronic thromboembolic pulmonary hypertension (CTEPH)

Adempas is indicated for the treatment of adult patients with WHO Functional Class (FC) II to III with

- inoperable CTEPH,
- persistent or recurrent CTEPH after surgical treatment, to improve exercise capacity (see section 5.1).

## Pulmonary arterial hypertension (PAH)

### *Adults*

Adempas, as monotherapy or in combination with endothelin receptor antagonists, is indicated for the treatment of adult patients with pulmonary arterial hypertension (PAH) with WHO Functional Class (FC) II to III to improve exercise capacity (see section 5.1).

### *Paediatrics*

Adempas is indicated for the treatment of PAH in paediatric patients aged 6 to less than 18 years with WHO Functional Class (FC) II to III in combination with endothelin receptor antagonists (see section 5.1).

## **4.2 Posology and method of administration**

Treatment should only be initiated and monitored by a physician experienced in the treatment of CTEPH or PAH.

### **Posology**

#### Starting dose

The recommended starting dose is 1 mg 3 times daily for 2 weeks. Tablets should be taken 3 times daily approximately 6 to 8 hours apart (see section 5.2).

#### Titration

##### *Adult patients*

Dose should be increased in 2-week intervals by 0.5 mg 3 times daily to a maximum of 2.5 mg 3 times daily, if systolic blood pressure is  $\geq 95$  mmHg and the patient has no signs or symptoms of hypotension. In some PAH patients, an adequate response on the 6-minute walk distance (6MWD) may be reached at a dose of 1.5 mg 3 times a day (see section 5.1). If systolic blood pressure falls below 95 mmHg, the dose should be maintained provided the patient does not show any signs or symptoms of hypotension. If at any time during the up-titration phase systolic blood pressure decreases below 95 mmHg and the patient shows signs or symptoms of hypotension the current dose should be decreased by 0.5 mg 3 times daily.

##### *Paediatric PAH patients aged 6 to < 18 years with body weight $\geq 50$ kg*

Adempas is available for paediatric use as a tablet for those with body weight  $\geq 50$  kg.

Titration of riociguat dose is to be performed based on the patient's systolic blood pressure and general tolerability at the discretion of the treating physician/healthcare provider. If the patient has no signs or symptoms of hypotension and systolic blood pressure is  $\geq 90$  mmHg for the 6 to < 12 year age group or  $\geq 95$  mmHg for the 12 to < 18 year age group, the dose should be

increased in 2-week intervals by 0.5 mg 3 times daily to a maximum daily dose of 3 times 2.5 mg.

If systolic blood pressure falls below these specified levels the dosage should be maintained as long as the patient does not show any signs or symptoms of hypotension. If at any time during the up-titration phase systolic blood pressure decreases below the specified levels, and the patient shows signs or symptoms of hypotension the current dose should be decreased by 0.5 mg 3 times daily.

### Maintenance dose

The established individual dose should be maintained unless signs and symptoms of hypotension occur.

The maximum total daily dose is 7.5 mg (i.e., 2.5 mg 3 times daily) for adults and paediatric patients with body weight of at least 50 kg.

If a dose is missed, treatment should be continued with the next dose as planned.

If not tolerated, dose reduction should be considered at any time.

### *Paediatric PAH patients weighing less than 50 kg*

Adempas is available as granules for oral suspension to treat paediatric PAH patients at least 6 years of age and weighing less than 50 kg – see Summary of Product Characteristics for Adempas granules for oral suspension for further direction. Patients may switch between tablets and oral suspension during therapy due to body weight changes.

### Treatment discontinuation

In case treatment has to be interrupted for 3 days or more, treatment should be restarted with 1 mg 3 times daily for 2 weeks, and continued with the dose titration regimen as described above.

### Transitioning between phosphodiesterase-5 (PDE5) inhibitors and riociguat

Sildenafil must be discontinued in adults and children at least 24 hours prior to administration of riociguat.

Tadalafil must be discontinued at least 48 hours in adults and 72 hours in children prior to administration of riociguat.

Riociguat must be discontinued in adults and children at least 24 hours prior to administration of a PDE5 inhibitor.

It is recommended to monitor for signs and symptoms of hypotension after any transition (see sections 4.3, 4.5 and 5.1).

### Special populations

Individual dose titration at treatment initiation allows adjustment of the dose to the patient's needs.

### *Elderly*

In elderly patients (65 years or older) there is a higher risk of hypotension and therefore particular care should be exercised during individual dose titration (see section 5.2).

#### *Hepatic impairment*

Patients with severe hepatic impairment (Child Pugh C) have not been studied and therefore use of riociguat is contraindicated in these patients (see section 4.3). Patients with moderate hepatic impairment (Child Pugh B) showed a higher exposure to this medicinal product (see section 5.2). Particular care should be exercised during individual dose titration. No clinical data are available in children and adolescents less than 18 years of age with hepatic impairment.

#### *Renal impairment*

Data in patients with severe renal impairment (creatinine clearance < 30 mL/min) are limited and there are no data for patients on dialysis. Therefore, use of riociguat is not recommended in these patients (see section 4.4).

Patients with mild and moderate renal impairment (creatinine clearance < 80 - 30 mL/min) showed a higher exposure to this medicinal product (see section 5.2). There is a higher risk of hypotension in patients with renal impairment, therefore particular care should be exercised during individual dose titration.

No clinical data are available in children and adolescents less than 18 years of age with renal impairment.

#### *Patients on stable doses of strong multi pathway CYP / P-glycoprotein (P-gp) and breast cancer resistance protein (BCRP) inhibitors*

Coadministration of riociguat with strong multi pathway CYP and P-gp/BCRP inhibitors such as azole antimycotics (e.g. ketoconazole, itraconazole) or HIV protease inhibitors (e.g. ritonavir) increases exposure to riociguat (see section 4.5). When initiating riociguat in patients on stable doses of strong multi pathway CYP and P-gp/BCRP inhibitors, consider a starting dose of 0.5 mg 3 times a day to mitigate the risk of hypotension. Monitor for signs and symptoms of hypotension on initiation and on treatment. Consider a dose reduction for patients on riociguat doses higher than or equal to 1.0 mg if the patient develops signs or symptoms of hypotension (see section 4.5).

No clinical data are available in children and adolescents less than 18 years of age receiving concomitant systemic treatment with strong CYP/P-gp and BCRP inhibitors.

#### *Paediatric population*

The safety and efficacy of riociguat have not been established in the following paediatric populations:

- Children aged < 6 years (see section 4.1), because of safety concerns. Non clinical data show undesirable effects on growing bone (see section 5.3).
- Children with PAH aged 6 to < 12 years with systolic blood pressure < 90 mmHg at treatment initiation (see section 4.3)

- Children and adolescents with PAH aged 12 to < 18 years with systolic blood pressure < 95 mmHg at treatment initiation (see section 4.3)
- Children and adolescents with CTEPH aged < 18 years old (see section 4.1).

No clinical trial data are available. Therefore, the use of riociguat is not recommended in these populations.

#### *Smokers*

Current smokers should be advised to stop smoking due to a risk of a lower response. Plasma concentrations of riociguat in smokers are reduced compared to non-smokers. A dose increase to the maximum daily dose of 2.5 mg 3 times daily may be required in patients who are smoking or start smoking during treatment (see sections 4.5 and 5.2).

A dose decrease may be required in patients who stop smoking.

### **Method of administration**

For oral use.

#### *Food*

Riociguat can generally be taken with or without food. For patients prone to hypotension, as a precautionary measure, switches between fed and fasted riociguat intake are not recommended because of increased peak plasma levels of riociguat in the fasting compared to the fed state (see section 5.2).

#### *Crushed tablets*

For patients who are unable to swallow whole tablets, Adempas tablets may be crushed and mixed with water or soft foods immediately prior to use and administered orally (see section 5.2).

## **4.3 Contraindications**

- Co-administration with PDE5 inhibitors (such as sildenafil, tadalafil, vardenafil) (see sections 4.2 and 4.5).
- Severe hepatic impairment (Child Pugh C).
- Hypersensitivity to the active substance or to any of the excipients listed in section 6.1.
- Pregnancy (see sections 4.4; 4.5 and 4.6).
- Co-administration with nitrates or nitric oxide donors (such as amyl nitrite) in any form including recreational drugs called 'poppers' (see section 4.5).
- Concomitant use with other soluble guanylate cyclase stimulators.
- Treatment initiation for
  - children aged 6 to < 12 years with systolic blood pressure < 90 mmHg,
  - patients  $\geq$  12 years with systolic blood pressure < 95 mmHg.
- Patients with pulmonary hypertension associated with idiopathic interstitial pneumonias (PH-IIP) (see section 5.1).

#### **4.4 Special warnings and precautions for use**

In pulmonary arterial hypertension, studies with riociguat have been mainly performed in forms related to idiopathic or heritable PAH and PAH associated with connective tissue disease. The use of riociguat in other forms of PAH not studied is not recommended (see section 5.1).

In chronic thromboembolic pulmonary hypertension, pulmonary endarterectomy is the treatment of choice as it is a potentially curative option. According to standard medical practice, expert assessment of operability should be done prior to treatment with riociguat.

##### Pulmonary veno-occlusive disease

Pulmonary vasodilators may significantly worsen the cardiovascular status of patients with pulmonary veno-occlusive disease (PVOD). Therefore, administration of riociguat to such patients is not recommended. Should signs of pulmonary oedema occur, the possibility of associated PVOD should be considered and treatment with riociguat should be discontinued.

##### Respiratory tract bleeding

In pulmonary hypertension patients there is increased likelihood for respiratory tract bleeding, particularly among patients receiving anticoagulation therapy. A careful monitoring of patients taking anticoagulants according to common medical practice is recommended.

The risk of serious and fatal respiratory tract bleeding may be further increased under treatment with riociguat, especially in the presence of risk factors, such as recent episodes of serious haemoptysis including those managed by bronchial arterial embolisation. Riociguat should be avoided in patients with a history of serious haemoptysis or who have previously undergone bronchial arterial embolisation. In case of respiratory tract bleeding, the prescriber should regularly assess the benefit risk of treatment continuation.

Serious bleeding occurred in 2.4% (12/490) of patients taking riociguat compared to 0/214 of placebo patients. Serious haemoptysis occurred in 1% (5/490) patients taking riociguat compared to 0/214 patients taking placebo, including one event with fatal outcome. Serious haemorrhagic events also included 2 patients with vaginal haemorrhage, 2 with catheter site haemorrhage, and 1 each with subdural haematoma, haematemesis, and intra-abdominal haemorrhage.

##### Hypotension

Riociguat has vasodilatory properties which may result in lowering of blood pressure. Before prescribing riociguat, physicians should carefully consider whether patients with certain underlying conditions, could be adversely affected by vasodilatory effects (e.g. patients on antihypertensive therapy or

with resting hypotension, hypovolaemia, severe left ventricular outflow obstruction or autonomic dysfunction).

Riociguat must not be used in patients with a systolic blood pressure below 95 mmHg (see section 4.3). Patients older than 65 years are at increased risk of hypotension. Therefore, caution should be exercised when administering riociguat in these patients.

#### Renal impairment

Data in adult patients with severe renal impairment (creatinine clearance < 30 mL/min) are limited and there are no data for patients on dialysis, therefore riociguat is not recommended in these patients. Patients with mild and moderate renal impairment were included in the pivotal studies. There is increased riociguat exposure in these patients (see section 5.2). There is a higher risk of hypotension in these patients, particular care should be exercised during individual dose titration.

#### Hepatic impairment

There is no experience in adult patients with severe hepatic impairment (Child Pugh C); riociguat is contraindicated in these patients (see section 4.3). PK data show that higher riociguat exposure was observed in patients with moderate hepatic impairment (Child Pugh B) (see section 5.2). Particular care should be exercised during individual dose titration.

There is no clinical experience with riociguat in patients with elevated liver aminotransferases (> 3 x Upper Limit of Normal (ULN)) or with elevated direct bilirubin (> 2 x ULN) prior to initiation of treatment; riociguat is not recommended in these patients.

#### Pregnancy/contraception

Riociguat is contraindicated during pregnancy (see section 4.3). Therefore, female patients at potential risk of pregnancy must use an effective method of contraception. Monthly pregnancy tests are recommended.

#### Smokers

Plasma concentrations of riociguat in smokers are reduced compared to non-smokers. Dose adjustment may be necessary in patients who start or stop smoking during treatment with riociguat (see sections 4.2 and 5.2).

#### Excipients with known effect

##### *Adempas contains lactose*

Patients with rare hereditary problems of galactose intolerance, total lactase deficiency or glucose-galactose malabsorption should not take this medicinal product.

*Adempas contains sodium*

This medicinal product contains less than 1 mmol sodium (23 mg) per tablet, that is to say essentially “sodium free”.

#### **4.5 Interaction with other medicinal products and other forms of interaction**

Interaction studies have been performed only in adults. Therefore, the absolute extent of interactions in the paediatric population is not known. The interaction data obtained in adults and the warnings in section 4.4 should be taken into account for the paediatric population.

##### Pharmacodynamic interactions

###### *Nitrates*

In a clinical study the highest dose of riociguat (2.5 mg tablets 3 times daily) potentiated the blood pressure lowering effect of sublingual nitroglycerin (0.4 mg) taken 4 and 8 hours after intake. Therefore co-administration of riociguat with nitrates or nitric oxide donors (such as amyl nitrite) in any form, including recreational drugs called ‘poppers’, is contraindicated (see section 4.3).

###### *PDE5 inhibitors*

Preclinical studies in animal models showed additive systemic blood pressure lowering effect when riociguat was combined with either sildenafil or vardenafil. With increased doses, over additive effects on systemic blood pressure were observed in some cases.

In an exploratory interaction study in 7 patients with PAH on stable sildenafil treatment (20 mg 3 times daily) single doses of riociguat (0.5 mg and 1 mg sequentially) showed additive haemodynamic effects. Doses above 1 mg riociguat were not investigated in this study.

A 12 week combination study in 18 patients with PAH on stable sildenafil treatment (20 mg 3 times daily) and riociguat (1.0 mg to 2.5 mg 3 times daily) compared to sildenafil alone was performed. In the long term extension part of this study (non controlled) the concomitant use of sildenafil and riociguat resulted in a high rate of discontinuation, predominately due to hypotension. There was no evidence of a favourable clinical effect of the combination in the population studied.

Concomitant use of riociguat with PDE5 inhibitors (such as sildenafil, tadalafil, vardenafil) is contraindicated (see sections 4.2 and 4.3).

RESPITE was a 24-week, uncontrolled study to investigate switching from PDE5 inhibitors to riociguat, in 61 adult PAH patients on stable PDE5 inhibitors. All patients were WHO Functional Class III and 82% received background therapy with an endothelin receptor antagonist (ERA). For the transition from PDE5 inhibitors to riociguat, median treatment-free time for sildenafil was 1 day and for tadalafil 3 days. Overall, the safety profile observed in the study was comparable with that observed in the pivotal trials, with no serious adverse reactions reported during the transition period. Six patients (10%) experienced at least one clinical worsening event, including

2 deaths unrelated to study drug. Changes from baseline suggested beneficial effects in selected patients, e.g. improvement in 6MWD (+31 m), N-terminal prohormone of brain natriuretic peptide (NT-proBNP) levels (-347 pg/mL), percent distribution of WHO FC I/II/III/IV (2% / 52% / 46% / 0%), and cardiac index (+ 0.3 L/min/m<sup>2</sup>).

#### *Soluble guanylate cyclase stimulators*

Concomitant use of riociguat with other soluble guanylate cyclase stimulators is contraindicated (see section 4.3).

#### *Warfarin/phenprocoumon*

Concomitant treatment of riociguat and warfarin did not alter prothrombin time induced by the anticoagulant. The concomitant use of riociguat with other coumarin-derivatives (e.g. phenprocoumon) is also not expected to alter prothrombin time.

Lack of pharmacokinetic interactions between riociguat and the CYP2C9 substrate warfarin was demonstrated *in vivo*.

#### *Acetylsalicylic acid*

Riociguat did not potentiate the bleeding time caused by acetyl-salicylic acid or affect the platelet aggregation in humans.

#### Effects of other substances on riociguat

Riociguat is cleared mainly via cytochrome P450-mediated (CYP1A1, CYP3A4, CYP3A5, CYP2J2) oxidative metabolism, direct biliary/faecal excretion of unchanged riociguat and renal excretion of unchanged riociguat via glomerular filtration.

#### *Concomitant use with strong multi pathway CYP and P-gp/BCRP inhibitors*

The concomitant use of riociguat with strong multi pathway CYP and P-gp / BCRP inhibitors such asazole antimycotics (e.g. ketoconazole, posaconazole, itraconazole) or HIV protease inhibitors (e.g. ritonavir) results in a pronounced increase in riociguat exposure: Concomitant administration of HAART combinations led to an increase in riociguat mean AUC of up to about 160% and to an approximate 30% increase in mean C<sub>max</sub>. The safety profile observed in HIV patients taking a single dose of 0.5 mg riociguat together with different combinations of HIV drugs used in HAART was generally comparable to other patient populations. Concomitant administration of 400 mg once daily ketoconazole led to a 150% (range up to 370%) increase in riociguat mean AUC and a 46% increase in mean C<sub>max</sub>. Terminal half-life increased from 7.3 to 9.2 hours and total body clearance decreased from 6.1 to 2.4 L/h. Assess the benefit-risk for each patient individually before prescribing riociguat in patients on stable doses of strong multi pathway CYP and P-gp/BCRP inhibitors.

To mitigate the risk of hypotension when riociguat is initiated in patients on stable doses of strong multi pathway CYP (especially CYP1A1 and CYP3A4) and P-gp/BCRP inhibitors, consider a reduced starting dose. It is recommended to monitor these patients for signs and symptoms of hypotension (see sections 4.2 ).

In patients on stable doses of riociguat, the initiation of strong multi pathway CYP and P-gp/BCRP inhibitors is not recommended as no dosage recommendation can be given due to limited data. Alternative treatments should be considered.

#### *Concomitant use with CYP1A1, UGT1A1 and UGT1A9 inhibitors*

From the recombinant CYP isoforms investigated in vitro CYP1A1 catalysed formation of riociguat's main metabolite most effectively. The class of tyrosine kinase inhibitors was identified as potent inhibitors of CYP1A1, with erlotinib and gefitinib exhibiting the highest inhibitory potency in vitro. Therefore, drug-drug interactions by inhibition of CYP1A1 could result in increased riociguat exposure, especially in smokers (see section 5.2). Strong CYP1A1 inhibitors should be used with caution.

Inhibitors for the UDP-Glykosyltransferases (UGT) 1A1 and 1A9 may potentially increase the exposure of the riociguat metabolite M1, which is pharmacologically active (pharmacological activity: 1/10<sup>th</sup> to 1/3<sup>rd</sup> of riociguat). For co-administration with these substances follow the recommendation on dose titration (see section 4.2).

#### *Concomitant use with other CYP and P-gp/BCRP inhibitors*

Medicinal products strongly inhibiting P-gp/BCRP such as the immunosuppressive cyclosporine A, should be used with caution (see section 5.2).

#### *Concomitant use with medicinal products increasing gastric pH*

Riociguat exhibits a reduced solubility at neutral pH vs. acidic medium. Co-treatment of medicinal products increasing the upper gastro intestinal pH may lead to lower oral bioavailability.

Co-administration of the antacid aluminium hydroxide / magnesium hydroxide reduced riociguat mean AUC by 34% and mean C<sub>max</sub> by 56% (see section 4.2). Antacids should be taken at least 2 hours before, or 1 hour after riociguat.

#### *Concomitant use with CYP3A4 inducers*

Bosentan, reported to be a moderate inducer of CYP3A4, led to a decrease of riociguat steady-state plasma concentrations in PAH patients by 27% (see sections 4.1 and 5.1). For co-administration with bosentan follow the recommendation on dose titration (see section 4.2).

The concomitant use of riociguat with strong CYP3A4 inducers (e.g. phenytoin, carbamazepine, phenobarbitone or St. John's Wort) may also lead to decreased riociguat plasma concentration. For co-administration with strong CYP3A4 inducers follow the recommendation on dose titration (see section 4.2).

#### *Smoking*

In cigarette smokers riociguat exposure is reduced by 50-60% (see section 5.2). Therefore, patients are advised to stop smoking (see section 4.2).

### Effects of riociguat on other substances

Riociguat and its main metabolite are strong inhibitors of CYP1A1 *in vitro*. Therefore, clinically relevant drug-drug interactions with co-treatment which are significantly cleared by CYP1A1-mediated biotransformation, such as erlotinib or granisetron cannot be ruled out.

Riociguat and its main metabolite are not inhibitors or inducers of major CYP isoforms (including CYP 3A4) or transporters (e.g. P-gp/BCRP) *in vitro* at therapeutic plasma concentrations.

Patients must not get pregnant during riociguat therapy (see section 4.3). Riociguat (2.5 mg 3 times daily) did not have a clinically meaningful effect on the plasma levels of combined oral contraceptives containing levonorgestrel and ethinyl estradiol when concomitantly administered to healthy female volunteers. Based on this study and as riociguat is not an inducer of any of the relevant metabolic enzymes, also no pharmacokinetic interaction is expected with other hormonal contraceptives.

## **4.6 Fertility, pregnancy and lactation**

### Women of childbearing potential / Contraception

Women and female adolescents of childbearing potential must use effective contraception during treatment with riociguat.

### Pregnancy

There are no data from the use of riociguat in pregnant women. Studies in animals have shown reproductive toxicity and placental transfer (see section 5.3). Therefore, riociguat is contraindicated during pregnancy (see section 4.3). Monthly pregnancy tests are recommended.

### Breast-feeding

No data on the use of riociguat in breast-feeding women are available. Data from animals indicate that riociguat is excreted into milk. Due to the potential for serious adverse reactions in breast-fed infants riociguat should not be used during breast-feeding. A risk to the suckling child cannot be excluded. Breast-feeding should be discontinued during treatment with this medicinal product.

### Fertility

No specific studies with riociguat in humans have been conducted to evaluate effects on fertility. In a reproduction toxicity study in rats, decreased testes weights were seen, but there were no effects on fertility (see section 5.3). The relevance of this finding for humans is unknown.

#### 4.7 Effects on ability to drive and use machines

Riociguat has moderate influence on the ability to cycle, drive and use machines. Dizziness has been reported and may affect the ability to drive and use machines (see section 4.8). Patients should be aware of how they react to this medicinal product, before cycling, driving or using machines.

#### 4.8 Undesirable effects

##### Summary of the safety profile

The safety of riociguat in adults has been evaluated in phase III studies of 650 patients with CTEPH and PAH receiving at least one dose of riociguat (see section 5.1). With longer observation in uncontrolled long term extension studies the safety profile was similar to that observed in the placebo controlled phase III trials.

Most of the adverse reactions are caused by relaxation of smooth muscle cells in vasculature or the gastrointestinal tract.

The most commonly reported adverse reactions, occurring in  $\geq 10\%$  of patients under riociguat treatment (up to 2.5 mg 3 times daily), were headache, dizziness, dyspepsia, peripheral oedema, nausea, diarrhoea and vomiting.

Serious haemoptysis and pulmonary haemorrhage, including cases with fatal outcome have been observed in patients with CTEPH or PAH treated with riociguat (see section 4.4).

The safety profile of riociguat in patients with CTEPH and PAH appeared to be similar, therefore adverse reactions identified from placebo controlled 12 and 16 weeks clinical studies are presented as pooled frequency in the table listed below (see table 1).

##### Tabulated list of adverse reactions

The adverse reactions reported with riociguat are listed in the table below by MedDRA system organ class and by frequency. Frequencies are defined as: very common ( $\geq 1/10$ ), common ( $\geq 1/100$  to  $< 1/10$ ), uncommon ( $\geq 1/1,000$  to  $< 1/100$ ), rare ( $\geq 1/10,000$  to  $< 1/1,000$ ), very rare ( $< 1/10,000$ ) and not known (cannot be estimated from the available data).

**Table 1:** Adverse reactions reported with riociguat in adult patients in phase III studies (pooled CHEST-1 and PATENT-1 data)

MedDRA System Organ Class	Very common	Common	Uncommon
Infections and infestations		Gastroenteritis	
Blood and lymphatic system disorders		Anaemia (incl. respective laboratory parameters)	
Nervous system disorders	Dizziness, Headache		
Cardiac disorders		Palpitations	
Vascular disorders		Hypotension	
Respiratory, thoracic and mediastinal disorders		Haemoptysis, Epistaxis, Nasal congestion	Pulmonary haemorrhage *
Gastrointestinal disorders	Dyspepsia, Diarrhoea, Nausea, Vomiting	Gastritis, Gastro-oesophageal reflux disease, Dysphagia, Gastrointestinal and abdominal pains, Constipation, Abdominal distension	
General disorders and administration site conditions	Oedema peripheral		

\*fatal pulmonary haemorrhage was reported in uncontrolled long term extension studies

### Paediatric patients

The safety of riociguat has been investigated in 24 paediatric patients aged 6 to less than 18 years over 24 weeks in an open-label uncontrolled trial (PATENT-CHILD) consisting of an individual dose titration phase starting with 1 mg (body weight adjusted) for 8 weeks and a maintenance phase for up to 16 weeks (see section 4.2), followed by an optional long-term extension phase. Most common adverse reactions including the long-term extension phase were hypotension and headache occurring in 4/24, and 2/24 patients, respectively.

Overall, the safety data is consistent with the safety profile observed in adults.

### Reporting of suspected adverse reactions

Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product. Healthcare professionals are asked to report any suspected adverse reactions via the Yellow Card Scheme, Website: [www.mhra.gov.uk/yellowcard](http://www.mhra.gov.uk/yellowcard) or search for MHRA Yellow Card in the Google Play or Apple App Store.

## 4.9 Overdose

In adults, inadvertent overdosing with total daily doses of 9 to 25 mg riociguat between 2 to 32 days was reported. Adverse reactions were similar to those seen at lower doses (see section 4.8).

In case of overdose, standard supportive measures should be adopted as required. In case of pronounced hypotension, active cardiovascular support may be required. Based on the high plasma protein binding riociguat is not expected to be dialysable.

## 5 PHARMACOLOGICAL PROPERTIES

### 5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Antihypertensives (antihypertensives for pulmonary arterial hypertension)  
ATC code: C02KX05

#### Mechanism of action

Riociguat is a stimulator of soluble guanylate cyclase (sGC), an enzyme in the cardiopulmonary system and the receptor for nitric oxide (NO). When NO binds to sGC, the enzyme catalyses synthesis of the signalling molecule cyclic guanosine monophosphate (cGMP). Intra-cellular cGMP plays an important role in regulating processes that influence vascular tone, proliferation, fibrosis, and inflammation.

Pulmonary hypertension is associated with endothelial dysfunction, impaired synthesis of NO and insufficient stimulation of the NO-sGC-cGMP pathway.

Riociguat has a dual mode of action. It sensitises sGC to endogenous NO by stabilising the NO-sGC binding. Riociguat also directly stimulates sGC independently of NO.

Riociguat restores the NO-sGC-cGMP pathway and leads to increased generation of cGMP.

#### Pharmacodynamic effects

Riociguat restores the NO-sGC-cGMP pathway resulting in a significant improvement of pulmonary vascular haemodynamics and an increase in exercise ability.

There is a direct relationship between riociguat plasma concentration and haemodynamic parameters such as systemic and pulmonary vascular resistance, systolic blood pressure and cardiac output.

#### Clinical efficacy and safety

### *Efficacy in adult patients with CTEPH*

A randomised, double-blind, multi-national, placebo controlled, phase III study (CHEST-1) was conducted in 261 adult patients with inoperable chronic thromboembolic pulmonary hypertension (CTEPH) (72%) or persistent or recurrent CTEPH after pulmonary endarterectomy (PEA; 28%). During the first 8 weeks riociguat was titrated every 2-weeks based on the patient's systolic blood pressure and signs or symptoms of hypotension to the optimal individual dose (range 0.5 mg to 2.5 mg 3 times daily) which was then maintained for a further 8 weeks. The primary endpoint of the study was the placebo adjusted change from baseline in 6-minute walk distance (6MWD) at the last visit (week 16).

At the last visit, the increase in 6MWD in patients treated with riociguat was 46 m (95% confidence interval (CI): 25 m to 67 m;  $p < 0.0001$ ), compared to placebo. Results were consistent in the main sub-groups evaluated (ITT analysis, see table 2).

**Table 2:** Effects of riociguat on 6MWD in CHEST-1 at last visit

<b>Entire patient population</b>	<b>Riociguat (n=173)</b>	<b>Placebo (n=88)</b>
Baseline (m) [SD]	342 [82]	356 [75]
Mean change from baseline (m) [SD]	39 [79]	-6 [84]
Placebo-adjusted difference (m) 95% CI, [p-value]	46 25 to 67 [ $<0.0001$ ]	
<b>FC III patient population</b>	<b>Riociguat (n=107)</b>	<b>Placebo (n=60)</b>
Baseline (m) [SD]	326 [81]	345 [73]
Mean change from baseline (m) [SD]	38 [75]	-17 [95]
Placebo-adjusted difference (m) 95% CI	56 29 to 83	
<b>FC II patient population</b>	<b>Riociguat (n=55)</b>	<b>Placebo (n=25)</b>
Baseline (m) [SD]	387 [59]	386 [64]
Mean change from baseline (m) [SD]	45 [82]	20 [51]
Placebo-adjusted difference (m) 95% CI	25 -10 to 61	
<b>Inoperable patient population</b>	<b>Riociguat (n=121)</b>	<b>Placebo (n=68)</b>
Baseline (m) [SD]	335 [83]	351 [75]
Mean change from baseline (m) [SD]	44 [84]	-8 [88]
Placebo-adjusted difference (m) 95% CI	54 29 to 79	
<b>Patient population with CTEPH post-PEA</b>	<b>Riociguat (n=52)</b>	<b>Placebo (n=20)</b>
Baseline (m) [SD]	360 [78]	374 [72]
Mean change from baseline (m) [SD]	27 [68]	1.8 [73]
Placebo-adjusted difference (m) 95% CI	27 -10 to 63	

Improvement in exercise capacity was accompanied by improvement in multiple clinically relevant secondary endpoints. These findings were in accordance with improvements in additional haemodynamic parameters.

**Table 3:** Effects of riociguat in CHEST-1 on PVR, NT-proBNP and WHO functional class at last visit

<b>PVR</b>	<b>Riociguat (n=151)</b>	<b>Placebo (n=82)</b>
Baseline (dyn·s·cm <sup>-5</sup> ) [SD]	790.7 [431.6]	779.3 [400.9]
Mean change from baseline (dyn·s·cm <sup>-5</sup> ) [SD]	-225.7 [247.5]	23.1 [273.5]
Placebo-adjusted difference (dyn·s·cm <sup>-5</sup> ) 95% CI, [p-value]	-246.4 -303.3 to -189.5 [ $<0.0001$ ]	
<b>NT-proBNP</b>	<b>Riociguat (n=150)</b>	<b>Placebo (n=73)</b>
Baseline (ng/L) [SD]	1508.3 [2337.8]	1705.8 [2567.2]
Mean change from baseline (ng/L) [SD]	-290.7 [1716.9]	76.4 [1446.6]
Placebo-adjusted difference (ng/L) 95% CI, [p-value]	-444.0 -843.0 to -45.0 [ $<0.0001$ ]	
<b>Change in WHO Functional Class</b>	<b>Riociguat (n=173)</b>	<b>Placebo (n=87)</b>
Improved	57 (32.9%)	13 (14.9%)
Stable	107 (61.8%)	68 (78.2%)
Deteriorated	9 (5.2%)	6 (6.9%)
p-value	0.0026	

PVR= pulmonary vascular resistance

Adverse reactions leading to discontinuation occurred at a similar frequency in both treatment groups (riociguat individual dose titration (IDT) 1.0-2.5 mg, 2.9%; placebo, 2.3%).

#### Long-term treatment of CTEPH

An open-label extension study (CHEST-2) included 237 adult patients who had completed CHEST-1. At the end of the study, mean (SD) treatment duration in the total group was 1285 (709) days and median duration was 1174 days (ranging from 15 to 3512 days). In total, 221 patients (93.2%) had a treatment duration of approximately 1 year (at least 48 weeks), 205 patients (86.5%) of approximately 2 years (at least 96 weeks) and 142 patients (59.9%) of approximately 3 years (at least 144 weeks). Treatment exposure was 834 person years in total.

The safety profile in CHEST-2 was similar to that observed in pivotal trials. After treatment with riociguat, the mean 6MWD improved in the overall population by 53 m at 12 months (n=208), 48 m at 24 months (n=182), and 49 m at 36 months (n=117) compared to baseline. Improvements in 6MWD persisted until the end of the study.

Table 4 shows the proportion of patients\* with changes in WHO functional class during riociguat treatment compared to baseline.

**Table 4: CHEST-2: Changes in WHO Functional Class**

Treatment duration in CHEST-2	Changes in WHO Functional Class (n (%) of patients)		
	Improved	Stable	Worsened
1 year (n=217)	100 (46%)	109 (50%)	6 (3%)
2 years (n=193)	76 (39%)	111 (58%)	5 (3%)
3 years (n=128)	48 (38%)	65 (51%)	14 (11%)

\*Patients participated in the study until the drug was approved and commercially available in their countries.

The probability of survival was 97% after 1 year, 93% after 2 years and 89% after 3 years of riociguat treatment.

#### *Efficacy in adult patients with PAH*

A randomised, double-blind, multi-national, placebo controlled, phase III study (PATENT-1) was conducted in 443 adult patients with PAH (riociguat individual dose titration up to 2.5 mg 3 times daily: n=254, placebo: n=126, riociguat “capped” dose titration (CT) up to 1.5 mg (exploratory dose arm, no statistical testing performed; n=63)). Patients were either treatment-naïve (50%) or pre-treated with ERA (43%) or a prostacyclin analogue (inhaled (iloprost), oral (beraprost) or subcutaneous (treprostinil); 7%) and had been diagnosed with idiopathic or heritable PAH (63.4%), PAH associated with connective tissue disease (25.1%) and congenital heart disease (7.9%). During the first 8 weeks riociguat was titrated every 2-weeks based on the patient’s systolic blood pressure and signs or symptoms of hypotension to the optimal individual dose (range 0.5 mg to 2.5 mg 3 times daily), which was then maintained for a further 4 weeks. The primary endpoint of the study was placebo-adjusted change from baseline in 6MWD at the last visit (week 12).

At the last visit the increase in 6MWD with riociguat individual dose titration (IDT) was 36 m (95% CI: 20 m to 52 m; p<0.0001) compared to placebo. Treatment-naïve patients (n=189) improved by 38 m, and pre-treated patients (n=191) by 36 m (ITT analysis, see table 5). Further exploratory subgroup analysis revealed a treatment effect of 26 m, (95% CI: 5 m to 46 m) in patients pre-treated with ERAs (n=167) and a treatment effect of 101 m (95% CI: 27 m to 176 m) in patients pre-treated with prostacyclin analogues (n=27).

**Table 5:** Effects of riociguat on 6MWD in PATENT-1 at last visit

<b>Entire patient population</b>	<b>Riociguat IDT (n=254)</b>	<b>Placebo (n=126)</b>	<b>Riociguat CT (n=63)</b>
Baseline (m) [SD]	361 [68]	368 [75]	363 [67]
Mean change from baseline (m) [SD]	30 [66]	-6 [86]	31 [79]
Placebo-adjusted difference (m) 95% CI, [p-value]	36  20 to 52 [ $<0.0001$ ]		
<b>FC III patients</b>	<b>Riociguat IDT (n=140)</b>	<b>Placebo (n=58)</b>	<b>Riociguat CT (n=39)</b>
Baseline (m) [SD]	338 [70]	347 [78]	351 [68]
Mean change from baseline (m) [SD]	31 [64]	-27 [98]	29 [94]
Placebo-adjusted difference (m) 95% CI	58  35 to 81		
<b>FC II patients</b>	<b>Riociguat IDT (n=108)</b>	<b>Placebo (n=60)</b>	<b>Riociguat CT (n=19)</b>
Baseline (m) [SD]	392 [51]	393 [61]	378 [64]
Mean change from baseline (m) [SD]	29 [69]	19 [63]	43 [50]
Placebo-adjusted difference (m) 95% CI	10  -11 to 31		
<b>Treatment-naïve patient population</b>	<b>Riociguat IDT (n=123)</b>	<b>Placebo (n=66)</b>	<b>Riociguat CT (n=32)</b>
Baseline (m) [SD]	370 [66]	360 [80]	347 [72]
Mean change from baseline (m) [SD]	32 [74]	-6 [88]	49 [47]
Placebo-adjusted difference (m) 95% CI	38  14 to 62		
<b>Pre-treated patient population</b>	<b>Riociguat IDT (n=131)</b>	<b>Placebo (n=60)</b>	<b>Riociguat CT (n=31)</b>
Baseline (m) [SD]	353 [69]	376 [68]	380 [57]
Mean change from baseline (m) [SD]	27 [58]	-5 [83]	12 [100]
Placebo- adjusted difference (m) 95% CI	36  15 to 56		

Improvement in exercise capacity was accompanied by consistent improvement in multiple clinically relevant secondary endpoints. These

findings were in accordance with improvements in additional haemodynamic parameters (see table 6).

**Table 6:** Effects of riociguat in PATENT-1 on PVR and NT-proBNP at last visit

<b>PVR</b>	<b>Riociguat IDT (n=232)</b>	<b>Placebo (n=107)</b>	<b>Riociguat CT (n=58)</b>
Baseline (dyn·s·cm <sup>-5</sup> ) [SD]	791 [452.6]	834.1 [476.7]	847.8 [548.2]
Mean change from PVR baseline (dyn·s·cm <sup>-5</sup> ) [SD]	-223 [260.1]	-8.9 [316.6]	-167.8 [320.2]
Placebo-adjusted difference (dyn·s·cm <sup>-5</sup> ) 95% CI, [p-value]	-225.7 -281.4 to -170.1 [ $<0.0001$ ]		
<b>NT-proBNP</b>	<b>Riociguat IDT (n = 228)</b>	<b>Placebo (n = 106)</b>	<b>Riociguat CT (n=54)</b>
Baseline (ng/L) [SD]	1,026.7 [1,799.2]	1,228.1 [1,774.9]	1,189.7 [1,404.7]
Mean change from baseline (ng/L) [SD]	-197.9 [1721.3]	232.4 [1011.1]	-471.5 [913.0]
Placebo-adjusted difference (ng/L) 95% CI, [p-value]	-431.8 -781.5 to -82.1 [ $<0.0001$ ]		
<b>Change in WHO Functional Class</b>	<b>Riociguat IDT (n = 254)</b>	<b>Placebo (n = 125)</b>	<b>Riociguat CT (n=63)</b>
Improved	53 (20.9%)	18 (14.4%)	15 (23.8%)
Stable	192 (75.6%)	89 (71.2%)	43 (68.3%)
Deteriorated	9 (3.6%)	18 (14.4%)	5 (7.9%)
p-value	0.0033		

Riociguat-treated patients experienced a significant delay in time to clinical worsening versus placebo-treated patients ( $p = 0.0046$ ; Stratified log-rank test) (see table 7).

**Table 7:** Effects of riociguat in PATENT-1 on events of clinical worsening

<b>Clinical Worsening Events</b>	<b>Riociguat IDT (n=254)</b>	<b>Placebo (n=126)</b>	<b>Riociguat CT (n=63)</b>
Patients with any clinical worsening	3 (1.2%)	8 (6.3%)	2 (3.2%)
Death	2 (0.8%)	3 (2.4%)	1 (1.6%)
Hospitalisations due to PH	1 (0.4%)	4 (3.2%)	0
Decrease in 6MWD due to PH	1 (0.4%)	2 (1.6%)	1 (1.6%)
Persistent worsening of Functional Class due to PH	0	1 (0.8%)	0
Start of new PH treatment	1 (0.4%)	5 (4.0%)	1 (1.6%)

Patients treated with riociguat showed significant improvement in Borg CR 10 dyspnoea score (mean change from baseline (SD): riociguat -0.4 (2), placebo 0.1 (2);  $p = 0.0022$ ).

Adverse reactions leading to discontinuation occurred less frequently in both riociguat treatment groups than in the placebo group (riociguat IDT 1.0-2.5 mg, 3.1%; riociguat CT 1.6%; placebo, 7.1%).

## Long-term treatment of PAH

An open label extension study (PATENT-2) included 396 adult patients who had completed PATENT-1.

In PATENT-2, mean (SD) treatment duration in the total group (not including exposure in PATENT-1) was 1375 (772) days and median duration was 1331 days (ranging from 1 to 3565 days). In total, treatment exposure was approximately 1 year (at least 48 weeks) for 90%, 2 years (at least 96 weeks) for 85%, and 3 years (at least 144 weeks) for 70% of patients. Treatment exposure was 1491 person years in total.

The safety profile in PATENT-2 was similar to that observed in pivotal trials. After treatment with riociguat, the mean 6MWD improved in the overall population by 50 m at 12 months (n=347), 46 m at 24 months (n=311) and 46 m at 36 months (n=238) compared to baseline. Improvements in 6MWD persisted until the end of the study.

Table 8 shows the proportion of patients\* with changes in WHO functional class during riociguat treatment compared to baseline.

**Table 8: PATENT-2: Changes in WHO Functional Class**

Treatment duration in PATENT-2	Changes in WHO Functional Class (n(%) of patients)		
	Improved	Stable	Worsened
1 year (n=358)	116 (32%)	222 (62%)	20 (6%)
2 years (n=321)	106 (33%)	189 (59%)	26 (8%)
3 years (n=257)	88 (34%)	147 (57%)	22 (9%)
*Patients participated in the study until the study drug was approved and commercially available in their countries.			

The probability of survival was 97% after 1 year, 93% after 2 years and 88% after 3 years of riociguat treatment.

### *Efficacy in paediatric patients with PAH*

#### *PATENT-CHILD*

The safety and tolerability of riociguat 3 times daily for 24 weeks was evaluated in an open-label uncontrolled study in 24 paediatric patients with PAH aged 6 to less than 18 years (median 9.5 years). Only patients who were receiving stable doses of ERA (n=15, 62.5%) or ERA + prostacyclin analogue (PCA) (n=9, 37.5%) were enrolled, and they continued their PAH treatment during the study. The main exploratory efficacy endpoint of the study was exercise capacity (6MWD).

The aetiologies of PAH were idiopathic (n=18, 75.0%), persistent congenital PAH despite shunt closure (n=4, 16.7%), heritable (n=1, 4.2%), and pulmonary hypertension associated with developmental abnormalities (n=1, 4.2%). Two distinct age groups were included ( $\geq 6$  to  $< 12$  years [n=6] and  $\geq 12$  to  $< 18$  years [n=18]).

At baseline, the majority of patients were WHO functional class II (n=18, 75%) one patient (4.2%) was WHO functional class I and five patients (20.8%) were WHO functional class III. The mean 6MWD at baseline was 442.12 m.

The 24-week treatment period was completed by 21 patients while 3 patients withdrew from the study due to adverse reactions.

For patients with assessments at baseline and at week 24:

- mean change in 6MWD from baseline +23.01 m (SD 68.8) (n=19)
- WHO functional class remained stable compared to baseline (n=21).
- median change in NT-proBNP was -12.05 pg/mL (n=14)

Two patients were hospitalised for right heart failure

Long-term data were generated from 21 patients who completed the first 24 weeks of treatment in PATENT-CHILD. All patients continued to receive riociguat in combination with either ERA or ERA + PCAs. The mean overall duration of exposure to riociguat treatment was  $109.79 \pm 80.38$  weeks (up to 311.9 weeks), with 37.5% (n=9) of patients treated for at least 104 weeks and 8.3% (n=2) for at least 208 weeks.

During the long-term extension (LTE) phase improvements or stabilization in 6MWD were maintained for patients on treatment with observed mean changes from baseline (before start of treatment [PATENT-CHILD]) of +5.86 m at month 6, -3.43 m at month 12; +28.98 m at month 18 and -11.80 m at month 24.

A majority of patients remained stable regarding WHO functional class II between baseline and month 24. Clinical worsening was observed in 8 (33.3%) patients in total including the main phase. Hospitalisation for right heart failure was reported in 5 (20.8%) patients. No deaths occurred during the observation period.

#### Patients with pulmonary hypertension associated with idiopathic interstitial pneumonias (PH-IIP)

A randomised, double blind, placebo-controlled phase II study (RISE-IIP) to evaluate the efficacy and safety of riociguat in adult patients with symptomatic pulmonary hypertension associated with idiopathic interstitial pneumonias (PH-IIP) was terminated early due to an increased risk of mortality and serious adverse reactions in patients treated with riociguat and a lack of efficacy. More patients taking riociguat died (11% vs. 4%) and had serious adverse reactions (37% vs. 23%) during the main phase. In the long-term extension, more

patients who switched from the placebo group to riociguat (21%) died than those who continued in the riociguat group (3%).

Riociguat is therefore contraindicated in patients with pulmonary hypertension associated with idiopathic interstitial pneumonias (see section 4.3).

## 5.2 Pharmacokinetic properties

### Absorption

#### *Adults*

The absolute bioavailability of riociguat is high (94%). Riociguat is rapidly absorbed with maximum concentrations ( $C_{max}$ ) appearing 1-1.5 hours after tablet intake. Intake with food reduced riociguat AUC slightly,  $C_{max}$  was reduced by 35%.

Bioavailability (AUC and  $C_{max}$ ) is comparable for riociguat administered orally as a crushed tablet suspended in water or in soft food compared to a whole tablet (see section 4.2).

#### *Paediatric population*

Children received riociguat tablet or oral suspension with or without food intake. Population PK modeling has shown that riociguat is readily absorbed in children as in adults, after oral administration as tablet or oral suspension. No difference in the absorption rate nor in the extent of absorption between the tablet and oral suspension formulation was observed.

### Distribution

#### *Adults*

Plasma protein binding in adults is high at approximately 95%, with serum albumin and alpha 1-acidic glycoprotein being the main binding components. The volume of distribution is moderate with volume of distribution at steady state being approximately 30 L.

#### *Paediatric population*

No data on riociguat plasma protein binding specific to children is available. Volume at steady-state ( $V_{ss}$ ) estimated via population pharmacokinetic modeling (age 6 to < 18 years) following oral administration of riociguat is 26 L on average.

### Biotransformation

#### *Adults*

N-demethylation, catalysed by CYP1A1, CYP3A4, CYP3A5 and CYP2J2 is the major biotransformation pathway of riociguat leading to its major

circulating active metabolite M-1 (pharmacological activity: 1/10<sup>th</sup> to 1/3<sup>rd</sup> of riociguat) which is further metabolised to the pharmacologically inactive N-glucuronide.

CYP1A1 catalyses the formation of riociguat's main metabolite in liver and lungs and is known to be inducible by polycyclic aromatic hydrocarbons, which, for example, are present in cigarette smoke.

#### *Paediatric population*

No metabolism data specific to children and adolescents less than 18 years of age is available.

#### Elimination

##### *Adults*

Total riociguat (parent compound and metabolites) is excreted via both renal (33-45%) and biliary/faecal routes (48-59%). Approximately 4-19% of the administered dose was excreted as unchanged riociguat via the kidneys. Approximately 9-44% of the administered dose was found as unchanged riociguat in faeces.

Based on *in vitro* data riociguat and its main metabolite are substrates of the transporter proteins P-gp (P-glycoprotein) and BCRP (breast cancer resistance protein). With a systemic clearance of about 3-6 L/h, riociguat can be classified as a low-clearance drug. Elimination half-life is about 7 hours in healthy volunteers and about 12 hours in patients.

##### *Paediatric population*

No mass balance study and metabolism data specific to children and adolescents less than 18 years of age are available. Clearance (CL) estimated via population PK modeling in children (age range 06 to < 18 years) following oral administration of riociguat is on average of 2.48 L/h. The geometric mean values for half-lives (t<sub>1/2</sub>) estimated via population PK modeling was 8.24 h.

#### Linearity

Riociguat pharmacokinetics are linear from 0.5 to 2.5 mg. Inter-individual variability (CV) of riociguat exposure (AUC) across all doses is approximately 60%.

The PK profile is similar in children as in adults.

#### Special populations

##### *Gender*

Pharmacokinetic data reveal no relevant differences due to gender in the exposure to riociguat.

##### *Elderly population*

Elderly patients (65 years or older) exhibited higher plasma concentrations than younger patients, with mean AUC values being approximately 40% higher in elderly, mainly due to reduced (apparent) total and renal clearance.

#### *Inter-ethnic differences*

In adults pharmacokinetic data reveal no relevant inter-ethnic differences.

#### *Different weight categories*

In adults pharmacokinetic data reveal no relevant differences due to weight in the exposure to riociguat.

#### *Hepatic impairment*

In cirrhotic adult patients (non-smokers) with mild hepatic impairment (classified as Child Pugh A) riociguat mean AUC was increased by 35% compared to healthy controls, which is within normal intra-individual variability. In cirrhotic patients (non-smokers) with moderate hepatic impairment (classified as Child Pugh B), riociguat mean AUC was increased by 51% compared to healthy controls. There are no data in patients with severe hepatic impairment (classified as Child Pugh C).

No clinical data are available in children and adolescents less than 18 years of age with hepatic impairment.

Patients with ALT > 3 x ULN and bilirubin > 2 x ULN were not studied (see section 4.4).

#### *Renal impairment*

Overall, mean dose- and weight- normalised exposure values for riociguat were higher in patients with renal impairment compared to patients with normal renal function. Corresponding values for the main metabolite were higher in patients with renal impairment compared to healthy volunteers. In non-smoking individuals with mild (creatinine clearance 80-50 mL/min), moderate (creatinine clearance < 50-30 mL/min) or severe (creatinine clearance < 30 mL/min) renal impairment, riociguat plasma concentrations (AUC) were increased by 53%, 139% or 54%, respectively.

Data in patients with creatinine clearance < 30 mL/min are limited and there are no data for patients on dialysis.

Due to the high plasma protein binding riociguat is not expected to be dialysable.

No clinical data are available in children and adolescents less than 18 years of age with renal impairment.

### **5.3 Preclinical safety data**

Non-clinical data revealed no specific hazard for humans based on conventional studies of safety pharmacology, single dose toxicity, phototoxicity, genotoxicity and carcinogenicity.

Effects observed in repeat-dose toxicity studies were mainly due to the exaggerated pharmacodynamic activity of riociguat (haemodynamic and smooth muscle relaxing effects).

In growing, juvenile and adolescent rats, effects on bone formation were seen. In juvenile rats, the changes consisted of thickening of trabecular bone and of

hyperostosis and remodeling of metaphyseal and diaphyseal bone, whereas in adolescent rats an overall increase of bone mass was observed at doses 10 times the unbound AUC in the paediatric population. The clinical relevance of this finding is not known. No such effects were observed in juvenile rats at doses  $\leq 2$  times the unbound AUC in the paediatric population, or in adult rats. No new target organs were identified.

In a fertility study in rats, decreased testes weights occurred at systemic exposure of about 7-fold of human exposure, whereas no effects on male and female fertility were seen. Moderate passage across the placental barrier was observed. Developmental toxicity studies in rats and rabbits have shown reproductive toxicity of riociguat. In rats, an increased rate of cardiac malformation was observed as well as a reduced gestation rate due to early resorption at maternal systemic exposure of about 8-fold of human exposure (2.5 mg 3 times daily). In rabbits, starting at systemic exposure of about 4-fold of human exposure (2.5 mg 3 times daily) abortion and foetal toxicity were seen.

## **6 PHARMACEUTICAL PARTICULARS**

### **6.1 List of excipients**

#### Tablet core:

cellulose microcrystalline  
crospovidone (type B)  
hypromellose 5 cP  
lactose monohydrate  
magnesium stearate  
sodium laurilsulfate

#### Tablet-coat:

hydroxypropylcellulose  
hypromellose 3 cP  
propylene glycol (E 1520)  
titanium dioxide (E 171)

### **6.2 Incompatibilities**

Not applicable.

### **6.3 Shelf life**

5 years

### **6.4 Special precautions for storage**

This medicinal product does not require any special storage conditions.

### **6.5 Nature and contents of container**

PP/Aluminium foil blister.

Pack sizes: 42, 84, 90 or 294 film-coated tablets.

Not all pack sizes may be marketed.

### **6.6 Special precautions for disposal**

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

## **7 MARKETING AUTHORISATION HOLDER**

Bayer plc  
400 South Oak Way  
Reading  
RG2 6AD

## **8 MARKETING AUTHORISATION NUMBER(S)**

PLGB 00010/0670

**9 DATE OF FIRST AUTHORISATION/RENEWAL OF THE  
AUTHORISATION**

01/01/2021

**10 DATE OF REVISION OF THE TEXT**

25/11/2025