

**ANNEX I**  
**SUMMARY OF PRODUCT CHARACTERISTICS**

## 1. NAME OF THE MEDICINAL PRODUCT

Revatio 20 mg film-coated tablets

## 2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Each film-coated tablet contains 20 mg of sildenafil (as citrate).

### Excipient(s) with known effect

Each tablet also contains 0.7 mg of lactose.

For the full list of excipients, see section 6.1.

## 3. PHARMACEUTICAL FORM

Film-coated tablet.

White, round, biconvex film-coated tablets marked "PFIZER" on one side and "RVT 20" on the other.

## 4. CLINICAL PARTICULARS

### 4.1 Therapeutic indications

#### Adults

Treatment of adult patients with pulmonary arterial hypertension classified as WHO functional class II and III, to improve exercise capacity. Efficacy has been shown in primary pulmonary hypertension and pulmonary hypertension associated with connective tissue disease.

#### Paediatric population

Treatment of paediatric patients aged 1 year to 17 years old with pulmonary arterial hypertension. Efficacy in terms of improvement of exercise capacity or pulmonary haemodynamics has been shown in primary pulmonary hypertension and pulmonary hypertension associated with congenital heart disease (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 pulmonary arterial hypertension. In case of clinical deterioration in spite of Revatio treatment, alternative therapies should be considered.

#### Posology

##### Adults

The recommended dose is 20 mg three times a day (TID). Physicians should advise patients who forget to take Revatio to take a dose as soon as possible and then continue with the normal dose. Patients should not take a double dose to compensate for the missed dose.

##### Paediatric population (1 year to 17 years)

For paediatric patients aged 1 year to 17 years old, the recommended dose in patients  $\leq 20$  kg is 10 mg three times a day and for patients  $> 20$  kg is 20 mg three times a day. Higher than recommended doses should not be used in paediatric patients with PAH (see also sections 4.4 and 5.1). The 20 mg tablet should not be used in cases where 10 mg TID should be administered in younger patients. Other pharmaceutical forms are available for administration to patients  $\leq 20$  kg and other younger patients who are not able to swallow tablets.

#### Patients using other medicinal products

In general, any dose adjustment should be administered only after a careful benefit-risk assessment. A downward dose adjustment to 20 mg twice daily should be considered when sildenafil is co-administered to patients already receiving CYP3A4 inhibitors like erythromycin or saquinavir. A downward dose adjustment to 20 mg once daily is recommended in case of co-administration with more potent CYP3A4 inhibitors clarithromycin, telithromycin and nefazodone. For the use of sildenafil with the most potent CYP3A4 inhibitors, see section 4.3. Dose adjustments for sildenafil may be required when co-administered with CYP3A4 inducers (see section 4.5).

#### Special populations

##### Elderly ( $\geq 65$ years)

Dose adjustments are not required in elderly patients. Clinical efficacy as measured by 6-minute walk distance could be less in elderly patients.

##### Renal impairment

Initial dose adjustments are not required in patients with renal impairment, including severe renal impairment (creatinine clearance  $< 30$  ml/min). A downward dose adjustment to 20 mg twice daily should be considered after a careful benefit-risk assessment only if therapy is not well-tolerated.

##### Hepatic impairment

Initial dose adjustments are not required in patients with hepatic impairment (Child-Pugh class A and B). A downward dose adjustment to 20 mg twice daily should be considered after a careful benefit-risk assessment only if therapy is not well-tolerated.

Revatio is contraindicated in patients with severe hepatic impairment (Child-Pugh class C) (see section 4.3).

##### Paediatric population

The safety and efficacy of Revatio in children below 1 year of age has not been established. No data are available.

##### Discontinuation of treatment

Limited data suggests that the abrupt discontinuation of Revatio is not associated with rebound worsening of pulmonary arterial hypertension. However to avoid the possible occurrence of sudden clinical deterioration during withdrawal, a gradual dose reduction should be considered. Intensified monitoring is recommended during the discontinuation period.

##### Method of administration

Revatio is for oral use only. Tablets should be taken approximately 6 to 8 hours apart with or without food.

### **4.3 Contraindications**

Hypersensitivity to the active substance or to any of the excipients listed in section 6.1.

Co-administration with nitric oxide donors (such as amyl nitrite) or nitrates in any form due to the hypotensive effects of nitrates (see section 5.1).

The co-administration of PDE5 inhibitors, including sildenafil, with guanylate cyclase stimulators, such as riociguat, is contraindicated as it may potentially lead to symptomatic hypotension (see section 4.5).

Combination with the most potent of the CYP3A4 inhibitors (eg, ketoconazole, itraconazole, ritonavir) (see section 4.5).

Patients who have loss of vision in one eye because of non-arteritic anterior ischaemic optic neuropathy (NAION), regardless of whether this episode was in connection or not with previous PDE5 inhibitor exposure (see section 4.4).

The safety of sildenafil has not been studied in the following sub-groups of patients and its use is therefore contraindicated:

Severe hepatic impairment,

Recent history of stroke or myocardial infarction,

Severe hypotension (blood pressure < 90/50 mmHg) at initiation.

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

The efficacy of Revatio has not been established in patients with severe pulmonary arterial hypertension (functional class IV). If the clinical situation deteriorates, therapies that are recommended at the severe stage of the disease (eg, epoprostenol) should be considered (see section 4.2). The benefit-risk balance of sildenafil has not been established in patients assessed to be at WHO functional class I pulmonary arterial hypertension.

Studies with sildenafil have been performed in forms of pulmonary arterial hypertension related to primary (idiopathic), connective tissue disease associated or congenital heart disease associated forms of PAH (see section 5.1). The use of sildenafil in other forms of PAH is not recommended.

In the long term paediatric extension study, an increase in deaths was observed in patients administered doses higher than the recommended dose. Therefore, doses higher than the recommended doses should not be used in paediatric patients with PAH (see also sections 4.2 and 5.1).

##### Retinitis pigmentosa

The safety of sildenafil has not been studied in patients with known hereditary degenerative retinal disorders such as *retinitis pigmentosa* (a minority of these patients have genetic disorders of retinal phosphodiesterases) and therefore its use is not recommended.

##### Vasodilatory action

When prescribing sildenafil, physicians should carefully consider whether patients with certain underlying conditions could be adversely affected by sildenafil's mild to moderate vasodilatory effects, for example patients with hypotension, patients with fluid depletion, severe left ventricular outflow obstruction or autonomic dysfunction (see section 4.4).

##### Cardiovascular risk factors

In post-marketing experience with sildenafil for male erectile dysfunction, serious cardiovascular events, including myocardial infarction, unstable angina, sudden cardiac death, ventricular arrhythmia, cerebrovascular haemorrhage, transient ischaemic attack, hypertension and hypotension have been reported in temporal association with the use of sildenafil. Most, but not all, of these patients had pre-existing cardiovascular risk factors. Many events were reported to occur during or shortly after sexual intercourse and a few were reported to occur shortly after the use of sildenafil without sexual activity. It is not possible to determine whether these events are related directly to these factors or to other factors.

##### Priapism

Sildenafil should be used with caution in patients with anatomical deformation of the penis (such as angulation, cavernosal fibrosis or Peyronie's disease), or in patients who have conditions which may predispose them to priapism (such as sickle cell anaemia, multiple myeloma or leukaemia).

Prolonged erections and priapism have been reported with sildenafil in post-marketing experience. In the event of an erection that persists longer than 4 hours, the patient should seek immediate medical

assistance. If priapism is not treated immediately, penile tissue damage and permanent loss of potency could result (see section 4.8).

#### Vaso-occlusive crises in patients with sickle cell anaemia

Sildenafil should not be used in patients with pulmonary hypertension secondary to sickle cell anaemia. In a clinical study events of vaso-occlusive crises requiring hospitalisation were reported more commonly by patients receiving Revatio than those receiving placebo leading to the premature termination of this study.

#### Visual events

Cases of visual defects have been reported spontaneously in connection with the intake of sildenafil and other PDE5 inhibitors. Cases of non-arteritic anterior ischaemic optic neuropathy, a rare condition, have been reported spontaneously and in an observational study in connection with the intake of sildenafil and other PDE5 inhibitors (see section 4.8). In the event of any sudden visual defect, the treatment should be stopped immediately and alternative treatment should be considered (see section 4.3).

#### Alpha-blockers

Caution is advised when sildenafil is administered to patients taking an alpha-blocker as the co-administration may lead to symptomatic hypotension in susceptible individuals (see section 4.5). In order to minimise the potential for developing postural hypotension, patients should be haemodynamically stable on alpha-blocker therapy prior to initiating sildenafil treatment. Physicians should advise patients what to do in the event of postural hypotensive symptoms.

#### Bleeding disorders

Studies with human platelets indicate that sildenafil potentiates the antiaggregatory effect of sodium nitroprusside *in vitro*. There is no safety information on the administration of sildenafil to patients with bleeding disorders or active peptic ulceration. Therefore sildenafil should be administered to these patients only after careful benefit-risk assessment.

#### Vitamin K antagonists

In pulmonary arterial hypertension patients, there may be a potential for increased risk of bleeding when sildenafil is initiated in patients already using a Vitamin K antagonist, particularly in patients with pulmonary arterial hypertension secondary to connective tissue disease.

#### Veno-occlusive disease

No data are available with sildenafil in patients with pulmonary hypertension associated with pulmonary veno-occlusive disease. However, cases of life threatening pulmonary oedema have been reported with vasodilators (mainly prostacyclin) when used in those patients. Consequently, should signs of pulmonary oedema occur when sildenafil is administered in patients with pulmonary hypertension, the possibility of associated veno-occlusive disease should be considered.

#### Galactose intolerance

Lactose monohydrate is present in the tablet film coat. Patients with rare hereditary problems of galactose intolerance, the Lapp lactase deficiency or glucose-galactose malabsorption should not take this medicine.

#### Use of sildenafil with bosentan

The efficacy of sildenafil in patients already on bosentan therapy has not been conclusively demonstrated (see sections 4.5 and 5.1).

#### Concomitant use with other PDE5 inhibitors

The safety and efficacy of sildenafil when co-administered with other PDE5 inhibitor products, including Viagra, has not been studied in PAH patients and such concomitant use is not recommended (see section 4.5).

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

### Effects of other medicinal products on sildenafil

#### In vitro studies

Sildenafil metabolism is principally mediated by the cytochrome P450 (CYP) isoforms 3A4 (major route) and 2C9 (minor route). Therefore, inhibitors of these isoenzymes may reduce sildenafil clearance and inducers of these isoenzymes may increase sildenafil clearance. For dose recommendations, see sections 4.2 and 4.3.

#### In vivo studies

Co-administration of oral sildenafil and intravenous epoprostenol has been evaluated (see sections 4.8 and 5.1).

The efficacy and safety of sildenafil co-administered with other treatments for pulmonary arterial hypertension (eg, ambrisentan, iloprost) has not been studied in controlled clinical trials. Therefore, caution is recommended in case of co-administration.

The safety and efficacy of sildenafil when co-administered with other PDE5 inhibitors has not been studied in pulmonary arterial hypertension patients (see section 4.4).

Population pharmacokinetic analysis of pulmonary arterial hypertension clinical trial data indicated a reduction in sildenafil clearance and/or an increase of oral bioavailability when co-administered with CYP3A4 substrates and the combination of CYP3A4 substrates and beta-blockers. These were the only factors with a statistically significant impact on sildenafil pharmacokinetics in patients with pulmonary arterial hypertension. The exposure to sildenafil in patients on CYP3A4 substrates and CYP3A4 substrates plus beta-blockers was 43 % and 66 % higher, respectively, compared to patients not receiving these classes of medicines. Sildenafil exposure was 5-fold higher at a dose of 80 mg three times a day compared to the exposure at a dose of 20 mg three times a day. This concentration range covers the increase in sildenafil exposure observed in specifically designed drug interaction studies with CYP3A4 inhibitors (except with the most potent of the CYP3A4 inhibitors eg, ketoconazole, itraconazole, ritonavir).

CYP3A4 inducers seemed to have a substantial impact on the pharmacokinetics of sildenafil in pulmonary arterial hypertension patients, which was confirmed in the in-vivo interaction study with CYP3A4 inducer bosentan.

Co-administration of bosentan (a moderate inducer of CYP3A4, CYP2C9 and possibly of CYP2C19) 125 mg twice daily with sildenafil 80 mg three times a day (at steady state) concomitantly administered during 6 days in healthy volunteers resulted in a 63 % decrease of sildenafil AUC. A population pharmacokinetic analysis of sildenafil data from adult PAH patients in clinical trials including a 12 week study to assess the efficacy and safety of oral sildenafil 20 mg three times a day when added to a stable dose of bosentan (62.5 mg – 125 mg twice a day) indicated a decrease in sildenafil exposure with bosentan co-administration, similar to that observed in healthy volunteers (see sections 4.4 and 5.1).

Efficacy of sildenafil should be closely monitored in patients using concomitant potent CYP3A4 inducers, such as carbamazepine, phenytoin, phenobarbital, St John's wort and rifampicine.

Co-administration of the HIV protease inhibitor ritonavir, which is a highly potent P450 inhibitor, at steady state (500 mg twice daily) with sildenafil (100 mg single dose) resulted in a 300 % (4-fold) increase in sildenafil  $C_{max}$  and a 1,000 % (11-fold) increase in sildenafil plasma AUC. At 24 hours, the plasma levels of sildenafil were still approximately 200 ng/ml, compared to approximately 5 ng/ml when sildenafil was administered alone. This is consistent with ritonavir's marked effects on a broad range of P450 substrates. Based on these pharmacokinetic results co-administration of sildenafil with ritonavir is contraindicated in pulmonary arterial hypertension patients (see section 4.3).

Co-administration of the HIV protease inhibitor saquinavir, a CYP3A4 inhibitor, at steady state (1200 mg three times a day) with sildenafil (100 mg single dose) resulted in a 140 % increase in sildenafil  $C_{max}$  and a 210 % increase in sildenafil AUC. Sildenafil had no effect on saquinavir pharmacokinetics. For dose recommendations, see section 4.2.

When a single 100 mg dose of sildenafil was administered with erythromycin, a moderate CYP3A4 inhibitor, at steady state (500 mg twice daily for 5 days), there was a 182 % increase in sildenafil systemic exposure (AUC). For dose recommendations, see section 4.2. In healthy male volunteers, there was no evidence of an effect of azithromycin (500 mg daily for 3 days) on the AUC,  $C_{max}$ ,  $T_{max}$ , elimination rate constant, or subsequent half-life of sildenafil or its principal circulating metabolite. No dose adjustment is required. Cimetidine (800 mg), a cytochrome P450 inhibitor and a non-specific CYP3A4 inhibitor, caused a 56 % increase in plasma sildenafil concentrations when co-administered with sildenafil (50 mg) to healthy volunteers. No dose adjustment is required.

The most potent of the CYP3A4 inhibitors such as ketoconazole and itraconazole would be expected to have effects similar to ritonavir (see section 4.3). CYP3A4 inhibitors like clarithromycin, telithromycin and nefazodone are expected to have an effect in between that of ritonavir and CYP3A4 inhibitors like saquinavir or erythromycin, a seven-fold increase in exposure is assumed. Therefore dose adjustments are recommended when using CYP3A4 inhibitors (see section 4.2).

The population pharmacokinetic analysis in pulmonary arterial hypertension patients suggested that co-administration of beta-blockers in combination with CYP3A4 substrates might result in an additional increase in sildenafil exposure compared with administration of CYP3A4 substrates alone.

Grapefruit juice is a weak inhibitor of CYP3A4 gut wall metabolism and may give rise to modest increases in plasma levels of sildenafil. No dose adjustment is required but the concomitant use of sildenafil and grapefruit juice is not recommended.

Single doses of antacid (magnesium hydroxide/aluminium hydroxide) did not affect the bioavailability of sildenafil.

Co-administration of oral contraceptives (ethinylloestradiol 30 µg and levonorgestrel 150 µg) did not affect the pharmacokinetics of sildenafil.

Nicorandil is a hybrid of potassium channel activator and nitrate. Due to the nitrate component it has the potential to have serious interaction with sildenafil (see section 4.3).

#### Effects of sildenafil on other medicinal products

##### *In vitro studies*

Sildenafil is a weak inhibitor of the cytochrome P450 isoforms 1A2, 2C9, 2C19, 2D6, 2E1 and 3A4 ( $IC_{50} > 150 \mu M$ ).

There are no data on the interaction of sildenafil and non-specific phosphodiesterase inhibitors such as theophylline or dipyridamole.

##### *In vivo studies*

No significant interactions were shown when sildenafil (50 mg) was co-administered with tolbutamide (250 mg) or warfarin (40 mg), both of which are metabolised by CYP2C9.

Sildenafil had no significant effect on atorvastatin exposure (AUC increased 11 %), suggesting that sildenafil does not have a clinically relevant effect on CYP3A4.

No interactions were observed between sildenafil (100 mg single dose) and acenocoumarol.

Sildenafil (50 mg) did not potentiate the increase in bleeding time caused by acetyl salicylic acid (150 mg).

Sildenafil (50 mg) did not potentiate the hypotensive effects of alcohol in healthy volunteers with mean maximum blood alcohol levels of 80 mg/dl.

In a study of healthy volunteers sildenafil at steady state (80 mg three times a day) resulted in a 50 % increase in bosentan AUC (125 mg twice daily). A population pharmacokinetic analysis of data from a study of adult PAH patients on background bosentan therapy (62.5 mg - 125 mg twice a day) indicated an increase (20% (95% CI: 9.8 - 30.8)) of bosentan AUC with co-administration of steady-state sildenafil (20 mg three times a day) of a smaller magnitude than seen in healthy volunteers when co-administered with 80 mg sildenafil three times a day (see sections 4.4 and 5.1).

In a specific interaction study, where sildenafil (100 mg) was co-administered with amlodipine in hypertensive patients, there was an additional reduction on supine systolic blood pressure of 8 mmHg. The corresponding additional reduction in supine diastolic blood pressure was 7 mmHg. These additional blood pressure reductions were of a similar magnitude to those seen when sildenafil was administered alone to healthy volunteers.

In three specific drug-drug interaction studies, the alpha-blocker doxazosin (4 mg and 8 mg) and sildenafil (25 mg, 50 mg, or 100 mg) were administered simultaneously to patients with benign prostatic hyperplasia (BPH) stabilized on doxazosin therapy. In these study populations, mean additional reductions of supine systolic and diastolic blood pressure of 7/7 mmHg, 9/5 mmHg, and 8/4 mmHg, respectively, and mean additional reductions of standing blood pressure of 6/6 mmHg, 11/4 mmHg, and 4/5 mmHg, respectively were observed. When sildenafil and doxazosin were administered simultaneously to patients stabilized on doxazosin therapy, there were infrequent reports of patients who experienced symptomatic postural hypotension. These reports included dizziness and lightheadedness, but not syncope. Concomitant administration of sildenafil to patients taking alpha-blocker therapy may lead to symptomatic hypotension in susceptible individuals (see section 4.4).

Sildenafil (100 mg single dose) did not affect the steady state pharmacokinetics of the HIV protease inhibitor saquinavir, which is a CYP3A4 substrate/inhibitor.

Consistent with its known effects on the nitric oxide/cGMP pathway (see section 5.1), sildenafil was shown to potentiate the hypotensive effects of nitrates, and its co-administration with nitric oxide donors or nitrates in any form is therefore contraindicated (see section 4.3).

Riociguat: Preclinical studies showed additive systemic blood pressure lowering effect when PDE5 inhibitors were combined with riociguat. In clinical studies, riociguat has been shown to augment the hypotensive effects of PDE5 inhibitors. There was no evidence of favourable clinical effect of the combination in the population studied. Concomitant use of riociguat with PDE5 inhibitors, including sildenafil, is contraindicated (see section 4.3).

Sildenafil had no clinically significant impact on the plasma levels of oral contraceptives (ethinylestradiol 30 µg and levonorgestrel 150 µg).

#### Paediatric population

Interaction studies have only been performed in adults.

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

### Women of childbearing potential and contraception in males and females

Due to lack of data on effects of Revatio in pregnant women, Revatio is not recommended for women of childbearing potential unless also using appropriate contraceptive measures.

### Pregnancy

There are no data from the use of sildenafil in pregnant women. Animal studies do not indicate direct or indirect harmful effects with respect to pregnancy and embryonal/foetal development. Studies in animals have shown toxicity with respect to postnatal development (see section 5.3).

Due to lack of data, Revatio should not be used in pregnant women unless strictly necessary.

### Breast-feeding

It is not known whether sildenafil enters the breast milk. Revatio should not be administered to breast-feeding mothers.

### Fertility

Non-clinical data revealed no special hazard for humans based on conventional studies of fertility (see section 5.3).

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

Revatio has moderate influence on the ability to drive and use machines.

As dizziness and altered vision were reported in clinical trials with sildenafil, patients should be aware of how they might be affected by Revatio, before driving or using machines.

## **4.8 Undesirable effects**

### Summary of the safety profile

In the pivotal placebo-controlled study of Revatio in pulmonary arterial hypertension, a total of 207 patients were randomized to and treated with 20 mg, 40 mg, or 80 mg TID doses of Revatio and 70 patients were randomized to placebo. The duration of treatment was 12 weeks. The overall frequency of discontinuation in sildenafil treated patients at doses of 20 mg, 40 mg and 80 mg TID was 2.9 %, 3.0 % and 8.5 % respectively, compared to 2.9 % with placebo. Of the 277 subjects treated in the pivotal study, 259 entered a long-term extension study. Doses up to 80 mg three times a day (4 times the recommended dose of 20 mg three times a day) were administered and after 3 years 87 % of 183 patients on study treatment were receiving Revatio 80 mg TID.

In a placebo-controlled study of Revatio as an adjunct to intravenous epoprostenol in pulmonary arterial hypertension, a total of 134 patients were treated with Revatio (in a fixed titration starting from 20 mg, to 40 mg and then 80 mg, three times a day, as tolerated) and epoprostenol, and 131 patients were treated with placebo and epoprostenol. The duration of treatment was 16 weeks. The overall frequency of discontinuations in sildenafil/epoprostenol treated patients due to adverse events was 5.2 % compared to 10.7 % in the placebo/epoprostenol treated patients. Newly reported adverse reactions, which occurred more frequently in the sildenafil/epoprostenol group, were ocular hyperaemia, vision blurred, nasal congestion, night sweats, back pain and dry mouth. The known adverse reactions headache, flushing, pain in extremity and oedema were noted in a higher frequency in sildenafil/epoprostenol treated patients compared to placebo/epoprostenol treated patients. Of the subjects who completed the initial study, 242 entered a long-term extension study. Doses up to 80 mg TID were administered and after 3 years 68 % of 133 patients on study treatment were receiving Revatio 80 mg TID.

In the two placebo-controlled studies adverse events were generally mild to moderate in severity. The most commonly reported adverse reactions that occurred (greater or equal to 10 %) on Revatio compared to placebo were headache, flushing, dyspepsia, diarrhoea and pain in extremity.

### Tabulated list of adverse reactions

Adverse reactions which occurred in > 1 % of Revatio-treated patients and were more frequent (> 1 % difference) on Revatio in the pivotal study or in the Revatio combined data set of both the placebo-controlled studies in pulmonary arterial hypertension, at doses of 20, 40 or 80 mg TID are

listed in the table below by class and frequency grouping (very common ( $\geq 1/10$ ), common ( $\geq 1/100$  to  $< 1/10$ ), uncommon ( $\geq 1/1000$  to  $\leq 1/100$ ) and not known (cannot be estimated from the available data). Within each frequency grouping, adverse reactions are presented in order of decreasing seriousness.

Reports from post-marketing experience are included in italics.

<b>MedDRA system organ class (V.14.0)</b>	<b>Adverse reaction</b>
<b>Infections and infestations</b>	
Common	cellulitis, influenza, bronchitis, sinusitis, rhinitis, gastroenteritis
<b>Blood and lymphatic system disorders</b>	
Common	anaemia
<b>Metabolism and nutrition disorders</b>	
Common	fluid retention
<b>Psychiatric disorders</b>	
Common	insomnia, anxiety
<b>Nervous system disorders</b>	
Very common	headache
Common	migraine, tremor, paraesthesia, burning sensation, hypoaesthesia
<b>Eye disorders</b>	
Common	retinal haemorrhage, visual impairment, vision blurred, photophobia, chromatopsia, cyanopsia, eye irritation, ocular hyperaemia
Uncommon	visual acuity reduced, diplopia, abnormal sensation in eye
Not known	<i>Non-arteritic anterior ischaemic optic neuropathy (NAION)*, Retinal vascular occlusion*, Visual field defect*</i>
<b>Ear and labyrinth disorders</b>	
Common	vertigo
Not known	<i>sudden hearing loss</i>
<b>Vascular disorders</b>	
Very common	flushing
Not Known	<i>hypotension</i>
<b>Respiratory, thoracic and mediastinal disorders</b>	
Common	epistaxis, cough, nasal congestion
<b>Gastrointestinal disorders</b>	
Very common	diarrhoea, dyspepsia
Common	gastritis, gastrooesophageal reflux disease, haemorrhoids, abdominal distension, dry mouth
<b>Skin and subcutaneous tissue disorders</b>	
Common	alopecia, erythema, night sweats
Not known	<i>rash</i>
<b>Musculoskeletal and connective tissue disorders</b>	
Very common	pain in extremity
Common	myalgia, back pain
<b>Renal and urinary disorders</b>	
Uncommon	haematuria
<b>Reproductive system and breast disorders</b>	
Uncommon	penile haemorrhage, haemospermia, gynaecomastia

Not known	<i>priapism, erection increased</i>
<b>General disorders and administration site conditions</b>	
Common	pyrexia

\*These adverse events/reactions have been reported in patients taking sildenafil for the treatment of male erectile dysfunction (MED).

### Paediatric population

In the placebo-controlled study of Revatio in patients 1 to 17 years of age with pulmonary arterial hypertension, a total of 174 patients were treated three times a day with either low (10 mg in patients > 20 kg; no patients ≤ 20 kg received the low dose), medium (10 mg in patients ≥ 8-20 kg; 20 mg in patients ≥ 20-45 kg; 40 mg in patients > 45 kg) or high dose (20 mg in patients ≥ 8-20 kg; 40 mg in patients ≥ 20-45 kg; 80 mg in patients > 45 kg) regimens of Revatio and 60 were treated with placebo.

The adverse reactions profile seen in this paediatric study was generally consistent with that in adults (see table above). The most common adverse reactions that occurred (with a frequency ≥ 1 %) in Revatio patients (combined doses) and with a frequency > 1 % over placebo patients were pyrexia, upper respiratory tract infection (each 11.5%), vomiting (10.9%), erection increased (including spontaneous penile erections in male subjects) (9.0%), nausea, bronchitis (each 4.6%), pharyngitis (4.0%), rhinorrhoea (3.4%), and pneumonia, rhinitis (each 2.9%).

Of the 234 paediatric subjects treated in the short-term, placebo-controlled study, 220 subjects entered the long-term extension study. Subjects on active sildenafil therapy continued on the same treatment regimen, while those in the placebo group in the short-term study were randomly reassigned to sildenafil treatment.

The most common adverse reactions reported across the duration of the short-term and long-term studies were generally similar to those observed in the short-term study. Adverse reactions reported in >10% of 229 subjects treated with sildenafil (combined dose group, including 9 patients that did not continue into the long-term study) were upper respiratory infection (31%), headache (26%), vomiting (22%), bronchitis (20%), pharyngitis (18%), pyrexia (17%), diarrhoea (15%), and influenza, epistaxis (12% each). Most of these adverse reactions were considered mild to moderate in severity.

Serious adverse events were reported in 94 (41%) of the 229 subjects receiving sildenafil. Of the 94 subjects reporting a serious adverse event, 14/55 (25.5%) subjects were in the low dose group, 35/74 (47.3%) in the medium dose group, and 45/100 (45%) in the high dose group. The most common serious adverse events that occurred with a frequency ≥ 1 % in sildenafil patients (combined doses) were pneumonia (7.4%), cardiac failure, pulmonary hypertension (each 5.2%), upper respiratory tract infection (3.1%), right ventricular failure, gastroenteritis (each 2.6%), syncope, bronchitis, bronchopneumonia, pulmonary arterial hypertension (each 2.2%), chest pain, dental caries (each 1.7%), and cardiogenic shock, gastroenteritis viral, urinary tract infection (each 1.3%).

The following serious adverse events were considered to be treatment related, enterocolitis, convulsion, hypersensitivity, stridor, hypoxia, neurosensory deafness and ventricular arrhythmia.

### 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 national reporting system listed in [Appendix V](#)**.

## **4.9 Overdose**

In single dose volunteer studies of doses up to 800 mg, adverse reactions were similar to those seen at lower doses, but the incidence rates and severities were increased. At single doses of 200 mg the incidence of adverse reactions (headache, flushing, dizziness, dyspepsia, nasal congestion, and altered vision) was increased.

In cases of overdose, standard supportive measures should be adopted as required. Renal dialysis is not expected to accelerate clearance as sildenafil is highly bound to plasma proteins and not eliminated in the urine.

## 5. PHARMACOLOGICAL PROPERTIES

### 5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Urologicals, Drugs used in erectile dysfunction, ATC code: G04BE03

#### Mechanism of action

Sildenafil is a potent and selective inhibitor of cyclic guanosine monophosphate (cGMP) specific phosphodiesterase type 5 (PDE5), the enzyme that is responsible for degradation of cGMP. Apart from the presence of this enzyme in the corpus cavernosum of the penis, PDE5 is also present in the pulmonary vasculature. Sildenafil, therefore, increases cGMP within pulmonary vascular smooth muscle cells resulting in relaxation. In patients with pulmonary arterial hypertension this can lead to vasodilation of the pulmonary vascular bed and, to a lesser degree, vasodilatation in the systemic circulation.

#### Pharmacodynamic effects

Studies *in vitro* have shown that sildenafil is selective for PDE5. Its effect is more potent on PDE5 than on other known phosphodiesterases. There is a 10-fold selectivity over PDE6 which is involved in the phototransduction pathway in the retina. There is an 80-fold selectivity over PDE1, and over 700-fold over PDE 2, 3, 4, 7, 8, 9, 10 and 11. In particular, sildenafil has greater than 4,000-fold selectivity for PDE5 over PDE3, the cAMP-specific phosphodiesterase isoform involved in the control of cardiac contractility.

Sildenafil causes mild and transient decreases in systemic blood pressure which, in the majority of cases, do not translate into clinical effects. After chronic dosing of 80 mg three times a day to patients with systemic hypertension the mean change from baseline in systolic and diastolic blood pressure was a decrease of 9.4 mmHg and 9.1 mm Hg respectively. After chronic dosing of 80 mg three times a day to patients with pulmonary arterial hypertension lesser effects in blood pressure reduction were observed (a reduction in both systolic and diastolic pressure of 2 mmHg). At the recommended dose of 20 mg three times a day no reductions in systolic or diastolic pressure were seen.

Single oral doses of sildenafil up to 100 mg in healthy volunteers produced no clinically relevant effects on ECG. After chronic dosing of 80 mg three times a day to patients with pulmonary arterial hypertension no clinically relevant effects on the ECG were reported.

In a study of the hemodynamic effects of a single oral 100 mg dose of sildenafil in 14 patients with severe coronary artery disease (CAD) (> 70 % stenosis of at least one coronary artery), the mean resting systolic and diastolic blood pressures decreased by 7 % and 6 % respectively compared to baseline. Mean pulmonary systolic blood pressure decreased by 9 %. Sildenafil showed no effect on cardiac output, and did not impair blood flow through the stenosed coronary arteries.

Mild and transient differences in colour discrimination (blue/green) were detected in some subjects using the Farnsworth-Munsell 100 hue test at 1 hour following a 100 mg dose, with no effects evident after 2 hours post-dose. The postulated mechanism for this change in colour discrimination is related to inhibition of PDE6, which is involved in the phototransduction cascade of the retina. Sildenafil has no effect on visual acuity or contrast sensitivity. In a small size placebo-controlled study of patients with documented early age-related macular degeneration (n = 9), sildenafil (single dose, 100 mg) demonstrated no significant changes in visual tests conducted (visual acuity, Amsler grid, colour discrimination simulated traffic light, Humphrey perimeter and photostress).

## Clinical efficacy and safety

### Efficacy in adult patients with pulmonary arterial hypertension (PAH)

A randomised, double-blind, placebo-controlled study was conducted in 278 patients with primary pulmonary hypertension, PAH associated with connective tissue disease, and PAH following surgical repair of congenital heart lesions. Patients were randomised to one of four treatment groups: placebo, sildenafil 20 mg, sildenafil 40 mg or sildenafil 80 mg, three times a day. Of the 278 patients randomised, 277 patients received at least 1 dose of study drug. The study population consisted of 68 (25 %) men and 209 (75 %) women with a mean age of 49 years (range: 18-81 years) and baseline 6-minute walk test distance between 100 and 450 metres inclusive (mean: 344 metres). 175 patients (63 %) included were diagnosed with primary pulmonary hypertension, 84 (30 %) were diagnosed with PAH associated with connective tissue disease and 18 (7 %) of the patients were diagnosed with PAH following surgical repair of congenital heart lesions. Most patients were WHO Functional Class II (107/277, 39 %) or III (160/277, 58 %) with a mean baseline 6 minute walking distance of 378 meters and 326 meters respectively; fewer patients were Class I (1/277, 0.4 %) or IV (9/277, 3 %) at baseline. Patients with left ventricular ejection fraction < 45 % or left ventricular shortening fraction < 0.2 were not studied.

Sildenafil (or placebo) was added to patients' background therapy which could have included a combination of anticoagulation, digoxin, calcium channel blockers, diuretics or oxygen. The use of prostacyclin, prostacyclin analogues and endothelin receptor antagonists was not permitted as add-on therapy, and neither was arginine supplementation. Patients who previously failed bosentan therapy were excluded from the study.

The primary efficacy endpoint was the change from baseline at week 12 in 6-minute walk distance (6MWD). A statistically significant increase in 6MWD was observed in all 3 sildenafil dose groups compared to those on placebo. Placebo corrected increases in 6MWD were 45 metres ( $p < 0.0001$ ), 46 metres ( $p < 0.0001$ ) and 50 metres ( $p < 0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID respectively. There was no significant difference in effect between sildenafil doses. For patients with a baseline 6MWD < 325 m improved efficacy was observed with higher doses (placebo-corrected improvements of 58 metres, 65 metres and 87 metres for 20 mg, 40 mg and 80 mg doses TID, respectively).

When analysed by WHO functional class, a statistically significant increase in 6MWD was observed in the 20 mg dose group. For class II and class III, placebo corrected increases of 49 metres ( $p = 0.0007$ ) and 45 metres ( $p = 0.0031$ ) were observed respectively.

The improvement in 6MWD was apparent after 4 weeks of treatment and this effect was maintained at weeks 8 and 12. Results were generally consistent in subgroups according to aetiology (primary and connective tissue disease-associated PAH), WHO functional class, gender, race, location, mean PAP and PVRI.

Patients on all sildenafil doses achieved a statistically significant reduction in mean pulmonary arterial pressure (mPAP) and pulmonary vascular resistance (PVR) compared to those on placebo. Placebo-corrected treatment effects with mPAP were -2.7 mmHg ( $p = 0.04$ ), -3.0 mm Hg ( $p = 0.01$ ) and -5.1 mm Hg ( $p < 0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID respectively. Placebo-corrected treatment effects with PVR were -178 dyne.sec/cm<sup>5</sup> ( $p=0.0051$ ), -195 dyne.sec/cm<sup>5</sup> ( $p=0.0017$ ) and -320 dyne.sec/cm<sup>5</sup> ( $p<0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID, respectively. The percent reduction at 12 weeks for sildenafil 20 mg, 40 mg and 80 mg TID in PVR (11.2 %, 12.9 %, 23.3 %) was proportionally greater than the reduction in systemic vascular resistance (SVR) (7.2 %, 5.9 %, 14.4 %). The effect of sildenafil on mortality is unknown.

A greater percentage of patients on each of the sildenafil doses (i.e. 28 %, 36 % and 42 % of subjects who received sildenafil 20 mg, 40 mg and 80 mg TID doses, respectively) showed an improvement by at least one WHO functional class at week 12 compared to placebo (7 %). The respective odds ratios were 2.92 ( $p=0.0087$ ), 4.32 ( $p=0.0004$ ) and 5.75 ( $p<0.0001$ ).

#### Long-term survival data in naive population

Patients enrolled into the pivotal study were eligible to enter a long term open label extension study. At 3 years 87 % of the patients were receiving a dose of 80 mg TID. A total of 207 patients were treated with Revatio in the pivotal study, and their long term survival status was assessed for a minimum of 3 years. In this population, Kaplan-Meier estimates of 1, 2 and 3 year survival were 96 %, 91 % and 82 %, respectively. Survival in patients of WHO functional class II at baseline at 1, 2 and 3 years was 99 %, 91 %, and 84 % respectively, and for patients of WHO functional class III at baseline was 94 %, 90 %, and 81 %, respectively.

#### Efficacy in adult patients with PAH (when used in combination with epoprostenol)

A randomised, double-blind, placebo controlled study was conducted in 267 patients with PAH who were stabilised on intravenous epoprostenol. The PAH patients included those with Primary Pulmonary Arterial Hypertension (212/267, 79 %) and PAH associated with connective tissue disease (55/267, 21 %). Most patients were WHO Functional Class II (68/267, 26 %) or III (175/267, 66 %); fewer patients were Class I (3/267, 1 %) or IV (16/267, 6 %) at baseline; for a few patients (5/267, 2 %), the WHO Functional Class was unknown. Patients were randomised to placebo or sildenafil (in a fixed titration starting from 20 mg, to 40 mg and then 80 mg, three times a day as tolerated) when used in combination with intravenous epoprostenol.

The primary efficacy endpoint was the change from baseline at week 16 in 6-minute walk distance. There was a statistically significant benefit of sildenafil compared to placebo in 6-minute walk distance. A mean placebo corrected increase in walk distance of 26 metres was observed in favour of sildenafil (95 % CI: 10.8, 41.2) ( $p = 0.0009$ ). For patients with a baseline walking distance  $\geq 325$  metres, the treatment effect was 38.4 metres in favour of sildenafil; for patients with a baseline walking distance  $< 325$  metres, the treatment effect was 2.3 metres in favour of placebo. For patients with primary PAH, the treatment effect was 31.1 metres compared to 7.7 metres for patients with PAH associated with connective tissue disease. The difference in results between these randomisation subgroups may have arisen by chance in view of their limited sample size.

Patients on sildenafil achieved a statistically significant reduction in mean Pulmonary Arterial Pressure (mPAP) compared to those on placebo. A mean placebo-corrected treatment effect of -3.9 mmHg was observed in favour of sildenafil (95 % CI: -5.7, -2.1) ( $p = 0.00003$ ). Time to clinical worsening was a secondary endpoint as defined as the time from randomisation to the first occurrence of a clinical worsening event (death, lung transplantation, initiation of bosentan therapy, or clinical deterioration requiring a change in epoprostenol therapy). Treatment with sildenafil significantly delayed the time to clinical worsening of PAH compared to placebo ( $p = 0.0074$ ). 23 subjects experienced clinical worsening events in the placebo group (17.6 %) compared with 8 subjects in the sildenafil group (6.0 %).

#### Long-term Survival Data in the background epoprostenol study

Patients enrolled into the epoprostenol add-on therapy study were eligible to enter a long term open label extension study. At 3 years 68 % of the patients were receiving a dose of 80 mg TID. A total of 134 patients were treated with Revatio in the initial study, and their long term survival status was assessed for a minimum of 3 years. In this population, Kaplan-Meier estimates of 1, 2 and 3 year survival were 92 %, 81 % and 74 %, respectively.

#### Efficacy and safety in adult patients with PAH (when used in combination with bosentan)

A randomized, double-blind, placebo controlled study was conducted in 103 clinically stable subjects with PAH (WHO FC II and III) who were on bosentan therapy for a minimum of three months. The PAH patients included those with primary PAH, and PAH associated with connective tissue disease. Patients were randomized to placebo or sildenafil (20 mg three times a day) in combination with bosentan (62.5-125 mg twice a day). The primary efficacy endpoint was the change from baseline at Week 12 in 6MWD. The results indicate that there is no significant difference in mean change from baseline on 6MWD observed between sildenafil (20 mg three times a day) and placebo (13.62 m (95% CI: -3.89 to 31.12) and 14.08 m (95% CI: -1.78 to 29.95), respectively).

Differences in 6MWD were observed between patients with primary PAH and PAH associated with connective tissue disease. For subjects with primary PAH (67 subjects), mean changes from baseline were 26.39 m (95% CI: 10.70 to 42.08) and 11.84 m (95% CI: -8.83 to 32.52) for the sildenafil and placebo groups, respectively. However, for subjects with PAH associated with connective tissue disease (36 subjects) mean changes from baseline were -18.32 m (95% CI: -65.66 to 29.02) and 17.50 m (95% CI: -9.41 to 44.41) for the sildenafil and placebo groups, respectively.

Overall, the adverse events were generally similar between the two treatment groups (sildenafil plus bosentan vs. bosentan alone), and consistent with the known safety profile of sildenafil when used as monotherapy (see sections 4.4 and 4.5).

#### Paediatric population

A total of 234 subjects aged 1 to 17 years were treated in a randomized, double-blind, multi-centre, placebo controlled parallel group, dose ranging study. Subjects (38 % male and 62 % female) had a body weight  $\geq$  8 kg, and had primary pulmonary hypertension (PPH) [33 %], or PAH secondary to congenital heart disease [systemic-to-pulmonary shunt 37 %, surgical repair 30 %]. In this trial, 63 of 234 (27 %) patients were  $<$  7 years old (sildenafil low dose = 2; medium dose = 17; high dose = 28; placebo = 16) and 171 of 234 (73 %) patients were 7 years or older (sildenafil low dose = 40; medium dose = 38; and high dose = 49; placebo = 44). Most subjects were WHO Functional Class I (75/234, 32 %) or II (120/234, 51 %) at baseline; fewer patients were Class III (35/234, 15 %) or IV (1/234, 0.4 %); for a few patients (3/234, 1.3 %), the WHO Functional Class was unknown.

Patients were naïve for specific PAH therapy and the use of prostacyclin, prostacyclin analogues and endothelin receptor antagonists was not permitted in the study, and neither was arginine supplementation, nitrates, alpha-blockers and potent CYP450 3A4 inhibitors.

The primary objective of the study was to assess the efficacy of 16 weeks of chronic treatment with oral sildenafil in paediatric subjects to improve exercise capacity as measured by the Cardiopulmonary Exercise Test (CPET) in subjects who were developmentally able to perform the test,  $n = 115$ ). Secondary endpoints included haemodynamic monitoring, symptom assessment, WHO functional class, change in background treatment, and quality of life measurements.

Subjects were allocated to one of three sildenafil treatment groups, low (10 mg), medium (10-40 mg) or high dose (20-80 mg) regimens of Revatio given three times a day, or placebo. Actual doses administered within a group were dependent on body weight (see Section 4.8). The proportion of subjects receiving supportive medicinal products at baseline (anticoagulants, digoxin, calcium channel blockers, diuretics and/or oxygen) was similar in the combined sildenafil treatment group (47.7 %) and the placebo treatment group (41.7 %).

The primary endpoint was the placebo-corrected percentage change in peak  $VO_2$  from baseline to week 16 assessed by CPET testing in the combined dose groups (Table 2). A total of 106 out of 234 (45 %) subjects were evaluable for CPET, which comprised those children  $\geq$  7 years old and developmentally able to perform the test. Children  $<$  7 years (sildenafil combined dose = 47; placebo = 16) were evaluable only for the secondary endpoints. Mean baseline peak volume of oxygen consumed ( $VO_2$ ) values were comparable across the sildenafil treatment groups (17.37 to 18.03 ml/kg/min), and slightly higher for the placebo treatment group (20.02 ml/kg/min). The results of the main analysis (combined dose groups versus placebo) were not statistically significant ( $p = 0.056$ ) (see Table 2). The estimated difference between the medium sildenafil dose and placebo was 11.33 % (95 % CI: 1.72 to 20.94) (see Table 2).

**Table 2: Placebo Corrected % Change from Baseline in Peak VO<sub>2</sub> by Active Treatment Group**

<b>Treatment group</b>	<b>Estimated difference</b>	<b>95% confidence interval</b>
<b>Low dose</b> (n=24)	3.81	-6.11, 13.73
<b>Medium dose</b> (n=26)	11.33	1.72, 20.94
<b>High dose</b> (n=27)	7.98	-1.64, 17.60
<b>Combined dose groups</b> (n=77)	7.71 (p = 0.056)	-0.19, 15.60

*n=29 for placebo group*

*Estimates based on ANCOVA with adjustments for the covariates baseline peak VO<sub>2</sub>, etiology and weight group*

Dose related improvements were observed with pulmonary vascular resistance index (PVRI) and mean pulmonary arterial pressure (mPAP). The sildenafil medium and high dose groups both showed PVRI reductions compared to placebo, of 18 % (95 % CI: 2 % to 32 %) and 27 % (95 % CI: 14 % to 39 %), respectively; whilst the low dose group showed no significant difference from placebo (difference of 2 %). The sildenafil medium and high dose groups displayed mPAP changes from baseline compared to placebo, of -3.5 mmHg (95 % CI: -8.9, 1.9) and -7.3 mmHg (95 % CI: -12.4, -2.1), respectively; whilst the low dose group showed little difference from placebo (difference of 1.6 mmHg). Improvements were observed with cardiac index with all three sildenafil groups over placebo, 10 %, 4 % and 15 % for the low, medium and high dose groups respectively.

Significant improvements in functional class were demonstrated only in subjects on sildenafil high dose compared to placebo. Odds ratios for the sildenafil low, medium and high dose groups compared to placebo were 0.6 (95 % CI: 0.18, 2.01), 2.25 (95 % CI: 0.75, 6.69) and 4.52 (95 % CI: 1.56, 13.10), respectively.

#### Long term extension data

Of the 234 paediatric subjects treated in the short-term, placebo-controlled study, 220 subjects entered the long-term extension study. Subjects who had been in the placebo group in the short-term study were randomly reassigned to sildenafil treatment; subjects weighing ≤ 20 kg entered the medium or high dose groups (1:1), while subjects weighing > 20 kg entered the low, medium or high dose groups (1:1:1). Of the total 229 subjects who received sildenafil, there were 55, 74, and 100 subjects in the low, medium and high dose groups, respectively. Across the short-term and long-term studies, the overall duration of treatment from start of double-blind for individual subjects ranged from 3 to 3129 days. By sildenafil treatment group, median duration of sildenafil treatment was 1696 days (excluding the 5 subjects who received placebo in double-blind and were not treated in the long-term extension study).

Kaplan-Meier estimates of survival at 3 years in patients > 20 kg in weight at baseline were 94 %, 93 % and 85 % in the low, medium and high dose groups, respectively; for patients ≤ 20 kg in weight at baseline, the survival estimates were 94 % and 93 % for subjects in the medium and high dose groups respectively (see sections 4.4 and 4.8).

During the conduct of the study, there were a total of 42 deaths reported, whether on treatment or reported as part of the survival follow-up. 37 deaths occurred prior to a decision taken by the Data Monitoring Committee to down titrate subjects to a lower dosage, based on an observed mortality imbalance with increasing sildenafil doses. Among these 37 deaths, the number (%) of deaths was 5/55 (9.1%), 10/74 (13.5%), and 22/100 (22%) in the sildenafil low, medium, and high dose groups, respectively. An additional 5 deaths were reported subsequently. The causes of deaths were related to PAH. Higher than recommended doses should not be used in paediatric patients with PAH (see sections 4.2 and 4.4).

Peak VO<sub>2</sub> was assessed 1 year after the start of the placebo-controlled study. Of those sildenafil treated subjects developmentally able to perform the CPET 59/114 subjects (52 %) had not shown any deterioration in Peak VO<sub>2</sub> from start of sildenafil. Similarly 191 of 229 subjects (83 %) who had received sildenafil had either maintained or improved their WHO Functional Class at 1 year assessment.

The European Medicines Agency has deferred the obligation to submit the results of studies with Revatio in newborns with pulmonary arterial hypertension (see section 4.2 for information on paediatric use).

## 5.2 Pharmacokinetic properties

### Absorption

Sildenafil is rapidly absorbed. Maximum observed plasma concentrations are reached within 30 to 120 minutes (median 60 minutes) of oral dosing in the fasted state. The mean absolute oral bioavailability is 41 % (range 25-63 %). After oral three times a day dosing of sildenafil, AUC and C<sub>max</sub> increase in proportion with dose over the dose range of 20-40 mg. After oral doses of 80 mg three times a day a more than dose proportional increase in sildenafil plasma levels has been observed. In pulmonary arterial hypertension patients, the oral bioavailability of sildenafil after 80 mg three times a day was on average 43 % (90 % CI: 27 % - 60 %) higher compared to the lower doses.

When sildenafil is taken with food, the rate of absorption is reduced with a mean delay in T<sub>max</sub> of 60 minutes and a mean reduction in C<sub>max</sub> of 29 % however, the extent of absorption was not significantly affected (AUC decreased by 11 %).

### Distribution

The mean steady state volume of distribution (V<sub>ss</sub>) for sildenafil is 105 l, indicating distribution into the tissues. After oral doses of 20 mg three times a day, the mean maximum total plasma concentration of sildenafil at steady state is approximately 113 ng/ml. Sildenafil and its major circulating N-desmethyl metabolite are approximately 96 % bound to plasma proteins. Protein binding is independent of total drug concentrations.

### Biotransformation

Sildenafil is cleared predominantly by the CYP3A4 (major route) and CYP2C9 (minor route) hepatic microsomal isoenzymes. The major circulating metabolite results from N-demethylation of sildenafil. This metabolite has a phosphodiesterase selectivity profile similar to sildenafil and an *in vitro* potency for PDE5 approximately 50 % that of the parent drug. The N-desmethyl metabolite is further metabolised, with a terminal half-life of approximately 4 h. In patients with pulmonary arterial hypertension, plasma concentrations of N-desmethyl metabolite are approximately 72 % those of sildenafil after 20 mg three times a day dosing (translating into a 36 % contribution to sildenafil's pharmacological effects). The subsequent effect on efficacy is unknown.

### Elimination

The total body clearance of sildenafil is 41 l/h with a resultant terminal phase half-life of 3-5 h. After either oral or intravenous administration, sildenafil is excreted as metabolites predominantly in the faeces (approximately 80 % of administered oral dose) and to a lesser extent in the urine (approximately 13 % of administered oral dose).

### Pharmacokinetics in special patient groups

#### Elderly

Healthy elderly volunteers (65 years or over) had a reduced clearance of sildenafil, resulting in approximately 90 % higher plasma concentrations of sildenafil and the active N-desmethyl metabolite compared to those seen in healthy younger volunteers (18-45 years). Due to age-differences in plasma protein binding, the corresponding increase in free sildenafil plasma concentration was approximately 40 %.

### Renal insufficiency

In volunteers with mild to moderate renal impairment (creatinine clearance = 30-80 ml/min), the pharmacokinetics of sildenafil were not altered after receiving a 50 mg single oral dose. In volunteers with severe renal impairment (creatinine clearance < 30 ml/min), sildenafil clearance was reduced, resulting in mean increases in AUC and  $C_{\max}$  of 100 % and 88 % respectively compared to age-matched volunteers with no renal impairment. In addition, N-desmethyl metabolite AUC and  $C_{\max}$  values were significantly increased by 200 % and 79 % respectively in subjects with severe renal impairment compared to subjects with normal renal function.

### Hepatic insufficiency

In volunteers with mild to moderate hepatic cirrhosis (Child-Pugh class A and B) sildenafil clearance was reduced, resulting in increases in AUC (85 %) and  $C_{\max}$  (47 %) compared to age-matched volunteers with no hepatic impairment. In addition, N-desmethyl metabolite AUC and  $C_{\max}$  values were significantly increased by 154 % and 87 %, respectively in cirrhotic subjects compared to subjects with normal hepatic function. The pharmacokinetics of sildenafil in patients with severely impaired hepatic function have not been studied.

### Population pharmacokinetics

In patients with pulmonary arterial hypertension, the average steady state concentrations were 20-50 % higher over the investigated dose range of 20–80 mg three times a day compared to healthy volunteers. There was a doubling of the  $C_{\min}$  compared to healthy volunteers. Both findings suggest a lower clearance and/or a higher oral bioavailability of sildenafil in patients with pulmonary arterial hypertension compared to healthy volunteers.

### Paediatric population

From the analysis of the pharmacokinetic profile of sildenafil in patients involved in the paediatric clinical trials, body weight was shown to be a good predictor of drug exposure in children. Sildenafil plasma concentration half-life values were estimated to range from 4.2 to 4.4 hours for a range of 10 to 70 kg of body weight and did not show any differences that would appear as clinically relevant.  $C_{\max}$  after a single 20 mg sildenafil dose administered PO was estimated at 49, 104 and 165 ng/ml for 70, 20 and 10 kg patients, respectively.  $C_{\max}$  after a single 10 mg sildenafil dose administered PO was estimated at 24, 53 and 85 ng/ml for 70, 20 and 10 kg patients, respectively.  $T_{\max}$  was estimated at approximately 1 hour and was almost independent from body weight.

## **5.3 Preclinical safety data**

Non-clinical data revealed no special hazard for humans based on conventional studies of safety pharmacology, repeated dose toxicity, genotoxicity and carcinogenic potential, toxicity to reproduction and development.

In pups of rats which were pre- and postnatally treated with 60 mg/kg sildenafil, a decreased litter size, a lower pup weight on day 1 and a decreased 4-day survival were seen at exposures which were approximately fifty times the expected human exposure at 20 mg three times a day. Effects in non-clinical studies were observed at exposures considered sufficiently in excess of the maximum human exposure indicating little relevance to clinical use.

There were no adverse reactions, with possible relevance to clinical use, seen in animals at clinically relevant exposure levels which were not also observed in clinical studies.

## **6. PHARMACEUTICAL PARTICULARS**

### **6.1 List of excipients**

#### Tablet core:

Microcrystalline cellulose  
Calcium hydrogen phosphate (anhydrous)  
Croscarmellose sodium  
Magnesium stearate

#### Film coat:

Hypromellose  
Titanium dioxide (E171)  
Lactose monohydrate  
Glycerol triacetate

### **6.2 Incompatibilities**

Not applicable.

### **6.3 Shelf life**

5 years.

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

Do not store above 30°C. Store in the original package in order to protect from moisture.

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

PVC/Aluminium blisters of 90 tablets.  
Pack size of 90 tablets in a carton.  
90 x 1 tablets in PVC/Aluminium perforated unit dose blisters.

PVC/Aluminium blisters of 300 tablets.  
Pack size of 300 tablets in a carton.

Not all pack sizes may be marketed.

### **6.6 Special precautions for disposal and other handling**

No special requirements for disposal.

## **7. MARKETING AUTHORISATION HOLDER**

Pfizer Limited, Sandwich, Kent CT13 9NJ, United Kingdom.

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

EU/1/05/318/001  
EU/1/05/318/004  
EU/1/05/318/005

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

Date of first authorisation: 28 October 2005

Date of latest renewal: 23 September 2010

## **10. DATE OF REVISION OF THE TEXT**

Detailed information on this medicinal product is available on the website of the European Medicines Agency <http://www.ema.europa.eu>

## 1. NAME OF THE MEDICINAL PRODUCT

Revatio 0.8 mg/ml solution for injection

## 2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Each ml of solution contains 0.8 mg of sildenafil (as citrate). Each 20 ml vial contains 12.5 ml of solution (10 mg of sildenafil, as citrate).

For the full list of excipients, see section 6.1.

## 3. PHARMACEUTICAL FORM

Solution for injection.  
Clear, colourless solution.

## 4. CLINICAL PARTICULARS

### 4.1 Therapeutic indications

Revatio solution for injection is for the treatment of adult patients ( $\geq 18$  years) with pulmonary arterial hypertension who are currently prescribed oral Revatio and who are temporarily unable to take oral therapy, but are otherwise clinically and haemodynamically stable.

Revatio (oral) is indicated for treatment of adult patients with pulmonary arterial hypertension classified as WHO functional class II and III, to improve exercise capacity. Efficacy has been shown in primary pulmonary hypertension and pulmonary hypertension associated with connective tissue disease.

### 4.2 Posology and method of administration

Treatment should only be initiated and monitored by a physician experienced in the treatment of pulmonary arterial hypertension. In case of clinical deterioration in spite of Revatio treatment, alternative therapies should be considered.

Revatio solution for injection should be administered to patients already prescribed oral Revatio as a replacement for oral administration under conditions where they are temporarily unable to take oral Revatio therapy.

Safety and effectiveness of doses higher than 12.5 ml (10 mg) TID have not been established.

#### Posology

##### Adults

The recommended dose is 10 mg (corresponding to 12.5 ml) three times a day administered as an intravenous bolus injection (see section 6.6).

A 10 mg dose of Revatio solution for injection is predicted to provide exposure of sildenafil and its N-desmethyl metabolite and pharmacological effects comparable to those of a 20 mg oral dose.

##### Patients using other medicinal products

In general, any dose adjustment should be administered only after a careful benefit-risk assessment. A downward dose adjustment to 10 mg twice daily should be considered when sildenafil is

co-administered to patients already receiving CYP3A4 inhibitors like erythromycin or saquinavir. A downward dose adjustment to 10 mg once daily is recommended in case of co-administration with more potent CYP3A4 inhibitors like clarithromycin, telithromycin and nefazodone. For the use of sildenafil with the most potent CYP3A4 inhibitors, see section 4.3. Dose adjustments for sildenafil may be required when co-administered with CYP3A4 inducers (see section 4.5).

### Special populations

#### Elderly ( $\geq 65$ years)

Dose adjustments are not required in elderly patients. Clinical efficacy as measured by 6-minute walk distance could be less in elderly patients.

#### Renal impairment

Initial dose adjustments are not required in patients with renal impairment, including severe renal impairment (creatinine clearance  $< 30$  ml/min). A downward dose adjustment to 10 mg twice daily should be considered after a careful benefit-risk assessment only if therapy is not well-tolerated.

#### Hepatic impairment

Initial dose adjustments are not required in patients with hepatic impairment (Child-Pugh class A and B). A downward dose adjustment to 10 mg twice daily should be considered after a careful benefit-risk assessment only if therapy is not well-tolerated.

Revatio is contraindicated in patients with severe hepatic impairment (Child-Pugh class C) (see section 4.3).

#### Paediatric population

Revatio solution for injection is not recommended for use in children below 18 years due to insufficient data on safety and efficacy.

#### Discontinuation of treatment

Limited data suggests that the abrupt discontinuation of oral Revatio is not associated with rebound worsening of pulmonary arterial hypertension. However to avoid the possible occurrence of sudden clinical deterioration during withdrawal, a gradual dose reduction should be considered. Intensified monitoring is recommended during the discontinuation period.

#### Method of administration

Revatio solution for injection is for intravenous use as a bolus injection. See section 6.6 for instructions of use.

## **4.3 Contraindications**

Hypersensitivity to the active substance or to any of the excipients listed in section 6.1.

Co-administration with nitric oxide donors (such as amyl nitrite) or nitrates in any form due to the hypotensive effects of nitrates (see section 5.1).

The co-administration of PDE5 inhibitors, including sildenafil, with guanylate cyclase stimulators, such as riociguat, is contraindicated as it may potentially lead to symptomatic hypotension (see section 4.5).

Combination with the most potent of the CYP3A4 inhibitors (eg, ketoconazole, itraconazole, ritonavir) (see section 4.5).

Patients who have loss of vision in one eye because of non-arteritic anterior ischaemic optic neuropathy (NAION), regardless of whether this episode was in connection or not with previous PDE5 inhibitor exposure (see section 4.4).

The safety of sildenafil has not been studied in the following sub-groups of patients, and its use is therefore contraindicated:

Severe hepatic impairment,

Recent history of stroke or myocardial infarction,

Severe hypotension (blood pressure < 90/50 mmHg) at initiation.

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

No clinical data is available for sildenafil IV administration in patients who are clinically or haemodynamically unstable. Its use is accordingly not recommended in these patients.

The efficacy of Revatio has not been established in patients with severe pulmonary arterial hypertension (functional class IV). If the clinical situation deteriorates, therapies that are recommended at the severe stage of the disease (eg, epoprostenol) should be considered (see section 4.2).

The benefit-risk balance of sildenafil has not been established in patients assessed to be at WHO functional class I pulmonary arterial hypertension.

Studies with sildenafil have been performed in forms of pulmonary arterial hypertension related to primary (idiopathic), connective tissue disease associated or congenital heart disease associated forms of PAH (see section 5.1). The use of sildenafil in other forms of PAH is not recommended.

##### Retinitis pigmentosa

The safety of sildenafil has not been studied in patients with known hereditary degenerative retinal disorders such as *retinitis pigmentosa* (a minority of these patients have genetic disorders of retinal phosphodiesterases) and therefore its use is not recommended.

##### Vasodilatory action

When prescribing sildenafil, physicians should carefully consider whether patients with certain underlying conditions could be adversely affected by sildenafil's mild to moderate vasodilatory effects, for example patients with hypotension, patients with fluid depletion, severe left ventricular outflow obstruction or autonomic dysfunction (see section 4.4)

##### Cardiovascular risk factors

In post-marketing experience with sildenafil for male erectile dysfunction, serious cardiovascular events, including myocardial infarction, unstable angina, sudden cardiac death, ventricular arrhythmia, cerebrovascular haemorrhage, transient ischaemic attack, hypertension and hypotension have been reported in temporal association with the use of sildenafil. Most, but not all, of these patients had pre-existing cardiovascular risk factors. Many events were reported to occur during or shortly after sexual intercourse and a few were reported to occur shortly after the use of sildenafil without sexual activity. It is not possible to determine whether these events are related directly to these factors or to other factors.

##### Priapism

Sildenafil should be used with caution in patients with anatomical deformation of the penis (such as angulation, cavernosal fibrosis or Peyronie's disease), or in patients who have conditions which may predispose them to priapism (such as sickle cell anaemia, multiple myeloma or leukaemia).

Prolonged erections and priapism have been reported with sildenafil in post-marketing experience. In the event of an erection that persists longer than 4 hours, the patient should seek immediate medical assistance. If priapism is not treated immediately, penile tissue damage and permanent loss of potency could result (see section 4.8).

#### Vaso-occlusive crises in patients with sickle cell anaemia

Sildenafil should not be used in patients with pulmonary hypertension secondary to sickle cell anaemia. In a clinical study events of vaso-occlusive crises requiring hospitalisation were reported more commonly by patients receiving Revatio than those receiving placebo leading to the premature termination of this study.

#### Visual events

Cases of visual defects have been reported spontaneously in connection with the intake of sildenafil and other PDE5 inhibitors. Cases of non-arteritic anterior ischaemic optic neuropathy, a rare condition, have been reported spontaneously and in an observational study in connection with the intake of sildenafil and other PDE5 inhibitors (see section 4.8). In the event of any sudden visual defect, the treatment should be stopped immediately and alternative treatment should be considered (see section 4.3).

#### Alpha-blockers

Caution is advised when sildenafil is administered to patients taking an alpha-blocker as the co-administration may lead to symptomatic hypotension in susceptible individuals (see section 4.5). In order to minimise the potential for developing postural hypotension, patients should be haemodynamically stable on alpha-blocker therapy prior to initiating sildenafil treatment. Physicians should advise patients what to do in the event of postural hypotensive symptoms.

#### Bleeding disorders

Studies with human platelets indicate that sildenafil potentiates the antiaggregatory effect of sodium nitroprusside *in vitro*. There is no safety information on the administration of sildenafil to patients with bleeding disorders or active peptic ulceration. Therefore sildenafil should be administered to these patients only after careful benefit-risk assessment.

#### Vitamin K antagonists

In pulmonary arterial hypertension patients, there may be a potential for increased risk of bleeding when sildenafil is initiated in patients already using a Vitamin K antagonist, particularly in patients with pulmonary arterial hypertension secondary to connective tissue disease.

#### Veno-occlusive disease

No data are available with sildenafil in patients with pulmonary hypertension associated with pulmonary veno-occlusive disease. However, cases of life threatening pulmonary oedema have been reported with vasodilators (mainly prostacyclin) when used in those patients. Consequently, should signs of pulmonary oedema occur when sildenafil is administered in patients with pulmonary hypertension, the possibility of associated veno-occlusive disease should be considered.

#### Use of sildenafil with bosentan

The efficacy of sildenafil in patients already on bosentan therapy has not been conclusively demonstrated (see sections 4.5 and 5.1).

#### Concomitant use with other PDE5 inhibitors

The safety and efficacy of sildenafil when co-administered with other PDE5 inhibitor products, including Viagra, has not been studied in PAH patients and such concomitant use is not recommended (see section 4.5).

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

Unless otherwise specified, drug interaction studies have been performed in healthy adult male subjects using oral sildenafil. These results are relevant to other populations and routes of administration.

### Effects of other medicinal products on intravenous sildenafil

Predictions based on a pharmacokinetic model suggest that drug-drug interactions with CYP3A4 inhibitors should be less than observed after oral sildenafil administration. The magnitude of the interaction is expected to be reduced for intravenous sildenafil, as interactions for oral sildenafil are due, at least in part, to effects on oral first pass metabolism.

### Effects of other medicinal products on oral sildenafil

#### *In vitro studies*

Sildenafil metabolism is principally mediated by the cytochrome P450 (CYP) isoforms 3A4 (major route) and 2C9 (minor route). Therefore, inhibitors of these isoenzymes may reduce sildenafil clearance and inducers of these isoenzymes may increase sildenafil clearance. For dose recommendations, see sections 4.2 and 4.3.

#### *In vivo studies*

Co-administration of oral sildenafil and intravenous epoprostenol has been evaluated (see sections 4.8 and 5.1).

The efficacy and safety of sildenafil co-administered with other treatments for pulmonary arterial hypertension (eg, ambrisentan, iloprost) has not been studied in controlled clinical trials. Therefore, caution is recommended in case of co-administration.

The safety and efficacy of sildenafil when co-administered with other PDE5 inhibitors has not been studied in pulmonary arterial hypertension patients (see section 4.4).

Population pharmacokinetic analysis of pulmonary arterial hypertension clinical trial data indicated a reduction in sildenafil clearance and/or an increase of oral bioavailability when co-administered with CYP3A4 substrates and the combination of CYP3A4 substrates and beta-blockers. These were the only factors with a statistically significant impact on oral sildenafil pharmacokinetics in patients with pulmonary arterial hypertension. The exposure to sildenafil in patients on CYP3A4 substrates and CYP3A4 substrates plus beta-blockers was 43 % and 66 % higher, respectively, compared to patients not receiving these classes of medicines. Sildenafil exposure was 5-fold higher at an oral dose of 80 mg three times a day compared to the exposure at an oral dose of 20 mg three times a day. This concentration range covers the increase in sildenafil exposure observed in specifically designed drug interaction studies with CYP3A4 inhibitors (except with the most potent of the CYP3A4 inhibitors eg, ketoconazole, itraconazole, ritonavir).

CYP3A4 inducers seemed to have a substantial impact on the oral pharmacokinetics of sildenafil in pulmonary arterial hypertension patients, which was confirmed in the in-vivo interaction study with CYP3A4 inducer bosentan.

Co-administration of bosentan (a moderate inducer of CYP3A4, CYP2C9 and possibly of CYP2C19) 125 mg twice daily with oral sildenafil 80 mg three times a day (at steady state) concomitantly administered during 6 days in healthy volunteers resulted in a 63 % decrease of sildenafil AUC. A population pharmacokinetic analysis of sildenafil data from adult PAH patients in clinical trials including a 12 week study to assess the efficacy and safety of oral sildenafil 20 mg three times a day when added to a stable dose of bosentan (62.5 mg – 125 mg twice a day) indicated a decrease in sildenafil exposure with bosentan co-administration, similar to that observed in healthy volunteers (see sections 4.4 and 5.1).

Efficacy of sildenafil should be closely monitored in patients using concomitant potent CYP3A4 inducers, such as carbamazepine, phenytoin, phenobarbital, St John's wort and rifampicine.

Co-administration of the HIV protease inhibitor ritonavir, which is a highly potent P450 inhibitor, at steady state (500 mg twice daily) with oral sildenafil (100 mg single dose) resulted in a 300 % (4-fold) increase in sildenafil  $C_{max}$  and a 1,000 % (11-fold) increase in sildenafil plasma AUC. At

24 hours, the plasma levels of sildenafil were still approximately 200 ng/ml, compared to approximately 5 ng/ml when sildenafil was administered alone. This is consistent with ritonavir's marked effects on a broad range of P450 substrates. Based on these pharmacokinetic results co-administration of sildenafil with ritonavir is contraindicated in pulmonary arterial hypertension patients (see section 4.3).

Co-administration of the HIV protease inhibitor saquinavir, a CYP3A4 inhibitor, at steady state (1200 mg three times a day) with oral sildenafil (100 mg single dose) resulted in a 140 % increase in sildenafil  $C_{max}$  and a 210 % increase in sildenafil AUC. Sildenafil had no effect on saquinavir pharmacokinetics. For dose recommendations, see section 4.2.

When a single 100 mg dose of oral sildenafil was administered with erythromycin, a moderate CYP3A4 inhibitor, at steady state (500 mg twice daily for 5 days), there was a 182 % increase in sildenafil systemic exposure (AUC). For dose recommendations, see section 4.2. In healthy male volunteers, there was no evidence of an effect of azithromycin (500 mg daily for 3 days) on the AUC,  $C_{max}$ ,  $T_{max}$ , elimination rate constant, or subsequent half-life of oral sildenafil or its principal circulating metabolite. No dose adjustment is required. Cimetidine (800 mg), a cytochrome P450 inhibitor and a non-specific CYP3A4 inhibitor, caused a 56 % increase in plasma sildenafil concentrations when co-administered with oral sildenafil (50 mg) to healthy volunteers. No dose adjustment is required.

The most potent of the CYP3A4 inhibitors such as ketoconazole and itraconazole would be expected to have effects similar to ritonavir (see section 4.3). CYP3A4 inhibitors like clarithromycin, telithromycin and nefazodone) are expected to have an effect in between that of ritonavir and CYP3A4 inhibitors like saquinavir or erythromycin), a seven-fold increase in exposure is assumed. Therefore dose adjustments are recommended when using CYP3A4 inhibitors (see section 4.2).

The population pharmacokinetic analysis in pulmonary arterial hypertension patients receiving oral sildenafil suggested that co-administration of beta-blockers in combination with CYP3A4 substrates might result in an additional increase in sildenafil exposure compared with administration of CYP3A4 substrates alone.

Grapefruit juice is a weak inhibitor of CYP3A4 gut wall metabolism and may give rise to modest increases in plasma levels of oral sildenafil. No dose adjustment is required but the concomitant use of sildenafil and grapefruit juice is not recommended.

Single doses of antacid (magnesium hydroxide/aluminium hydroxide) did not affect the oral bioavailability of sildenafil.

Co-administration of oral contraceptives (ethinylloestradiol 30 µg and levonorgestrel 150 µg) did not affect the oral pharmacokinetics of sildenafil.

Nicorandil is a hybrid of potassium channel activator and nitrate. Due to the nitrate component it has the potential to have serious interaction with sildenafil (see section 4.3).

#### Effects of oral sildenafil on other medicinal products

##### *In vitro studies*

Sildenafil is a weak inhibitor of the cytochrome P450 isoforms 1A2, 2C9, 2C19, 2D6, 2E1 and 3A4 ( $IC_{50} > 150 \mu M$ ).

There are no data on the interaction of sildenafil and non-specific phosphodiesterase inhibitors such as theophylline or dipyridamole.

### *In vivo studies*

No significant interactions were shown when oral sildenafil (50 mg) was co-administered with tolbutamide (250 mg) or warfarin (40 mg), both of which are metabolised by CYP2C9.

Oral sildenafil had no significant effect on atorvastatin exposure (AUC increased 11 %), suggesting that sildenafil does not have a clinically relevant effect on CYP3A4.

No interactions were observed between sildenafil (100 mg single oral dose) and acenocoumarol.

Oral sildenafil (50 mg) did not potentiate the increase in bleeding time caused by acetyl salicylic acid (150 mg).

Oral sildenafil (50 mg) did not potentiate the hypotensive effects of alcohol in healthy volunteers with mean maximum blood alcohol levels of 80 mg/dl.

In a study of healthy volunteers oral sildenafil at steady state (80 mg three times a day) resulted in a 50 % increase in bosentan AUC (125 mg twice daily). A population pharmacokinetic analysis of data from a study of adult PAH patients on background bosentan therapy (62.5 mg - 125 mg twice a day) indicated an increase (20% (95% CI: 9.8 - 30.8)) of bosentan AUC with co-administration of steady-state sildenafil (20 mg three times a day) of a smaller magnitude than seen in healthy volunteers when co-administered with 80 mg sildenafil three times a day (see sections 4.4 and 5.1).

In a specific interaction study, where oral sildenafil (100 mg) was co-administered with amlodipine in hypertensive patients, there was an additional reduction on supine systolic blood pressure of 8 mmHg. The corresponding additional reduction in supine diastolic blood pressure was 7 mmHg. These additional blood pressure reductions were of a similar magnitude to those seen when sildenafil was administered alone to healthy volunteers.

In three specific drug-drug interaction studies, the alpha-blocker doxazosin (4 mg and 8 mg) and oral sildenafil (25 mg, 50 mg, or 100 mg) were administered simultaneously to patients with benign prostatic hyperplasia (BPH) stabilized on doxazosin therapy. In these study populations, mean additional reductions of supine systolic and diastolic blood pressure of 7/7 mmHg, 9/5 mmHg, and 8/4 mmHg, respectively, and mean additional reductions of standing blood pressure of 6/6 mmHg, 11/4 mmHg, and 4/5 mmHg, respectively were observed. When sildenafil and doxazosin were administered simultaneously to patients stabilized on doxazosin therapy, there were infrequent reports of patients who experienced symptomatic postural hypotension. These reports included dizziness and lightheadedness, but not syncope. Concomitant administration of sildenafil to patients taking alpha-blocker therapy may lead to symptomatic hypotension in susceptible individuals (see section 4.4).

Sildenafil (100 mg single oral dose) did not affect the steady state pharmacokinetics of the HIV protease inhibitor saquinavir, which is a CYP3A4 substrate/inhibitor.

Consistent with its known effects on the nitric oxide/cGMP pathway (see section 5.1), sildenafil was shown to potentiate the hypotensive effects of nitrates, and its co-administration with nitric oxide donors or nitrates in any form is therefore contraindicated (see section 4.3).

Riociguat: Preclinical studies showed additive systemic blood pressure lowering effect when PDE5 inhibitors were combined with riociguat. In clinical studies, riociguat has been shown to augment the hypotensive effects of PDE5 inhibitors. There was no evidence of favourable clinical effect of the combination in the population studied. Concomitant use of riociguat with PDE5 inhibitors, including sildenafil, is contraindicated (see section 4.3).

Oral sildenafil had no clinically significant impact on the plasma levels of oral contraceptives (ethinylloestradiol 30 µg and levonorgestrel 150 µg).

### Paediatric population

Interaction studies have only been performed in adults.

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

### Women of childbearing potential and contraception in males and females

Due to lack of data on effects of Revatio in pregnant women, Revatio is not recommended for women of childbearing potential unless also using appropriate contraceptive measures.

### Pregnancy

There are no data from the use of sildenafil in pregnant women. Animal studies do not indicate direct or indirect harmful effects with respect to pregnancy and embryonal/foetal development. Studies in animals have shown toxicity with respect to postnatal development (see section 5.3).

### Breast-feeding

Due to lack of data, Revatio should not be used in pregnant women unless strictly necessary. It is not known whether sildenafil enters the breast milk. Revatio should not be administered to breast-feeding mothers.

### Fertility

Non-clinical data revealed no special hazard for humans based on conventional studies of fertility (see section 5.3).

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

Revatio has moderate influence on the ability to drive and use machines.

As dizziness and altered vision were reported in clinical trials with sildenafil, patients should be aware of how they might be affected by Revatio, before driving or using machines.

## **4.8 Undesirable effects**

Adverse reactions that resulted from intravenous Revatio use are similar to those associated with oral Revatio use. Since there are limited data for intravenous Revatio use and since pharmacokinetic models predict that 20 mg oral and 10 mg intravenous formulations will yield similar plasma exposures, the safety information for intravenous Revatio is supported by that of oral Revatio.

### Intravenous administration

A 10 mg dose of Revatio solution for injection is predicted to provide total exposure of free sildenafil and its N-desmethyl metabolite and their combined pharmacological effects comparable to those of a 20 mg oral dose.

Study A1481262 was a single centre, single dose, open label study to assess the safety, tolerability and pharmacokinetics of a single intravenous dose of sildenafil (10 mg) administered as a bolus injection to patients with Pulmonary Arterial Hypertension (PAH) who were already receiving and stable on oral Revatio 20 mg three times per day.

A total of 10 PAH subjects enrolled and completed the study. The mean postural changes in systolic and diastolic blood pressure over time were small (< 10 mmHg) and returned towards baseline beyond 2 hours. No symptoms of hypotension were associated with these changes. The mean changes in heart rate were clinically insignificant. Two subjects experienced a total of 3 adverse reactions (flushing, flatulence and hot flush). There was one serious adverse reaction in a subject with severe ischaemic cardiomyopathy who experienced ventricular fibrillation and death 6 days post study. It was judged to be unrelated to the study medicinal product.

### Oral administration

In the pivotal placebo-controlled study of Revatio in pulmonary arterial hypertension, a total of 207 patients were randomized to and treated with 20 mg, 40 mg or 80 mg TID doses of oral Revatio and 70 patients were randomized to placebo. The duration of treatment was 12 weeks. The overall frequency of discontinuation in sildenafil treated patients at doses of 20 mg, 40 mg and 80 mg TID was 2.9 %, 3.0 % and 8.5 % respectively, compared to 2.9 % with placebo. Of the 277 subjects treated in the pivotal study, 259 entered a long-term extension study. Doses up to 80 mg three times a day (4 times the recommended dose of 20 mg three times a day) were administered and after 3 years 87 % of 183 patients on study treatment were receiving Revatio 80 mg TID.

In a placebo-controlled study of Revatio as an adjunct to intravenous epoprostenol in pulmonary arterial hypertension, a total of 134 patients were treated with oral Revatio (in a fixed titration starting from 20 mg, to 40 mg and then 80 mg, three times a day as tolerated) and epoprostenol, and 131 patients were treated with placebo and epoprostenol. The duration of treatment was 16 weeks. The overall frequency of discontinuations in sildenafil/epoprostenol treated patients due to adverse events was 5.2 % compared to 10.7 % in the placebo/epoprostenol treated patients. Newly reported adverse drug reactions, which occurred more frequently in the sildenafil/ epoprostenol group, were ocular hyperaemia, vision blurred, nasal congestion, night sweats, back pain and dry mouth. The known adverse events headache, flushing, pain in extremity and oedema were noted in a higher frequency in sildenafil/epoprostenol treated patients compared to placebo/epoprostenol treated patients. Of the subjects who completed the initial study, 242 entered a long-term extension study. Doses up to 80 mg TID were administered and after 3 years 68 % of 133 patients on study treatment were receiving Revatio 80 mg TID.

In the two-placebo controlled oral Revatio studies adverse events were generally mild to moderate in severity. The most commonly reported adverse reactions that occurred (greater or equal to 10 %) on Revatio compared to placebo were headache, flushing, dyspepsia, diarrhoea and pain in extremity.

### Tabulated list of adverse reactions

Adverse reactions which occurred in > 1 % of Revatio-treated patients and were more frequent (> 1 % difference) on Revatio in the pivotal study or in the Revatio combined data set of both the placebo-controlled studies in pulmonary arterial hypertension, at oral doses of 20, 40 or 80 mg TID are listed in the table below by class and frequency grouping (very common ( $\geq 1/10$ ), common ( $\geq 1/100$  to  $< 1/10$ ), uncommon ( $\geq 1/1000$  to  $\leq 1/100$ ) and not known (cannot be estimated from the available data). Within each frequency grouping, undesirable effects are presented in order of decreasing seriousness.

Reports from post-marketing experience are included in italics.

<b>MedDRA system organ class (V.14.0)</b>	<b>Adverse reaction</b>
<b>Infections and infestations</b>	
Common	cellulitis, influenza, bronchitis, sinusitis, rhinitis, gastroenteritis
<b>Blood and lymphatic system disorders</b>	
Common	anaemia
<b>Metabolism and nutrition disorders</b>	
Common	fluid retention
<b>Psychiatric disorders</b>	
Common	insomnia, anxiety
<b>Nervous system disorders</b>	
Very common	headache
Common	migraine, tremor, paraesthesia, burning sensation, hypoaesthesia
<b>Eye disorders</b>	
Common	retinal haemorrhage, visual impairment, vision blurred,

Uncommon	photophobia, chromatopsia, cyanopsia, eye irritation, ocular hyperaemia
Not known	visual acuity reduced, diplopia, abnormal sensation in eye <i>Non-arteritic anterior ischaemic optic neuropathy (NAION)*, Retinal vascular occlusion*, Visual field defect*</i>
<b>Ear and labyrinth disorders</b>	
Common	vertigo
Not known	<i>sudden hearing loss</i>
<b>Vascular disorders</b>	
Very common	flushing
Not Known	<i>hypotension</i>
<b>Respiratory, thoracic and mediastinal disorders</b>	
Common	epistaxis, cough, nasal congestion
<b>Gastrointestinal disorders</b>	
Very common	diarrhoea, dyspepsia
Common	gastritis, gastroesophageal reflux disease, haemorrhoids, abdominal distension, dry mouth
<b>Skin and subcutaneous tissue disorders</b>	
Common	alopecia, erythema, night sweats
Not known	<i>rash</i>
<b>Musculoskeletal and connective tissue disorders</b>	
Very common	pain in extremity
Common	myalgia, back pain
<b>Renal and urinary disorders</b>	
Uncommon	haematuria
<b>Reproductive system and breast disorders</b>	
Uncommon	penile haemorrhage, haemospermia, gynaecomastia
Not known	<i>priapism, erection increased</i>
<b>General disorders and administration site conditions</b>	
Common	pyrexia

\*These adverse events/reactions have been reported in patients taking sildenafil in the treatment of male erectile dysfunction (MED).

#### 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 national reporting system listed in Appendix V](#).

#### **4.9 Overdose**

In single dose volunteer studies of oral doses up to 800 mg, adverse reactions were similar to those seen at lower doses, but the incidence rates and severities were increased. At single oral doses of 200 mg the incidence of adverse reactions (headache, flushing, dizziness, dyspepsia, nasal congestion, and altered vision) was increased.

In cases of overdose, standard supportive measures should be adopted as required. Renal dialysis is not expected to accelerate clearance as sildenafil is highly bound to plasma proteins and not eliminated in the urine.

## 5. PHARMACOLOGICAL PROPERTIES

### 5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Urologicals, Drugs used in erectile dysfunction, ATC code: G04BE03

#### Mechanism of action

Sildenafil is a potent and selective inhibitor of cyclic guanosine monophosphate (cGMP) specific phosphodiesterase type 5 (PDE5), the enzyme that is responsible for degradation of cGMP. Apart from the presence of this enzyme in the corpus cavernosum of the penis, PDE5 is also present in the pulmonary vasculature. Sildenafil, therefore, increases cGMP within pulmonary vascular smooth muscle cells resulting in relaxation. In patients with pulmonary arterial hypertension this can lead to vasodilation of the pulmonary vascular bed and, to a lesser degree, vasodilatation in the systemic circulation.

#### Pharmacodynamic effects

Studies *in vitro* have shown that sildenafil is selective for PDE5. Its effect is more potent on PDE5 than on other known phosphodiesterases. There is a 10-fold selectivity over PDE6 which is involved in the phototransduction pathway in the retina. There is an 80-fold selectivity over PDE1, and over 700-fold over PDE 2, 3, 4, 7, 8, 9, 10 and 11. In particular, sildenafil has greater than 4,000-fold selectivity for PDE5 over PDE3, the cAMP-specific phosphodiesterase isoform involved in the control of cardiac contractility.

Sildenafil causes mild and transient decreases in systemic blood pressure which, in the majority of cases, do not translate into clinical effects. After chronic oral dosing of 80 mg three times a day to patients with systemic hypertension the mean change from baseline in systolic and diastolic blood pressure was a decrease of 9.4 mmHg and 9.1 mm Hg respectively. After chronic oral dosing of 80 mg three times a day to patients with pulmonary arterial hypertension lesser effects in blood pressure reduction were observed (a reduction in both systolic and diastolic pressure of 2 mmHg). At the recommended oral dose of 20 mg three times a day no reductions in systolic or diastolic pressure were seen.

Single oral doses of sildenafil up to 100 mg in healthy volunteers produced no clinically relevant effects on ECG. After chronic dosing of 80 mg three times a day to patients with pulmonary arterial hypertension no clinically relevant effects on the ECG were reported.

In a study of the hemodynamic effects of a single oral 100 mg dose of sildenafil in 14 patients with severe coronary artery disease (CAD) (> 70 % stenosis of at least one coronary artery), the mean resting systolic and diastolic blood pressures decreased by 7 % and 6 % respectively compared to baseline. Mean pulmonary systolic blood pressure decreased by 9 %. Sildenafil showed no effect on cardiac output, and did not impair blood flow through the stenosed coronary arteries.

Mild and transient differences in colour discrimination (blue/green) were detected in some subjects using the Farnsworth-Munsell 100 hue test at 1 hour following a 100 mg dose, with no effects evident after 2 hours post-dose. The postulated mechanism for this change in colour discrimination is related to inhibition of PDE6, which is involved in the phototransduction cascade of the retina. Sildenafil has no effect on visual acuity or contrast sensitivity. In a small size placebo-controlled study of patients with documented early age-related macular degeneration (n = 9), sildenafil (single dose, 100 mg) demonstrated no significant changes in visual tests conducted (visual acuity, Amsler grid, colour discrimination simulated traffic light, Humphrey perimeter and photostress).

## Clinical efficacy and safety

### *Efficacy of intravenous sildenafil in adult patients with pulmonary arterial hypertension (PAH)*

A 10 mg dose of Revatio solution for injection is predicted to provide total exposure of free sildenafil and its N-desmethyl metabolite and their combined pharmacological effects comparable to those of a 20 mg oral dose. This is based on Pharmacokinetic data only (see section 5.2. Pharmacokinetic Properties). The consequences of the subsequent lower exposure to the active N-desmethyl metabolite observed after repeated IV administration of Revatio have not been documented. No clinical studies have been performed to demonstrate that these formulations have comparable efficacy

Study A1481262 was a single centre, single dose, open label study to assess the safety, tolerability and pharmacokinetics of a single intravenous dose of sildenafil (10 mg) administered as a bolus injection to patients with PAH who were already receiving and stable on oral Revatio 20 mg TID.

A total of 10 PAH subjects enrolled and completed the study. Eight subjects were taking bosentan and one subject was taking treprostinil in addition to bosentan and Revatio. After dosing, sitting and standing blood pressure and heart rate were recorded at 30, 60, 120, 180 and 360 minute post dose. The mean changes from baseline in sitting blood pressure were greatest at 1 hour, -9.1 mmHg (SD ± 12.5) and -3.0 (SD ± 4.9) mmHg for systolic and diastolic pressure respectively. The mean postural changes in systolic and diastolic blood pressure over time were small (< 10 mmHg) and returned towards baseline beyond 2 hours.

### *Efficacy of oral sildenafil in adult patients with pulmonary arterial hypertension (PAH)*

A randomised, double-blind, placebo-controlled study was conducted in 278 patients with primary pulmonary hypertension, PAH associated with connective tissue disease, and PAH following surgical repair of congenital heart lesions. Patients were randomised to one of four treatment groups: placebo, sildenafil 20 mg, sildenafil 40 mg or sildenafil 80 mg, three times a day. Of the 278 patients randomised, 277 patients received at least 1 dose of study drug. The study population consisted of 68 (25 %) men and 209 (75 %) women with a mean age of 49 years (range: 18-81 years) and baseline 6-minute walk test distance between 100 and 450 metres inclusive (mean: 344 metres). 175 patients (63 %) included were diagnosed with primary pulmonary hypertension, 84 (30 %) were diagnosed with PAH associated with connective tissue disease and 18 (7 %) of the patients were diagnosed with PAH following surgical repair of congenital heart lesions. Most patients were WHO Functional Class II (107/277, 39 %) or III (160/277, 58 %) with a mean baseline 6 minute walking distance of 378 meters and 326 meters respectively; fewer patients were Class I (1/277, 0.4 %) or IV (9/277, 3 %) at baseline. Patients with left ventricular ejection fraction < 45 % or left ventricular shortening fraction < 0.2 were not studied.

Sildenafil (or placebo) was added to patients' background therapy which could have included a combination of anticoagulation, digoxin, calcium channel blockers, diuretics or oxygen. The use of prostacyclin, prostacyclin analogues and endothelin receptor antagonists was not permitted as add-on therapy, and neither was arginine supplementation. Patients who previously failed bosentan therapy were excluded from the study.

The primary efficacy endpoint was the change from baseline at week 12 in 6-minute walk distance (6MWD). A statistically significant increase in 6MWD was observed in all 3 sildenafil dose groups compared to those on placebo. Placebo corrected increases in 6MWD were 45 metres (p < 0.0001), 46 metres (p < 0.0001) and 50 metres (p < 0.0001) for sildenafil 20 mg, 40 mg and 80 mg TID respectively. There was no significant difference in effect between sildenafil doses. For patients with a low baseline 6 MWD < 325 m improved efficacy was observed with higher doses (placebo-corrected improvements of 58 metres, 65 metres and 87 metres for 20 mg, 40 mg and 80 mg doses TID, respectively).

When analysed by WHO functional class, a statistically significant increase in 6MWD was observed in the 20 mg dose group. For class II and class III, placebo corrected increases of 49 metres (p = 0.0007) and 45 metres (p = 0.0031) were observed respectively.

The improvement in 6MWD was apparent after 4 weeks of treatment and this effect was maintained at weeks 8 and 12. Results were generally consistent in subgroups according to aetiology (primary and connective tissue disease-associated PAH), WHO functional class, gender, race, location, mean PAP and PVRI.

Patients on all sildenafil doses achieved a statistically significant reduction in mean pulmonary arterial pressure (mPAP) and pulmonary vascular resistance (PVR) compared to those on placebo. Placebo-corrected treatment effects with mPAP were -2.7 mm Hg ( $p = 0.04$ ), -3.0 mm Hg ( $p = 0.01$ ) and -5.1 mm Hg ( $p < 0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID, respectively. Placebo-corrected treatment effects with PVR were -178 dyne.sec/cm<sup>5</sup> ( $p=0.0051$ ), -195 dyne.sec/cm<sup>5</sup> ( $p=0.0017$ ) and -320 dyne.sec/cm<sup>5</sup> ( $p<0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID, respectively. The percent reduction at 12 weeks for sildenafil 20 mg, 40 mg and 80 mg TID in PVR (11.2 %, 12.9 %, 23.3 %) was proportionally greater than the reduction in systemic vascular resistance (SVR) (7.2 %, 5.9 %, and 14.4 %). The effect of sildenafil on mortality is unknown.

A greater percentage of patients on each of the sildenafil doses (i.e. 28 %, 36 % and 42 % of subjects who received sildenafil 20 mg, 40 mg and 80 mg TID doses, respectively) showed an improvement by at least one WHO functional class at week 12 compared to placebo (7 %). The respective odds ratios were 2.92 ( $p=0.0087$ ), 4.32 ( $p=0.0004$ ) and 5.75 ( $p<0.0001$ ).

#### Long-term survival data in naive population

Patients enrolled into the pivotal oral route study were eligible to enter a long term open label extension study. At 3 years 87 % of the patients were receiving a dose of 80 mg TID. A total of 207 patients were treated with Revatio in the pivotal study, and their long term survival status was assessed for a minimum of 3 years. In this population, Kaplan-Meier estimates of 1, 2 and 3 year survival were 96 %, 91 % and 82 %, respectively. Survival in patients of WHO functional class II at baseline at 1, 2 and 3 years was 99 %, 91 %, and 84 % respectively, and for patients of WHO functional class III at baseline was 94 %, 90 %, and 81 %, respectively.

#### Efficacy of oral sildenafil in adult patients with PAH (when used in combination with epoprostenol)

A randomised, double-blind, placebo controlled study was conducted in 267 patients with PAH who were stabilised on intravenous epoprostenol. The PAH patients included those with Primary Pulmonary Arterial Hypertension (212/267, 79 %) and PAH associated with connective tissue disease (55/267, 21 %). Most patients were WHO Functional Class II (68/267, 26 %) or III (175/267, 66 %); fewer patients were Class I (3/267, 1 %) or IV (16/267, 6 %) at baseline; for a few patients (5/267, 2 %), the WHO Functional Class was unknown. Patients were randomised to placebo or sildenafil (in a fixed titration starting from 20 mg, to 40 mg and then 80 mg, three times a day as tolerated) when used in combination with intravenous epoprostenol.

The primary efficacy endpoint was the change from baseline at week 16 in 6-minute walk distance. There was a statistically significant benefit of sildenafil compared to placebo in 6-minute walk distance. A mean placebo corrected increase in walk distance of 26 metres was observed in favour of sildenafil (95 % CI: 10.8, 41.2) ( $p = 0.0009$ ). For patients with a baseline walking distance  $\geq 325$  metres, the treatment effect was 38.4 metres in favour of sildenafil; for patients with a baseline walking distance  $< 325$  metres, the treatment effect was 2.3 metres in favour of placebo. For patients with primary PAH, the treatment effect was 31.1 metres compared to 7.7 metres for patients with PAH associated with connective tissue disease. The difference in results between these randomisation subgroups may have arisen by chance in view of their limited sample size.

Patients on sildenafil achieved a statistically significant reduction in mean Pulmonary Arterial Pressure (mPAP) compared to those on placebo. A mean placebo-corrected treatment effect of -3.9 mmHg was observed in favour of sildenafil (95 % CI: -5.7, -2.1) ( $p = 0.00003$ ). Time to clinical worsening was a secondary endpoint as defined as the time from randomisation to the first occurrence of a clinical worsening event (death, lung transplantation, initiation of bosentan therapy, or clinical deterioration requiring a change in epoprostenol therapy). Treatment with sildenafil significantly

delayed the time to clinical worsening of PAH compared to placebo ( $p = 0.0074$ ). 23 subjects experienced clinical worsening events in the placebo group (17.6 %) compared with 8 subjects in the sildenafil group (6.0 %).

#### Long-term Survival Data in the background epoprostenol study

Patients enrolled into the epoprostenol add-on therapy study were eligible to enter a long term open label extension study. At 3 years 68 % of the patients were receiving a dose of 80 mg TID. A total of 134 patients were treated with Revatio in the initial study, and their long term survival status was assessed for a minimum of 3 years. In this population, Kaplan-Meier estimates of 1, 2 and 3 year survival were 92 %, 81 % and 74 %, respectively.

#### Efficacy and safety in adult patients with PAH (when used in combination with bosentan)

A randomized, double-blind, placebo controlled study was conducted in 103 clinically stable subjects with PAH (WHO FC II and III) who were on bosentan therapy for a minimum of three months. The PAH patients included those with Primary PAH, and PAH associated with connective tissue disease. Patients were randomized to placebo or sildenafil (20 mg three times a day) in combination with bosentan (62.5-125 mg twice a day). The primary efficacy endpoint was the change from baseline at Week 12 in 6MWD. The results indicate that there is no significant difference in mean change from baseline on 6MWD observed between sildenafil (20 mg three times a day) and placebo (13.62 m (95% CI: -3.89 to 31.12) and 14.08 m (95% CI: -1.78 to 29.95), respectively).

Differences in 6MWD were observed between patients with primary PAH and PAH associated with connective tissue disease. For subjects with primary PAH (67 subjects), mean changes from baseline were 26.39 m (95% CI: 10.70 to 42.08) and 11.84 m (95% CI: -8.83 to 32.52) for the sildenafil and placebo groups, respectively. However, for subjects with PAH associated with connective tissue disease (36 subjects) mean changes from baseline were -18.32 m (95% CI: -65.66 to 29.02) and 17.50 m (95% CI: -9.41 to 44.41) for the sildenafil and placebo groups, respectively.

Overall, the adverse events were generally similar between the two treatment groups (sildenafil plus bosentan vs. bosentan alone), and consistent with the known safety profile of sildenafil when used as monotherapy (see sections 4.4 and 4.5).

## **5.2 Pharmacokinetic properties**

### Absorption

The mean absolute oral bioavailability for sildenafil is 41 % (range 25-63 %). In study A1481262  $C_{max}$ , CL and AUC (0-8) of 248 ng/ml, 30.3 l/h and 330 ng h/ml, were observed respectively. The  $C_{max}$  and AUC (0-8) of the N-desmethyl metabolite were 30.8 ng/ml and 147 ng h/ml, respectively.

### Distribution

The mean steady state volume of distribution ( $V_{ss}$ ) for sildenafil is 105 l, indicating distribution into the tissues. After oral doses of 20 mg three times a day, the mean maximum total plasma concentration of sildenafil at steady state is approximately 113 ng/ml. Sildenafil and its major circulating N-desmethyl metabolite are approximately 96 % bound to plasma proteins. Protein binding is independent of total drug concentrations.

### Biotransformation

Sildenafil is cleared predominantly by the CYP3A4 (major route) and CYP2C9 (minor route) hepatic microsomal isoenzymes. The major circulating metabolite results from N-demethylation of sildenafil. This metabolite has a phosphodiesterase selectivity profile similar to sildenafil and an *in vitro* potency for PDE5 approximately 50 % that of the parent drug. The N-desmethyl metabolite is further metabolised, with a terminal half-life of approximately 4 h. In patients with pulmonary arterial hypertension, plasma concentrations of N-desmethyl metabolite are approximately 72 % those of sildenafil after 20 mg three times a day oral dosing (translating into a 36 % contribution to sildenafil's pharmacological effects). The subsequent effect on efficacy is unknown. In healthy volunteers, the plasma levels of the N-desmethyl metabolite following intravenous dosing are significantly lower than

those observed following oral dosing. At steady state plasma concentrations of N-desmethyl metabolite are approximately 16 % versus 61 % those of sildenafil after IV and oral dosing, respectively.

#### Elimination

The total body clearance of sildenafil is 41 l/h with a resultant terminal phase half-life of 3-5 h. After either oral or intravenous administration, sildenafil is excreted as metabolites predominantly in the faeces (approximately 80 % of administered oral dose) and to a lesser extent in the urine (approximately 13 % of administered oral dose).

#### Pharmacokinetics in special patient groups

##### *Elderly*

Healthy elderly volunteers (65 years or over) had a reduced clearance of sildenafil, resulting in approximately 90 % higher plasma concentrations of sildenafil and the active N-desmethyl metabolite compared to those seen in healthy younger volunteers (18-45 years). Due to age-differences in plasma protein binding, the corresponding increase in free sildenafil plasma concentration was approximately 40 %.

##### *Renal insufficiency*

In volunteers with mild to moderate renal impairment (creatinine clearance = 30-80 ml/min), the pharmacokinetics of sildenafil were not altered after receiving a 50 mg single oral dose. In volunteers with severe renal impairment (creatinine clearance < 30 ml/min), sildenafil clearance was reduced, resulting in mean increases in AUC and  $C_{max}$  of 100 % and 88 % respectively compared to age-matched volunteers with no renal impairment. In addition, N-desmethyl metabolite AUC and  $C_{max}$  values were significantly increased by 200 % and 79 % respectively in subjects with severe renal impairment compared to subjects with normal renal function.

##### *Hepatic insufficiency*

In volunteers with mild to moderate hepatic cirrhosis (Child-Pugh class A and B) sildenafil clearance was reduced, resulting in increases in AUC (85 %) and  $C_{max}$  (47 %) compared to age-matched volunteers with no hepatic impairment. In addition, N-desmethyl metabolite AUC and  $C_{max}$  values were significantly increased by 154 % and 87 %, respectively in cirrhotic subjects compared to subjects with normal hepatic function. The pharmacokinetics of sildenafil in patients with severely impaired hepatic function have not been studied.

##### *Population pharmacokinetics*

In patients with pulmonary arterial hypertension, the average steady state concentrations were 20-50 % higher over the investigated oral dose range of 20–80 mg three times a day compared to healthy volunteers. There was a doubling of the  $C_{min}$  compared to healthy volunteers. Both findings suggest a lower clearance and/or a higher oral bioavailability of sildenafil in patients with pulmonary arterial hypertension compared to healthy volunteers.

### **5.3 Preclinical safety data**

Non-clinical data revealed no special hazard for humans based on conventional studies of safety pharmacology, repeated dose toxicity, genotoxicity and carcinogenic potential, toxicity to reproduction and development.

In pups of rats which were pre- and postnatally treated with 60 mg/kg sildenafil, a decreased litter size, a lower pup weight on day 1 and a decreased 4-day survival were seen at exposures which were approximately fifty times the expected human intravenous exposure at 10 mg three times a day. Effects in non-clinical studies were observed at exposures considered sufficiently in excess of the maximum human exposure indicating little relevance to clinical use.

There were no adverse reactions, with possible relevance to clinical use, seen in animals at clinically relevant exposure levels which were not also observed in clinical studies.

## **6. PHARMACEUTICAL PARTICULARS**

### **6.1 List of excipients**

Glucose  
Water for injections

### **6.2 Incompatibilities**

This medicinal product must not be mixed with other medicinal products or intravenous diluents except those mentioned in section 6.6.

### **6.3 Shelf life**

3 years.

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

This medicinal product does not require any special storage conditions.

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

Each pack contains one 20 ml clear, type I glass vial with a chlorobutyl rubber stopper and an aluminium overseal.

### **6.6 Special precautions for disposal and other handling**

This medicinal product does not require dilution or reconstitution before use.

One 20 ml vial contains 10 mg of sildenafil (as citrate). The recommended dose of 10 mg requires a volume of 12.5 ml, to be administered as an intravenous bolus injection.

Chemical and physical compatibility has been demonstrated with the following diluents:

5 % glucose solution  
sodium chloride 9 mg/ml (0.9 %) solution  
Lactated Ringer's solution  
5 % glucose/0.45 % sodium chloride solution  
5 % glucose/lactated Ringer's solution  
5 % glucose/20 mEq potassium chloride solution

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

## **7. MARKETING AUTHORISATION HOLDER**

Pfizer Limited, Sandwich, Kent CT13 9NJ, United Kingdom.

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

EU/1/05/318/002

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

Date of first authorisation: 28 October 2005

Date of latest renewal: 23 September 2010

**10. DATE OF REVISION OF THE TEXT**

Detailed information on this product is available on the website of the European Medicines Agency  
<http://www.ema.europa.eu>

## 1. NAME OF THE MEDICINAL PRODUCT

Revatio 10 mg/ml powder for oral suspension

## 2. QUALITATIVE AND QUANTITATIVE COMPOSITION

After reconstitution, each ml of the oral suspension contains 10 mg of sildenafil (as citrate)  
One bottle of reconstituted oral suspension (112 ml) contains 1.12 g of sildenafil (as citrate)

### Excipient(s) with known effect

Each ml of oral suspension contains 250 mg sorbitol.

For the full list of excipients, see section 6.1.

## 3. PHARMACEUTICAL FORM

Powder for oral suspension.  
White to off-white powder.

## 4. CLINICAL PARTICULARS

### 4.1 Therapeutic indications

#### Adults

Treatment of adult patients with pulmonary arterial hypertension classified as WHO functional class II and III, to improve exercise capacity. Efficacy has been shown in primary pulmonary hypertension and pulmonary hypertension associated with connective tissue disease.

#### Paediatric population

Treatment of paediatric patients aged 1 year to 17 years old with pulmonary arterial hypertension. Efficacy in terms of improvement of exercise capacity or pulmonary haemodynamics has been shown in primary pulmonary hypertension and pulmonary hypertension associated with congenital heart disease (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 pulmonary arterial hypertension. In case of clinical deterioration in spite of Revatio treatment, alternative therapies should be considered.

#### Posology

##### Adults

The recommended dose is 20 mg three times a day (TID). Physicians should advise patients who forget to take Revatio to take a dose as soon as possible and then continue with the normal dose. Patients should not take a double dose to compensate for the missed dose.

##### Paediatric population (1 year to 17 years)

For paediatric patients aged 1 year to 17 years old, the recommended dose in patients  $\leq 20$  kg is 10 mg (1 ml of reconstituted suspension) three times a day and for patients  $> 20$  kg is 20 mg (2 ml of reconstituted suspension) three times a day. Higher than recommended doses should not be used in paediatric patients with PAH (see also sections 4.4 and 5.1).

### Patients using other medicinal products

In general, any dose adjustment should be administered only after a careful benefit-risk assessment. A downward dose adjustment to 20 mg twice daily should be considered when sildenafil is co-administered to patients already receiving CYP3A4 inhibitors like erythromycin or saquinavir. A downward dose adjustment to 20 mg once daily is recommended in case of co-administration with more potent CYP3A4 inhibitors clarithromycin, telithromycin and nefazodone. For the use of sildenafil with the most potent CYP3A4 inhibitors, see section 4.3. Dose adjustments for sildenafil may be required when co-administered with CYP3A4 inducers (see section 4.5).

### Special populations

#### Elderly ( $\geq 65$ years)

Dose adjustments are not required in elderly patients. Clinical efficacy as measured by 6-minute walk distance could be less in elderly patients.

#### Renal impairment

Initial dose adjustments are not required in patients with renal impairment, including severe renal impairment (creatinine clearance  $< 30$  ml/min). A downward dose adjustment to 20 mg twice daily should be considered after a careful benefit-risk assessment only if therapy is not well-tolerated.

#### Hepatic impairment

Initial dose adjustments are not required in patients with hepatic impairment (Child-Pugh class A and B). A downward dose adjustment to 20 mg twice daily should be considered after a careful benefit-risk assessment only if therapy is not well-tolerated.

Revatio is contraindicated in patients with severe hepatic impairment (Child-Pugh class C), (see section 4.3).

#### Paediatric population

The safety and efficacy of Revatio in children below 1 year of age has not been established. No data are available.

#### Discontinuation of treatment

Limited data suggests that the abrupt discontinuation of Revatio is not associated with rebound worsening of pulmonary arterial hypertension. However to avoid the possible occurrence of sudden clinical deterioration during withdrawal, a gradual dose reduction should be considered. Intensified monitoring is recommended during the discontinuation period.

#### Method of administration

Revatio powder for oral suspension is for oral use only. The constituted oral suspension (a white, grape flavoured oral suspension) should be taken approximately 6 to 8 hours apart with or without food.

Before withdrawing the required dose, shake the bottle vigorously for a minimum of 10 seconds.

For instructions on constitution of the medicinal product before administration, see section 6.6.

## **4.3 Contraindications**

Hypersensitivity to the active substance or to any of the excipients listed in section 6.1.

Co-administration with nitric oxide donors (such as amyl nitrite) or nitrates in any form due to the hypotensive effects of nitrates (see section 5.1).

The co-administration of PDE5 inhibitors, including sildenafil, with guanylate cyclase stimulators, such as riociguat, is contraindicated as it may potentially lead to symptomatic hypotension (see section 4.5).

Combination with the most potent of the CYP3A4 inhibitors (eg, ketoconazole, itraconazole, ritonavir) (see section 4.5).

Patients who have loss of vision in one eye because of non-arteritic anterior ischaemic optic neuropathy (NAION), regardless of whether this episode was in connection or not with previous PDE5 inhibitor exposure (see section 4.4).

The safety of sildenafil has not been studied in the following sub-groups of patients and its use is therefore contraindicated:

Severe hepatic impairment,

Recent history of stroke or myocardial infarction,

Severe hypotension (blood pressure < 90/50 mmHg) at initiation.

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

The efficacy of Revatio has not been established in patients with severe pulmonary arterial hypertension (functional class IV). If the clinical situation deteriorates, therapies that are recommended at the severe stage of the disease (eg, epoprostenol) should be considered (see section 4.2). The benefit-risk balance of sildenafil has not been established in patients assessed to be at WHO functional class I pulmonary arterial hypertension.

Studies with sildenafil have been performed in forms of pulmonary arterial hypertension related to primary (idiopathic), connective tissue disease associated or congenital heart disease associated forms of PAH (see section 5.1). The use of sildenafil in other forms of PAH is not recommended.

In the long term paediatric extension study, an increase in deaths was observed in patients administered doses higher than the recommended dose. Therefore, doses higher than the recommended doses should not be used in paediatric patients with PAH (see also sections 4.2 and 5.1).

##### Retinitis pigmentosa

The safety of sildenafil has not been studied in patients with known hereditary degenerative retinal disorders such as *retinitis pigmentosa* (a minority of these patients have genetic disorders of retinal phosphodiesterases) and therefore its use is not recommended.

##### Vasodilatory action

When prescribing sildenafil, physicians should carefully consider whether patients with certain underlying conditions could be adversely affected by sildenafil's mild to moderate vasodilatory effects, for example patients with hypotension, patients with fluid depletion, severe left ventricular outflow obstruction or autonomic dysfunction (see section 4.4).

##### Cardiovascular risk factors

In post-marketing experience with sildenafil for male erectile dysfunction, serious cardiovascular events, including myocardial infarction, unstable angina, sudden cardiac death, ventricular arrhythmia, cerebrovascular haemorrhage, transient ischaemic attack, hypertension and hypotension have been reported in temporal association with the use of sildenafil. Most, but not all, of these patients had pre-existing cardiovascular risk factors. Many events were reported to occur during or shortly after sexual intercourse and a few were reported to occur shortly after the use of sildenafil without sexual activity. It is not possible to determine whether these events are related directly to these factors or to other factors.

### Priapism

Sildenafil should be used with caution in patients with anatomical deformation of the penis (such as angulation, cavernosal fibrosis or Peyronie's disease), or in patients who have conditions which may predispose them to priapism (such as sickle cell anaemia, multiple myeloma or leukaemia).

Prolonged erections and priapism have been reported with sildenafil in post-marketing experience. In the event of an erection that persists longer than 4 hours, the patient should seek immediate medical assistance. If priapism is not treated immediately, penile tissue damage and permanent loss of potency could result (see section 4.8).

### Vaso-occlusive crises in patients with sickle cell anaemia

Sildenafil should not be used in patients with pulmonary hypertension secondary to sickle cell anaemia. In a clinical study events of vaso-occlusive crises requiring hospitalisation were reported more commonly by patients receiving Revatio than those receiving placebo leading to the premature termination of this study.

### Visual events

Cases of visual defects have been reported spontaneously in connection with the intake of sildenafil and other PDE5 inhibitors. Cases of non-arteritic anterior ischaemic optic neuropathy, a rare condition, have been reported spontaneously and in an observational study in connection with the intake of sildenafil and other PDE5 inhibitors (see section 4.8). In the event of any sudden visual defect, the treatment should be stopped immediately and alternative treatment should be considered (see section 4.3).

### Alpha-blockers

Caution is advised when sildenafil is administered to patients taking an alpha-blocker as the co-administration may lead to symptomatic hypotension in susceptible individuals (see section 4.5). In order to minimise the potential for developing postural hypotension, patients should be haemodynamically stable on alpha-blocker therapy prior to initiating sildenafil treatment. Physicians should advise patients what to do in the event of postural hypotensive symptoms.

### Bleeding disorders

Studies with human platelets indicate that sildenafil potentiates the antiaggregatory effect of sodium nitroprusside *in vitro*. There is no safety information on the administration of sildenafil to patients with bleeding disorders or active peptic ulceration. Therefore sildenafil should be administered to these patients only after careful benefit-risk assessment.

### Vitamin K antagonists

In pulmonary arterial hypertension patients, there may be a potential for increased risk of bleeding when sildenafil is initiated in patients already using a Vitamin K antagonist, particularly in patients with pulmonary arterial hypertension secondary to connective tissue disease.

### Veno-occlusive disease

No data are available with sildenafil in patients with pulmonary hypertension associated with pulmonary veno-occlusive disease. However, cases of life threatening pulmonary oedema have been reported with vasodilators (mainly prostacyclin) when used in those patients. Consequently, should signs of pulmonary oedema occur when sildenafil is administered in patients with pulmonary hypertension, the possibility of associated veno-occlusive disease should be considered.

### Fructose intolerance

The powder contains sorbitol. Patients with rare hereditary problems of fructose intolerance should not take this medicine.

### Use of sildenafil with bosentan

The efficacy of sildenafil in patients already on bosentan therapy has not been conclusively demonstrated (see sections 4.5 and 5.1).

#### Concomitant use with other PDE5 inhibitors

The safety and efficacy of sildenafil when co-administered with other PDE5 inhibitor products, including Viagra, has not been studied in PAH patients and such concomitant use is not recommended (see section 4.5).

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

#### Effects of other medicinal products on sildenafil

##### *In vitro studies*

Sildenafil metabolism is principally mediated by the cytochrome P450 (CYP) isoforms 3A4 (major route) and 2C9 (minor route). Therefore, inhibitors of these isoenzymes may reduce sildenafil clearance and inducers of these isoenzymes may increase sildenafil clearance. For dose recommendations, see sections 4.2 and 4.3.

##### *In vivo studies*

Co-administration of oral sildenafil and intravenous epoprostenol has been evaluated (see sections 4.8 and 5.1).

The efficacy and safety of sildenafil co-administered with other treatments for pulmonary arterial hypertension (eg, ambrisentan, iloprost) has not been studied in controlled clinical trials. Therefore, caution is recommended in case of co-administration.

The safety and efficacy of sildenafil when co-administered with other PDE5 inhibitors has not been studied in pulmonary arterial hypertension patients (see section 4.4).

Population pharmacokinetic analysis of pulmonary arterial hypertension clinical trial data indicated a reduction in sildenafil clearance and/or an increase of oral bioavailability when co-administered with CYP3A4 substrates and the combination of CYP3A4 substrates and beta-blockers. These were the only factors with a statistically significant impact on sildenafil pharmacokinetics in patients with pulmonary arterial hypertension. The exposure to sildenafil in patients on CYP3A4 substrates and CYP3A4 substrates plus beta-blockers was 43 % and 66 % higher, respectively, compared to patients not receiving these classes of medicines. Sildenafil exposure was 5-fold higher at a dose of 80 mg three times a day compared to the exposure at a dose of 20 mg three times a day. This concentration range covers the increase in sildenafil exposure observed in specifically designed drug interaction studies with CYP3A4 inhibitors (except with the most potent of the CYP3A4 inhibitors eg, ketoconazole, itraconazole, ritonavir).

CYP3A4 inducers seemed to have a substantial impact on the pharmacokinetics of sildenafil in pulmonary arterial hypertension patients, which was confirmed in the *in-vivo* interaction study with CYP3A4 inducer bosentan.

Co-administration of bosentan (a moderate inducer of CYP3A4, CYP2C9 and possibly of CYP2C19) 125 mg twice daily with sildenafil 80 mg three times a day (at steady state) concomitantly administered during 6 days in healthy volunteers resulted in a 63 % decrease of sildenafil AUC. A population pharmacokinetic analysis of sildenafil data from adult PAH patients in clinical trials including a 12 week study to assess the efficacy and safety of oral sildenafil 20 mg three times a day when added to a stable dose of bosentan (62.5 mg – 125 mg twice a day) indicated a decrease in sildenafil exposure with bosentan co-administration, similar to that observed in healthy volunteers (see sections 4.4 and 5.1).

Efficacy of sildenafil should be closely monitored in patients using concomitant potent CYP3A4 inducers, such as carbamazepine, phenytoin, phenobarbital, St John's wort and rifampicine.

Co-administration of the HIV protease inhibitor ritonavir, which is a highly potent P450 inhibitor, at steady state (500 mg twice daily) with sildenafil (100 mg single dose) resulted in a 300 % (4-fold) increase in sildenafil  $C_{max}$  and a 1,000 % (11-fold) increase in sildenafil plasma AUC. At 24 hours, the plasma levels of sildenafil were still approximately 200 ng/ml, compared to approximately 5 ng/ml when sildenafil was administered alone. This is consistent with ritonavir's marked effects on a broad range of P450 substrates. Based on these pharmacokinetic results co-administration of sildenafil with ritonavir is contraindicated in pulmonary arterial hypertension patients (see section 4.3).

Co-administration of the HIV protease inhibitor saquinavir, a CYP3A4 inhibitor, at steady state (1200 mg three times a day) with sildenafil (100 mg single dose) resulted in a 140 % increase in sildenafil  $C_{max}$  and a 210 % increase in sildenafil AUC. Sildenafil had no effect on saquinavir pharmacokinetics. For dose recommendations, see section 4.2.

When a single 100 mg dose of sildenafil was administered with erythromycin, a moderate CYP3A4 inhibitor, at steady state (500 mg twice daily for 5 days), there was a 182 % increase in sildenafil systemic exposure (AUC). For dose recommendations, see section 4.2. In healthy male volunteers, there was no evidence of an effect of azithromycin (500 mg daily for 3 days) on the AUC,  $C_{max}$ ,  $T_{max}$ , elimination rate constant, or subsequent half-life of sildenafil or its principal circulating metabolite. No dose adjustment is required. Cimetidine (800 mg), a cytochrome P450 inhibitor and a non-specific CYP3A4 inhibitor, caused a 56 % increase in plasma sildenafil concentrations when co-administered with sildenafil (50 mg) to healthy volunteers. No dose adjustment is required.

The most potent of the CYP3A4 inhibitors such as ketoconazole and itraconazole would be expected to have effects similar to ritonavir (see section 4.3). CYP3A4 inhibitors like clarithromycin, telithromycin and nefazodone are expected to have an effect in between that of ritonavir and CYP3A4 inhibitors like saquinavir or erythromycin, a seven-fold increase in exposure is assumed. Therefore dose adjustments are recommended when using CYP3A4 inhibitors (see section 4.2).

The population pharmacokinetic analysis in pulmonary arterial hypertension patients suggested that co-administration of beta-blockers in combination with CYP3A4 substrates might result in an additional increase in sildenafil exposure compared with administration of CYP3A4 substrates alone.

Grapefruit juice is a weak inhibitor of CYP3A4 gut wall metabolism and may give rise to modest increases in plasma levels of sildenafil. No dose adjustment is required but the concomitant use of sildenafil and grapefruit juice is not recommended.

Single doses of antacid (magnesium hydroxide/aluminium hydroxide) did not affect the bioavailability of sildenafil.

Co-administration of oral contraceptives (ethinylloestradiol 30 µg and levonorgestrel 150 µg) did not affect the pharmacokinetics of sildenafil.

Nicorandil is a hybrid of potassium channel activator and nitrate. Due to the nitrate component it has the potential to have serious interaction with sildenafil (see section 4.3).

#### Effects of sildenafil on other medicinal products

##### *In vitro studies*

Sildenafil is a weak inhibitor of the cytochrome P450 isoforms 1A2, 2C9, 2C19, 2D6, 2E1 and 3A4 ( $IC_{50} > 150 \mu M$ ).

There are no data on the interaction of sildenafil and non-specific phosphodiesterase inhibitors such as theophylline or dipyridamole.

### In vivo studies

No significant interactions were shown when sildenafil (50 mg) was co-administered with tolbutamide (250 mg) or warfarin (40 mg), both of which are metabolised by CYP2C9.

Sildenafil had no significant effect on atorvastatin exposure (AUC increased 11 %), suggesting that sildenafil does not have a clinically relevant effect on CYP3A4.

No interactions were observed between sildenafil (100 mg single dose) and acenocoumarol.

Sildenafil (50 mg) did not potentiate the increase in bleeding time caused by acetyl salicylic acid (150 mg).

Sildenafil (50 mg) did not potentiate the hypotensive effects of alcohol in healthy volunteers with mean maximum blood alcohol levels of 80 mg/dl.

In a study of healthy volunteers sildenafil at steady state (80 mg three times a day) resulted in a 50 % increase in bosentan AUC (125 mg twice daily). A population pharmacokinetic analysis of data from a study of adult PAH patients on background bosentan therapy (62.5 mg - 125 mg twice a day) indicated an increase (20% (95% CI: 9.8 - 30.8)) of bosentan AUC with co-administration of steady-state sildenafil (20 mg three times a day) of a smaller magnitude than seen in healthy volunteers when co-administered with 80 mg sildenafil three times a day (see sections 4.4 and 5.1).

In a specific interaction study, where sildenafil (100 mg) was co-administered with amlodipine in hypertensive patients, there was an additional reduction on supine systolic blood pressure of 8 mmHg. The corresponding additional reduction in supine diastolic blood pressure was 7 mmHg. These additional blood pressure reductions were of a similar magnitude to those seen when sildenafil was administered alone to healthy volunteers.

In three specific drug-drug interaction studies, the alpha-blocker doxazosin (4 mg and 8 mg) and sildenafil (25 mg, 50 mg, or 100 mg) were administered simultaneously to patients with benign prostatic hyperplasia (BPH) stabilized on doxazosin therapy. In these study populations, mean additional reductions of supine systolic and diastolic blood pressure of 7/7 mmHg, 9/5 mmHg, and 8/4 mmHg, respectively, and mean additional reductions of standing blood pressure of 6/6 mmHg, 11/4 mmHg, and 4/5 mmHg, respectively were observed. When sildenafil and doxazosin were administered simultaneously to patients stabilized on doxazosin therapy, there were infrequent reports of patients who experienced symptomatic postural hypotension. These reports included dizziness and lightheadedness, but not syncope. Concomitant administration of sildenafil to patients taking alpha-blocker therapy may lead to symptomatic hypotension in susceptible individuals (see section 4.4).

Sildenafil (100 mg single dose) did not affect the steady state pharmacokinetics of the HIV protease inhibitor saquinavir, which is a CYP3A4 substrate/inhibitor.

Consistent with its known effects on the nitric oxide/cGMP pathway (see section 5.1), sildenafil was shown to potentiate the hypotensive effects of nitrates, and its co-administration with nitric oxide donors or nitrates in any form is therefore contraindicated (see section 4.3).

Riociguat: Preclinical studies showed additive systemic blood pressure lowering effect when PDE5 inhibitors were combined with riociguat. In clinical studies, riociguat has been shown to augment the hypotensive effects of PDE5 inhibitors. There was no evidence of favourable clinical effect of the combination in the population studied. Concomitant use of riociguat with PDE5 inhibitors, including sildenafil, is contraindicated (see section 4.3).

Sildenafil had no clinically significant impact on the plasma levels of oral contraceptives (ethinylloestradiol 30 µg and levonorgestrel 150 µg).

### Paediatric population

Interaction studies have only been performed in adults.

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

### Women of childbearing potential and contraception in males and females

Due to lack of data on effects of Revatio in pregnant women, Revatio is not recommended for women of childbearing potential unless also using appropriate contraceptive measures.

### Pregnancy

There are no data from the use of sildenafil in pregnant women. Animal studies do not indicate direct or indirect harmful effects with respect to pregnancy and embryonal/foetal development. Studies in animals have shown toxicity with respect to postnatal development (see section 5.3).

Due to lack of data, Revatio should not be used in pregnant women unless strictly necessary.

### Breast-feeding

It is not known whether sildenafil enters the breast milk. Revatio should not be administered to breast-feeding mothers.

### Fertility

Non-clinical data revealed no special hazard for humans based on conventional studies of fertility (see section 5.3).

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

Revatio has moderate influence on the ability to drive and use machines.

As dizziness and altered vision were reported in clinical trials with sildenafil, patients should be aware of how they might be affected by Revatio, before driving or using machines.

## **4.8 Undesirable effects**

### Summary of the safety profile

In the pivotal placebo-controlled study of Revatio in pulmonary arterial hypertension, a total of 207 patients were randomized to and treated with 20 mg, 40 mg, or 80 mg TID doses of Revatio and 70 patients were randomized to placebo. The duration of treatment was 12 weeks. The overall frequency of discontinuation in sildenafil treated patients at doses of 20 mg, 40 mg and 80 mg TID was 2.9 %, 3.0 % and 8.5 % respectively, compared to 2.9 % with placebo. Of the 277 subjects treated in the pivotal study, 259 entered a long-term extension study. Doses up to 80 mg three times a day (4 times the recommended dose of 20 mg three times a day) were administered and after 3 years 87 % of 183 patients on study treatment were receiving Revatio 80 mg TID.

In a placebo-controlled study of Revatio as an adjunct to intravenous epoprostenol in pulmonary arterial hypertension, a total of 134 patients were treated with Revatio (in a fixed titration starting from 20 mg, to 40 mg and then 80 mg, three times a day as tolerated) and epoprostenol, and 131 patients were treated with placebo and epoprostenol. The duration of treatment was 16 weeks. The overall frequency of discontinuations in sildenafil/epoprostenol treated patients due to adverse events was 5.2 % compared to 10.7 % in the placebo/epoprostenol treated patients. Newly reported adverse reactions, which occurred more frequently in the sildenafil/ epoprostenol group, were ocular hyperaemia, vision blurred, nasal congestion, night sweats, back pain and dry mouth. The known adverse reactions headache, flushing, pain in extremity and oedema were noted in a higher frequency in sildenafil/epoprostenol treated patients compared to placebo/epoprostenol treated patients. Of the subjects who completed the initial study, 242 entered a long-term extension study. Doses up to 80 mg TID were administered and after 3 years 68 % of 133 patients on study treatment were receiving Revatio 80 mg TID.

In the two-placebo controlled studies adverse events were generally mild to moderate in severity. The most commonly reported adverse reactions that occurred (greater or equal to 10 %) on Revatio compared to placebo were headache, flushing, dyspepsia, diarrhoea and pain in extremity.

Tabulated list of adverse reactions

Adverse reactions which occurred in > 1 % of Revatio-treated patients and were more frequent (> 1 % difference) on Revatio in the pivotal study or in the Revatio combined data set of both the placebo-controlled studies in pulmonary arterial hypertension, at doses of 20, 40 or 80 mg TID are listed in the table below by class and frequency grouping (very common (≥ 1/10), common (≥ 1/100 to < 1/10), uncommon (≥ 1/1000 to ≤ 1/100) and not known (cannot be estimated from the available data). Within each frequency grouping, adverse reactions are presented in order of decreasing seriousness.

Reports from post-marketing experience are included in italics.

<b>MedDRA system organ class (V.14.0)</b>	<b>Adverse reaction</b>
<b>Infections and infestations</b>	
Common	cellulitis, influenza, bronchitis, sinusitis, rhinitis, gastroenteritis
<b>Blood and lymphatic system disorders</b>	
Common	anaemia
<b>Metabolism and nutrition disorders</b>	
Common	fluid retention
<b>Psychiatric disorders</b>	
Common	insomnia, anxiety
<b>Nervous system disorders</b>	
Very common	headache
Common	migraine, tremor, paraesthesia, burning sensation, hypoaesthesia
<b>Eye disorders</b>	
Common	retinal haemorrhage, visual impairment, vision blurred, photophobia, chromatopsia, cyanopsia, eye irritation, ocular hyperaemia
Uncommon	visual acuity reduced, diplopia, abnormal sensation in eye
Not known	<i>Non-arteritic anterior ischaemic optic neuropathy (NAION)*, Retinal vascular occlusion*, Visual field defect*</i>
<b>Ear and labyrinth disorders</b>	
Common	vertigo
Not known	<i>sudden hearing loss</i>
<b>Vascular disorders</b>	
Very common	flushing
Not known	<i>hypotension</i>
<b>Respiratory, thoracic and mediastinal disorders</b>	
Common	epistaxis, cough, nasal congestion
<b>Gastrointestinal disorders</b>	
Very common	diarrhoea, dyspepsia
Common	gastritis, gastrooesophageal reflux disease, haemorrhoids, abdominal distension, dry mouth
<b>Skin and subcutaneous tissue disorders</b>	
Common	alopecia, erythema, night sweats

Not known	<i>rash</i>
<b>Musculoskeletal and connective tissue disorders</b>	
Very common	pain in extremity
Common	myalgia, back pain
<b>Renal and urinary disorders</b>	
Uncommon	haematuria
<b>Reproductive system and breast disorders</b>	
Uncommon	penile haemorrhage, haemospermia, gynaecomastia
Not known	<i>priapism, erection increased</i>
<b>General disorders and administration site conditions</b>	
Common	pyrexia

\*These adverse events/reactions have been reported in patients taking sildenafil for the treatment of male erectile dysfunction (MED).

### Paediatric population

In the placebo-controlled study of Revatio in patients 1 to 17 years of age with pulmonary arterial hypertension, a total of 174 patients were treated three times a day with either low (10 mg in patients > 20 kg; no patients ≤ 20 kg received the low dose), medium (10 mg in patients ≥ 8-20 kg; 20 mg in patients ≥ 20-45 kg; 40 mg in patients > 45 kg) or high dose (20 mg in patients ≥ 8-20 kg; 40 mg in patients ≥ 20-45 kg; 80 mg in patients > 45 kg) regimens of Revatio and 60 were treated with placebo.

The adverse reactions profile seen in this paediatric study was generally consistent with that in adults (see table above). The most common adverse reactions that occurred (with a frequency ≥ 1 %) in Revatio patients (combined doses) and with a frequency > 1 % over placebo patients were pyrexia, upper respiratory tract infection (each 11.5%), vomiting (10.9%), erection increased (including spontaneous penile erections in male subjects) (9.0%), nausea, bronchitis (each 4.6%), pharyngitis (4.0%), rhinorrhoea (3.4%), and pneumonia, rhinitis (each 2.9%).

Of the 234 paediatric subjects treated in the short-term, placebo-controlled study, 220 subjects entered the long-term extension study. Subjects on active sildenafil therapy continued on the same treatment regimen, while those in the placebo group in the short-term study were randomly reassigned to sildenafil treatment.

The most common adverse reactions reported across the duration of the short-term and long-term studies were generally similar to those observed in the short-term study. Adverse reactions reported in >10% of 229 subjects treated with sildenafil (combined dose group, including 9 patients that did not continue into the long-term study) were upper respiratory infection (31%), headache (26%), vomiting (22%), bronchitis (20%), pharyngitis (18%), pyrexia (17%), diarrhoea (15%), and influenza, epistaxis (12% each). Most of these adverse reactions were considered mild to moderate in severity.

Serious adverse events were reported in 94 (41%) of the 229 subjects receiving sildenafil. Of the 94 subjects reporting a serious adverse event, 14/55 (25.5%) subjects were in the low dose group, 35/74 (47.3%) in the medium dose group, and 45/100 (45%) in the high dose group. The most common serious adverse events that occurred with a frequency ≥ 1 % in sildenafil patients (combined doses) were pneumonia (7.4%), cardiac failure, pulmonary hypertension (each 5.2%), upper respiratory tract infection (3.1%), right ventricular failure, gastroenteritis (each 2.6%), syncope, bronchitis, bronchopneumonia, pulmonary arterial hypertension (each 2.2%), chest pain, dental caries (each 1.7%), and cardiogenic shock, gastroenteritis viral, urinary tract infection (each 1.3%).

The following serious adverse events were considered to be treatment related, enterocolitis, convulsion, hypersensitivity, stridor, hypoxia, neurosensory deafness and ventricular arrhythmia.

### 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 national reporting system listed in Appendix V.

## **4.9 Overdose**

In single dose volunteer studies of doses up to 800 mg, adverse reactions were similar to those seen at lower doses, but the incidence rates and severities were increased. At single doses of 200 mg the incidence of adverse reactions (headache, flushing, dizziness, dyspepsia, nasal congestion, and altered vision) was increased.

In cases of overdose, standard supportive measures should be adopted as required. Renal dialysis is not expected to accelerate clearance as sildenafil is highly bound to plasma proteins and not eliminated in the urine.

## **5. PHARMACOLOGICAL PROPERTIES**

### **5.1 Pharmacodynamic properties**

Pharmacotherapeutic group: Urologicals, Drugs used in erectile dysfunction, ATC code: G04BE03

#### Mechanism of action

Sildenafil is a potent and selective inhibitor of cyclic guanosine monophosphate (cGMP) specific phosphodiesterase type 5 (PDE5), the enzyme that is responsible for degradation of cGMP. Apart from the presence of this enzyme in the corpus cavernosum of the penis, PDE5 is also present in the pulmonary vasculature. Sildenafil, therefore, increases cGMP within pulmonary vascular smooth muscle cells resulting in relaxation. In patients with pulmonary arterial hypertension this can lead to vasodilation of the pulmonary vascular bed and, to a lesser degree, vasodilatation in the systemic circulation.

#### Pharmacodynamic effects

Studies *in vitro* have shown that sildenafil is selective for PDE5. Its effect is more potent on PDE5 than on other known phosphodiesterases. There is a 10-fold selectivity over PDE6 which is involved in the phototransduction pathway in the retina. There is an 80-fold selectivity over PDE1, and over 700-fold over PDE 2, 3, 4, 7, 8, 9, 10 and 11. In particular, sildenafil has greater than 4,000-fold selectivity for PDE5 over PDE3, the cAMP-specific phosphodiesterase isoform involved in the control of cardiac contractility.

Sildenafil causes mild and transient decreases in systemic blood pressure which, in the majority of cases, do not translate into clinical effects. After chronic dosing of 80 mg three times a day to patients with systemic hypertension the mean change from baseline in systolic and diastolic blood pressure was a decrease of 9.4 mm Hg and 9.1 mm Hg respectively. After chronic dosing of 80 mg three times a day to patients with pulmonary arterial hypertension lesser effects in blood pressure reduction were observed (a reduction in both systolic and diastolic pressure of 2 mm Hg). At the recommended dose of 20 mg three times a day no reductions in systolic or diastolic pressure were seen.

Single oral doses of sildenafil up to 100 mg in healthy volunteers produced no clinically relevant effects on ECG. After chronic dosing of 80 mg three times a day to patients with pulmonary arterial hypertension no clinically relevant effects on the ECG were reported.

In a study of the hemodynamic effects of a single oral 100 mg dose of sildenafil in 14 patients with severe coronary artery disease (CAD) (> 70 % stenosis of at least one coronary artery), the mean resting systolic and diastolic blood pressures decreased by 7 % and 6 % respectively compared to

baseline. Mean pulmonary systolic blood pressure decreased by 9 %. Sildenafil showed no effect on cardiac output, and did not impair blood flow through the stenosed coronary arteries.

Mild and transient differences in colour discrimination (blue/green) were detected in some subjects using the Farnsworth-Munsell 100 hue test at 1 hour following a 100 mg dose, with no effects evident after 2 hours post-dose. The postulated mechanism for this change in colour discrimination is related to inhibition of PDE6, which is involved in the phototransduction cascade of the retina. Sildenafil has no effect on visual acuity or contrast sensitivity. In a small size placebo-controlled study of patients with documented early age-related macular degeneration (n = 9), sildenafil (single dose, 100 mg) demonstrated no significant changes in visual tests conducted (visual acuity, Amsler grid, colour discrimination simulated traffic light, Humphrey perimeter and photostress).

### Clinical efficacy and safety

#### *Efficacy in adult patients with pulmonary arterial hypertension (PAH)*

A randomised, double-blind, placebo-controlled study was conducted in 278 patients with primary pulmonary hypertension, PAH associated with connective tissue disease, and PAH following surgical repair of congenital heart lesions. Patients were randomised to one of four treatment groups: placebo, sildenafil 20 mg, sildenafil 40 mg or sildenafil 80 mg, three times a day. Of the 278 patients randomised, 277 patients received at least 1 dose of study drug. The study population consisted of 68 (25 %) men and 209 (75 %) women with a mean age of 49 years (range: 18-81 years) and baseline 6-minute walk test distance between 100 and 450 metres inclusive (mean: 344 metres). 175 patients (63 %) included were diagnosed with primary pulmonary hypertension, 84 (30 %) were diagnosed with PAH associated with connective tissue disease and 18 (7 %) of the patients were diagnosed with PAH following surgical repair of congenital heart lesions. Most patients were WHO Functional Class II (107/277, 39 %) or III (160/277, 58 %) with a mean baseline 6 minute walking distance of 378 meters and 326 meters respectively; fewer patients were Class I (1/277, 0.4 %) or IV (9/277, 3 %) at baseline. Patients with left ventricular ejection fraction < 45 % or left ventricular shortening fraction < 0.2 were not studied.

Sildenafil (or placebo) was added to patients' background therapy which could have included a combination of anticoagulation, digoxin, calcium channel blockers, diuretics or oxygen. The use of prostacyclin, prostacyclin analogues and endothelin receptor antagonists was not permitted as add-on therapy, and neither was arginine supplementation. Patients who previously failed bosentan therapy were excluded from the study.

The primary efficacy endpoint was the change from baseline at week 12 in 6-minute walk distance (6MWD). A statistically significant increase in 6MWD was observed in all 3 sildenafil dose groups compared to those on placebo. Placebo corrected increases in 6MWD were 45 metres (p < 0.0001), 46 metres (p < 0.0001) and 50 metres (p < 0.0001) for sildenafil 20 mg, 40 mg and 80 mg TID, respectively. There was no significant difference in effect between sildenafil doses. For patients with a baseline 6MWD < 325 m improved efficacy was observed with higher doses (placebo-corrected improvements of 58 metres, 65 metres and 87 metres for 20 mg, 40 mg and 80 mg doses TID, respectively).

When analysed by WHO functional class, a statistically significant increase in 6MWD was observed in the 20 mg dose group. For class II and class III, placebo corrected increases of 49 metres (p = 0.0007) and 45 metres (p = 0.0031) were observed respectively.

The improvement in 6MWD was apparent after 4 weeks of treatment and this effect was maintained at weeks 8 and 12. Results were generally consistent in subgroups according to aetiology (primary and connective tissue disease-associated PAH), WHO functional class, gender, race, location, mean PAP and PVRI.

Patients on all sildenafil doses achieved a statistically significant reduction in mean pulmonary arterial pressure (mPAP) and pulmonary vascular resistance (PVR) compared to those on placebo.

Placebo-corrected treatment effects with mPAP were -2.7 mmHg ( $p = 0.04$ ), -3.0 mm Hg ( $p = 0.01$ ) and -5.1 mm Hg ( $p < 0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID respectively. Placebo-corrected treatment effects with PVR were -178 dyne.sec/cm<sup>5</sup> ( $p=0.0051$ ), -195 dyne.sec/cm<sup>5</sup> ( $p=0.0017$ ) and -320 dyne.sec/cm<sup>5</sup> ( $p<0.0001$ ) for sildenafil 20 mg, 40 mg and 80 mg TID, respectively. The percent reduction at 12 weeks for sildenafil 20 mg, 40 mg and 80 mg TID in PVR (11.2 %, 12.9 %, 23.3 %) was proportionally greater than the reduction in systemic vascular resistance (SVR) (7.2 %, 5.9 %, 14.4 %). The effect of sildenafil on mortality is unknown.

A greater percentage of patients on each of the sildenafil doses (i.e. 28 %, 36 % and 42 % of subjects who received sildenafil 20 mg, 40 mg and 80 mg TID doses, respectively) showed an improvement by at least one WHO functional class at week 12 compared to placebo (7 %). The respective odds ratios were 2.92 ( $p=0.0087$ ), 4.32 ( $p=0.0004$ ) and 5.75 ( $p<0.0001$ ).

#### Long-term survival data in naive population

Patients enrolled into the pivotal study were eligible to enter a long term open label extension study. At 3 years 87 % of the patients were receiving a dose of 80 mg TID. A total of 207 patients were treated with Revatio in the pivotal study, and their long term survival status was assessed for a minimum of 3 years. In this population, Kaplan-Meier estimates of 1, 2 and 3 year survival were 96 %, 91 % and 82 %, respectively. Survival in patients of WHO functional class II at baseline at 1, 2 and 3 years was 99 %, 91 %, and 84 % respectively, and for patients of WHO functional class III at baseline was 94 %, 90 %, and 81 %, respectively.

#### Efficacy in adult patients with PAH (when used in combination with epoprostenol)

A randomised, double-blind, placebo controlled study was conducted in 267 patients with PAH who were stabilised on intravenous epoprostenol. The PAH patients included those with Primary Pulmonary Arterial Hypertension (212/267, 79 %) and PAH associated with connective tissue disease (55/267, 21 %). Most patients were WHO Functional Class II (68/267, 26 %) or III (175/267, 66 %); fewer patients were Class I (3/267, 1 %) or IV (16/267, 6 %) at baseline; for a few patients (5/267, 2 %), the WHO Functional Class was unknown. Patients were randomised to placebo or sildenafil (in a fixed titration starting from 20 mg, to 40 mg and then 80 mg, three times a day as tolerated) when used in combination with intravenous epoprostenol.

The primary efficacy endpoint was the change from baseline at week 16 in 6-minute walk distance. There was a statistically significant benefit of sildenafil compared to placebo in 6-minute walk distance. A mean placebo corrected increase in walk distance of 26 metres was observed in favour of sildenafil (95 % CI: 10.8, 41.2) ( $p = 0.0009$ ). For patients with a baseline walking distance  $\geq 325$  metres, the treatment effect was 38.4 metres in favour of sildenafil; for patients with a baseline walking distance  $< 325$  metres, the treatment effect was 2.3 metres in favour of placebo. For patients with primary PAH, the treatment effect was 31.1 metres compared to 7.7 metres for patients with PAH associated with connective tissue disease. The difference in results between these randomisation subgroups may have arisen by chance in view of their limited sample size.

Patients on sildenafil achieved a statistically significant reduction in mean Pulmonary Arterial Pressure (mPAP) compared to those on placebo. A mean placebo-corrected treatment effect of -3.9 mmHg was observed in favour of sildenafil (95 % CI: -5.7, -2.1) ( $p = 0.00003$ ). Time to clinical worsening was a secondary endpoint as defined as the time from randomisation to the first occurrence of a clinical worsening event (death, lung transplantation, initiation of bosentan therapy, or clinical deterioration requiring a change in epoprostenol therapy). Treatment with sildenafil significantly delayed the time to clinical worsening of PAH compared to placebo ( $p = 0.0074$ ). 23 subjects experienced clinical worsening events in the placebo group (17.6 %) compared with 8 subjects in the sildenafil group (6.0 %).

#### Long-term Survival Data in the background epoprostenol study

Patients enrolled into the epoprostenol add-on therapy study were eligible to enter a long term open label extension study. At 3 years 68 % of the patients were receiving a dose of 80 mg TID. A total of 134 patients were treated with Revatio in the initial study, and their long term survival status was

assessed for a minimum of 3 years. In this population, Kaplan-Meier estimates of 1, 2 and 3 year survival were 92 %, 81 % and 74 %, respectively.

#### Efficacy and safety in adult patients with PAH (when used in combination with bosentan)

A randomized, double-blind, placebo controlled study was conducted in 103 clinically stable subjects with PAH (WHO FC II and III) who were on bosentan therapy for a minimum of three months. The PAH patients included those with Primary PAH, and PAH associated with connective tissue disease. Patients were randomized to placebo or sildenafil (20 mg three times a day) in combination with bosentan (62.5-125 mg twice a day). The primary efficacy endpoint was the change from baseline at Week 12 in 6MWD. The results indicate that there is no significant difference in mean change from baseline on 6MWD observed between sildenafil (20 mg three times a day) and placebo (13.62 m (95% CI: -3.89 to 31.12) and 14.08 m (95% CI: -1.78 to 29.95), respectively).

Differences in 6MWD were observed between patients with primary PAH and PAH associated with connective tissue disease. For subjects with primary PAH (67 subjects), mean changes from baseline were 26.39 m (95% CI: 10.70 to 42.08) and 11.84 m (95% CI: -8.83 to 32.52) for the sildenafil and placebo groups, respectively. However, for subjects with PAH associated with connective tissue disease (36 subjects) mean changes from baseline were -18.32 m (95% CI: -65.66 to 29.02) and 17.50 m (95% CI: -9.41 to 44.41) for the sildenafil and placebo groups, respectively.

Overall, the adverse events were generally similar between the two treatment groups (sildenafil plus bosentan vs. bosentan alone), and consistent with the known safety profile of sildenafil when used as monotherapy (see sections 4.4 and 4.5).

#### Paediatric population

A total of 234 subjects aged 1 to 17 years were treated in a randomized, double-blind, multi-centre, placebo controlled parallel group, dose ranging study. Subjects (38 % male and 62 % female) had a body weight  $\geq$  8 kg, and had primary pulmonary hypertension (PPH) [33 %], or PAH secondary to congenital heart disease [systemic-to-pulmonary shunt 37 %, surgical repair 30 %]. In this trial, 63 of 234 (27 %) patients were  $<$  7 years old (sildenafil low dose = 2; medium dose = 17; high dose = 28; placebo = 16) and 171 of 234 (73 %) patients were 7 years or older (sildenafil low dose = 40; medium dose = 38; and high dose = 49; placebo = 44). Most subjects were WHO Functional Class I (75/234, 32 %) or II (120/234, 51 %) at baseline; fewer patients were Class III (35/234, 15 %) or IV (1/234, 0.4 %); for a few patients (3/234, 1.3 %), the WHO Functional Class was unknown.

Patients were naïve for specific PAH therapy and the use of prostacyclin, prostacyclin analogues and endothelin receptor antagonists was not permitted in the study, and neither was arginine supplementation, nitrates, alpha-blockers and potent CYP450 3A4 inhibitors.

The primary objective of the study was to assess the efficacy of 16 weeks of chronic treatment with oral sildenafil in paediatric subjects to improve exercise capacity as measured by the Cardiopulmonary Exercise Test (CPET) in subjects who were developmentally able to perform the test,  $n = 115$ ). Secondary endpoints included haemodynamic monitoring, symptom assessment, WHO functional class, change in background treatment, and quality of life measurements.

Subjects were allocated to one of three sildenafil treatment groups, low (10 mg), medium (10-40 mg) or high dose (20-80 mg) regimens of Revatio given three times a day, or placebo. Actual doses administered within a group were dependent on body weight (see Section 4.8). The proportion of subjects receiving supportive medicinal products at baseline (anticoagulants, digoxin, calcium channel blockers, diuretics and/or oxygen) was similar in the combined sildenafil treatment group (47.7 %) and the placebo treatment group (41.7 %).

The primary endpoint was the placebo-corrected percentage change in peak  $VO_2$  from baseline to week 16 assessed by CPET in the combined dose groups (Table 2). A total of 106 out of 234 (45 %) subjects were evaluable for CPET, which comprised those children  $\geq$  7 years old and developmentally able to perform the test. Children  $<$  7 years (sildenafil combined dose = 47; placebo = 16) were

evaluable only for the secondary endpoints. Mean baseline peak volume of oxygen consumed ( $VO_2$ ) values were comparable across the sildenafil treatment groups (17.37 to 18.03 ml/kg/min), and slightly higher for the placebo treatment group (20.02 ml/kg/min). The results of the main analysis (combined dose groups versus placebo) were not statistically significant ( $p = 0.056$ ) (see Table 2). The estimated difference between the medium sildenafil dose and placebo was 11.33 % (95 % CI: 1.72 to 20.94) (see Table 2).

**Table 2: Placebo corrected % change from baseline in peak  $VO_2$  by active treatment group**

Treatment group	Estimated difference	95 % Confidence interval
<b>Low dose</b> (n=24)	3.81	-6.11, 13.73
<b>Medium dose</b> (n=26)	11.33	1.72, 20.94
<b>High dose</b> (n=27)	7.98	-1.64, 17.60
<b>Combined dose groups</b> (n=77)	7.71 ( $p = 0.056$ )	-0.19, 15.60

*n=29 for placebo group*

*Estimates based on ANCOVA with adjustments for the covariates baseline peak  $VO_2$ , etiology and weight group*

Dose related improvements were observed with pulmonary vascular resistance index (PVRI) and mean pulmonary arterial pressure (mPAP). The sildenafil medium and high dose groups both showed PVRI reductions compared to placebo, of 18 % (95 %CI: 2 % to 32 %) and 27 % (95 %CI: 14 % to 39 %), respectively; whilst the low dose group showed no significant difference from placebo (difference of 2 %). The sildenafil medium and high dose groups displayed mPAP changes from baseline compared to placebo, of -3.5 mmHg (95 %CI: -8.9, 1.9) and -7.3 mmHg (95 %CI: -12.4, -2.1), respectively; whilst the low dose group showed little difference from placebo (difference of 1.6 mmHg). Improvements were observed with cardiac index with all three sildenafil groups over placebo, 10 %, 4 % and 15 % for the low, medium and high dose groups respectively.

Significant improvements in functional class were demonstrated only in subjects on sildenafil high dose compared to placebo. Odds ratios for the sildenafil low, medium and high dose groups compared to placebo were 0.6 (95 % CI: 0.18, 2.01), 2.25 (95 % CI: 0.75, 6.69) and 4.52 (95 % CI: 1.56, 13.10), respectively.

#### Long term extension data

Of the 234 paediatric subjects treated in the short-term, placebo-controlled study, 220 subjects entered the long-term extension study. Subjects who had been in the placebo group in the short-term study were randomly reassigned to sildenafil treatment; subjects weighing  $\leq 20$  kg entered the medium or high dose groups (1:1), while subjects weighing  $> 20$  kg entered the low, medium or high dose groups (1:1:1). Of the total 229 subjects who received sildenafil, there were 55, 74, and 100 subjects in the low, medium and high dose groups, respectively. Across the short-term and long-term studies, the overall duration of treatment from start of double-blind for individual subjects ranged from 3 to 3129 days. By sildenafil treatment group, median duration of sildenafil treatment was 1696 days (excluding the 5 subjects who received placebo in double-blind and were not treated in the long-term extension study).

Kaplan-Meier estimates of survival at 3 years in patients  $> 20$  kg in weight at baseline were 94 %, 93 % and 85 % in the low, medium and high dose groups, respectively; for patients  $\leq 20$  kg in weight at baseline, the survival estimates were 94 % and 93 % for subjects in the medium and high dose groups respectively (see sections 4.4 and 4.8).

During the conduct of the study, there were a total of 42 deaths reported, whether on treatment or reported as part of the survival follow-up. 37 deaths occurred prior to a decision taken by the Data

Monitoring Committee to down titrate subjects to a lower dosage, based on an observed mortality imbalance with increasing sildenafil doses. Among these 37 deaths, the number (%) of deaths was 5/55 (9.1%), 10/74 (13.5%), and 22/100 (22%) in the sildenafil low, medium, and high dose groups, respectively. An additional 5 deaths were reported subsequently. The causes of deaths were related to PAH. Higher than recommended doses should not be used in paediatric patients with PAH (see sections 4.2 and 4.4).

Peak  $VO_2$  was assessed 1 year after the start of the placebo-controlled study. Of those sildenafil treated subjects developmentally able to perform the CPET 59/114 subjects (52 %) had not shown any deterioration in Peak  $VO_2$  from start of sildenafil. Similarly 191 of 229 subjects (83 %) who had received sildenafil had either maintained or improved their WHO Functional Class at 1 year assessment.

The European Medicines Agency has deferred the obligation to submit the results of studies with Revatio in newborns with pulmonary arterial hypertension (see section 4.2 for information on paediatric use).

## 5.2 Pharmacokinetic properties

### Absorption

Sildenafil is rapidly absorbed. Maximum observed plasma concentrations are reached within 30 to 120 minutes (median 60 minutes) of oral dosing in the fasted state. The mean absolute oral bioavailability is 41 % (range 25-63 %). After oral three times a day dosing of sildenafil, AUC and  $C_{max}$  increase in proportion with dose over the dose range of 20-40 mg. After oral doses of 80 mg three times a day a more than dose proportional increase in sildenafil plasma levels has been observed. In pulmonary arterial hypertension patients, the oral bioavailability of sildenafil after 80 mg three times a day was on average 43 % (90 % CI: 27 % -60 %) higher compared to the lower doses.

When sildenafil is taken with food, the rate of absorption is reduced with a mean delay in  $T_{max}$  of 60 minutes and a mean reduction in  $C_{max}$  of 29 % however, the extent of absorption was not significantly affected (AUC decreased by 11 %).

### Distribution

The mean steady state volume of distribution ( $V_{ss}$ ) for sildenafil is 105 l, indicating distribution into the tissues. After oral doses of 20 mg three times a day, the mean maximum total plasma concentration of sildenafil at steady state is approximately 113 ng/ml. Sildenafil and its major circulating N-desmethyl metabolite are approximately 96 % bound to plasma proteins. Protein binding is independent of total drug concentrations.

### Biotransformation

Sildenafil is cleared predominantly by the CYP3A4 (major route) and CYP2C9 (minor route) hepatic microsomal isoenzymes. The major circulating metabolite results from N-demethylation of sildenafil. This metabolite has a phosphodiesterase selectivity profile similar to sildenafil and an *in vitro* potency for PDE5 approximately 50 % that of the parent drug. The N-desmethyl metabolite is further metabolised, with a terminal half-life of approximately 4 h. In patients with pulmonary arterial hypertension, plasma concentrations of N-desmethyl metabolite are approximately 72 % those of sildenafil after 20 mg three times a day dosing (translating into a 36 % contribution to sildenafil's pharmacological effects). The subsequent effect on efficacy is unknown.

### Elimination

The total body clearance of sildenafil is 41 l/h with a resultant terminal phase half-life of 3-5 h. After either oral or intravenous administration, sildenafil is excreted as metabolites predominantly in the faeces (approximately 80 % of administered oral dose) and to a lesser extent in the urine (approximately 13 % of administered oral dose).

## Pharmacokinetics in special patient groups

### Elderly

Healthy elderly volunteers (65 years or over) had a reduced clearance of sildenafil, resulting in approximately 90 % higher plasma concentrations of sildenafil and the active N-desmethyl metabolite compared to those seen in healthy younger volunteers (18-45 years). Due to age-differences in plasma protein binding, the corresponding increase in free sildenafil plasma concentration was approximately 40 %.

### Renal insufficiency

In volunteers with mild to moderate renal impairment (creatinine clearance = 30-80 ml/min), the pharmacokinetics of sildenafil were not altered after receiving a 50 mg single oral dose. In volunteers with severe renal impairment (creatinine clearance < 30 ml/min), sildenafil clearance was reduced, resulting in mean increases in AUC and  $C_{\max}$  of 100 % and 88 % respectively compared to age-matched volunteers with no renal impairment. In addition, N-desmethyl metabolite AUC and  $C_{\max}$  values were significantly increased by 200 % and 79 % respectively in subjects with severe renal impairment compared to subjects with normal renal function.

### Hepatic insufficiency

In volunteers with mild to moderate hepatic cirrhosis (Child-Pugh class A and B) sildenafil clearance was reduced, resulting in increases in AUC (85 %) and  $C_{\max}$  (47 %) compared to age-matched volunteers with no hepatic impairment. In addition, N-desmethyl metabolite AUC and  $C_{\max}$  values were significantly increased by 154 % and 87 %, respectively in cirrhotic subjects compared to subjects with normal hepatic function. The pharmacokinetics of sildenafil in patients with severely impaired hepatic function have not been studied.

### Population pharmacokinetics

In patients with pulmonary arterial hypertension, the average steady state concentrations were 20-50 % higher over the investigated dose range of 20–80 mg three times a day compared to healthy volunteers. There was a doubling of the  $C_{\min}$  compared to healthy volunteers. Both findings suggest a lower clearance and/or a higher oral bioavailability of sildenafil in patients with pulmonary arterial hypertension compared to healthy volunteers.

### Paediatric population

From the analysis of the pharmacokinetic profile of sildenafil in patients involved in the paediatric clinical trials, body weight was shown to be a good predictor of drug exposure in children. Sildenafil plasma concentration half-life values were estimated to range from 4.2 to 4.4 hours for a range of 10 to 70 kg of body weight and did not show any differences that would appear as clinically relevant.  $C_{\max}$  after a single 20 mg sildenafil dose administered PO was estimated at 49, 104 and 165 ng/ml for 70, 20 and 10 kg patients, respectively.  $C_{\max}$  after a single 10 mg sildenafil dose administered PO was estimated at 24, 53 and 85 ng/ml for 70, 20 and 10 kg patients, respectively.  $T_{\max}$  was estimated at approximately 1 hour and was almost independent from body weight.

## **5.3 Preclinical safety data**

Non-clinical data revealed no special hazard for humans based on conventional studies of safety pharmacology, repeated dose toxicity, genotoxicity and carcinogenic potential, toxicity to reproduction and development.

In pups of rats which were pre- and postnatally treated with 60 mg/kg sildenafil, a decreased litter size, a lower pup weight on day 1 and a decreased 4-day survival were seen at exposures which were approximately fifty times the expected human exposure at 20 mg three times a day. Effects in non-clinical studies were observed at exposures considered sufficiently in excess of the maximum human exposure indicating little relevance to clinical use.

There were no adverse reactions, with possible relevance to clinical use, seen in animals at clinically relevant exposure levels which were not also observed in clinical studies.

## **6. PHARMACEUTICAL PARTICULARS**

### **6.1 List of excipients**

#### Powder for oral suspension:

Sorbitol  
Citric acid anhydrous  
Sucralose  
Sodium citrate  
Xanthan gum  
Titanium dioxide (E171)  
Sodium benzoate (E211)  
Silica, colloidal anhydrous

#### Grape flavour:

Maltodextrin  
Grape juice concentrate  
Gum acacia  
Pineapple juice concentrate  
Citric acid anhydrous  
Natural flavouring

### **6.2 Incompatibilities**

Not applicable.

### **6.3 Shelf life**

2 years.

After reconstitution, the oral suspension is stable for 30 days.

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

#### Powder

Do not store above 30°C.  
Store in the original package in order to protect from moisture.

#### Oral suspension

Store below 30°C or in refrigerator (2°C to 8°C). Do not freeze.

For storage conditions after reconstitution of the medicinal product, see section 6.3.

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

One 125 ml amber glass bottle (with a polypropylene screw cap) contains 32.27 g of powder for oral suspension.

Once reconstituted the bottle contains 112 ml of oral suspension, of which 90 ml is intended for dosing and administration.

Pack size: 1 bottle

Each pack also contains a polypropylene measuring cup (graduated to indicate 30 ml), polypropylene oral dosing syringe (3 ml) with HDPE plunger and a LDPE press-in bottle adaptor.

## 6.6 Special precautions for disposal and other handling

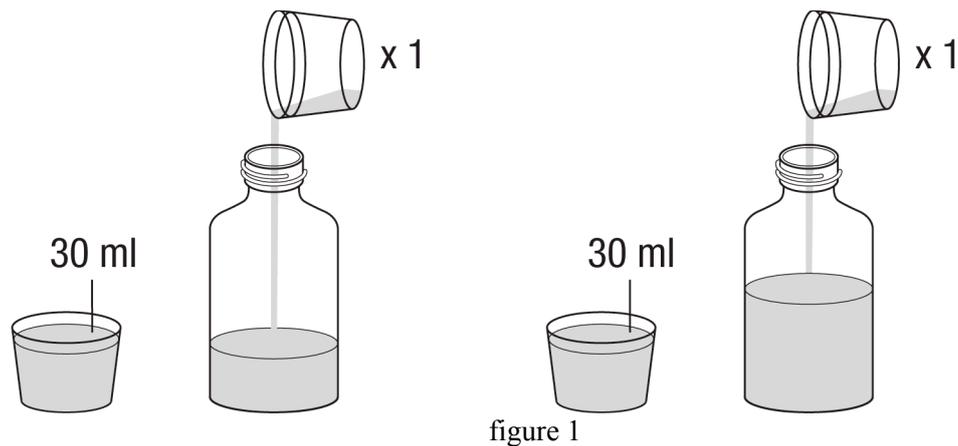
Any unused medicinal product or waste material should be disposed of in accordance with local requirements.

It is recommended that a pharmacist constitutes Revatio oral suspension prior to its dispensing to the patient.

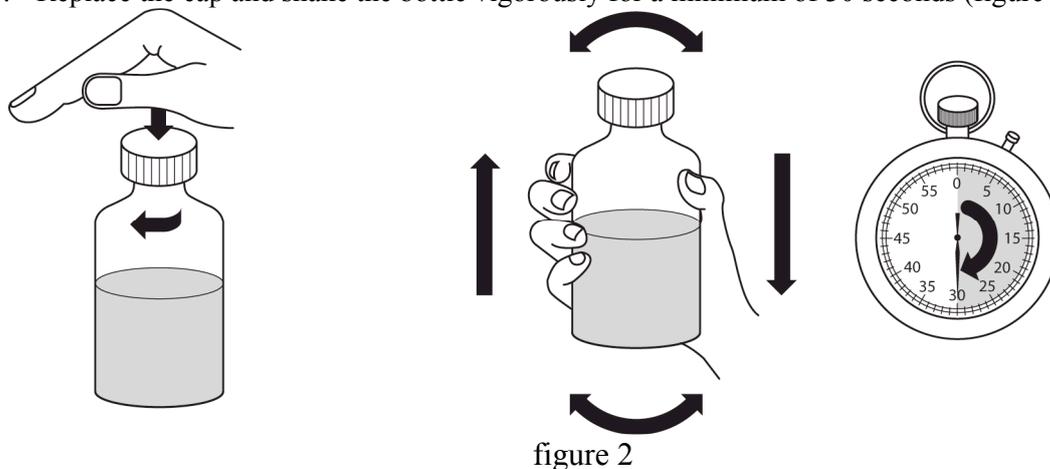
### Reconstitution instructions

**Note:** A total volume of 90 ml (3 x 30 ml) of water irrespective of the dose to be taken should be used to reconstitute the contents of the bottle

1. Tap the bottle to release the powder.
2. Remove the cap.
3. Measure 30 ml of water by filling the measuring cup (included in the carton) to the marked line then pour the water into the bottle. Using the cup measure another 30 ml of water and add this to the bottle (figure 1).



4. Replace the cap and shake the bottle vigorously for a minimum of 30 seconds (figure 2).



5. Remove the cap.

6. Using the cup measure another 30 ml of water and add this to the bottle. You should always add a total of 90 ml (3 x 30 ml) of water irrespective of the dose you are taking (figure 3).

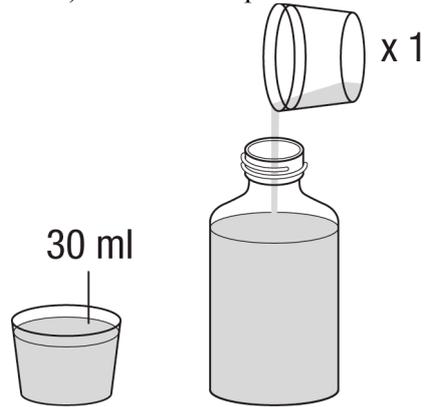


figure 3

7. Replace the cap and shake the bottle vigorously for a minimum of 30 seconds (figure 4).

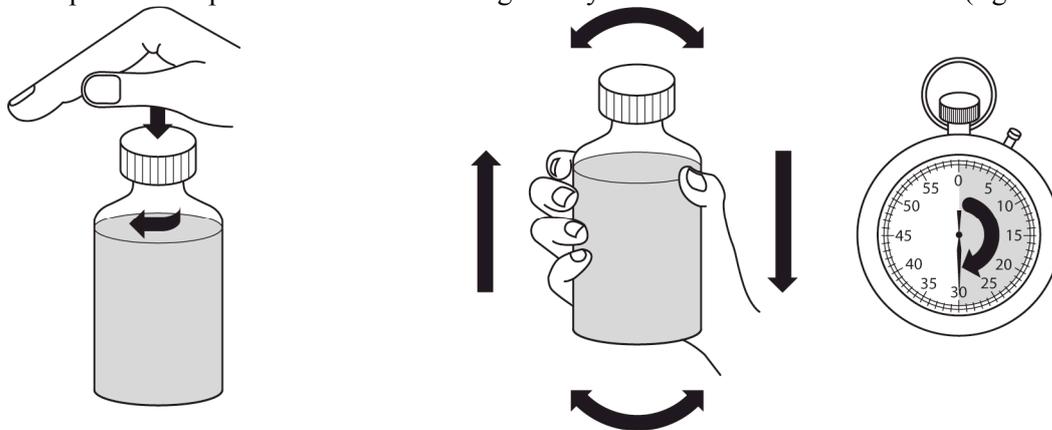


figure 4

8. Remove the cap.  
9. Press the bottle adaptor into the neck of the bottle (as shown on figure 5 below). The adaptor is provided so that you can fill the oral dosing syringe with medicine from the bottle. Replace the cap on the bottle.

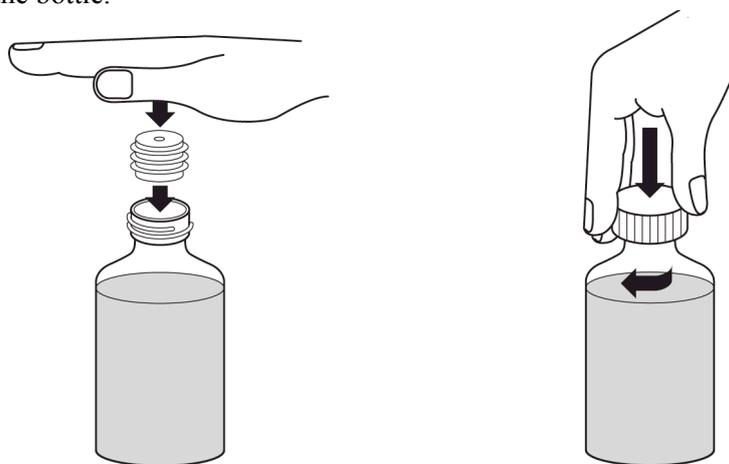


figure 5

10. When constituted the powder provides a white grape flavoured oral suspension. Write the date of expiry of the constituted oral suspension on the bottle label (the date of expiry of the

constituted oral suspension is 30 days from the date of constitution). Any unused oral suspension should be discarded or returned to your pharmacist after this date.

Instructions for use

1. Shake the closed bottle of constituted oral suspension vigorously for a minimum of 10 seconds before use. Remove the cap (figure 6).

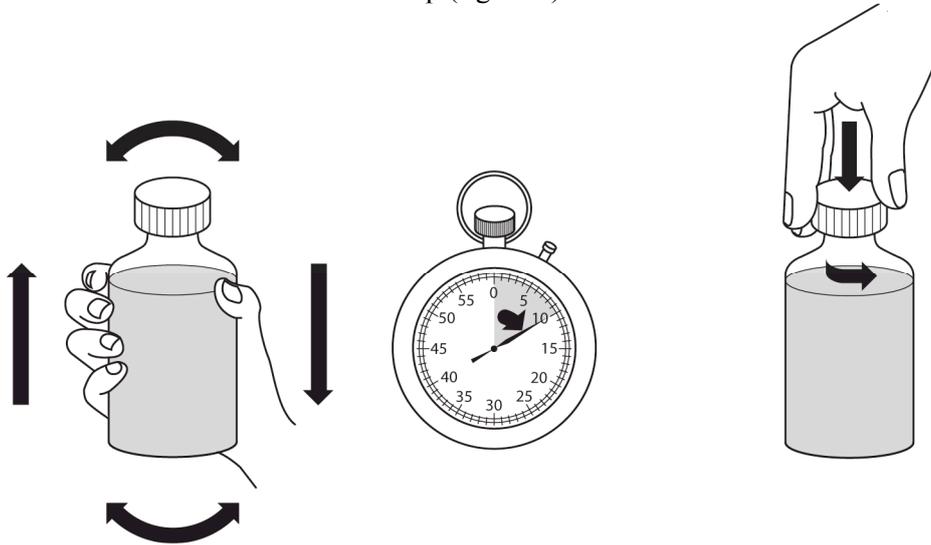


figure 6

2. While the bottle is upright, on a flat surface, insert the tip of the oral dosing syringe into the adaptor (figure 7).

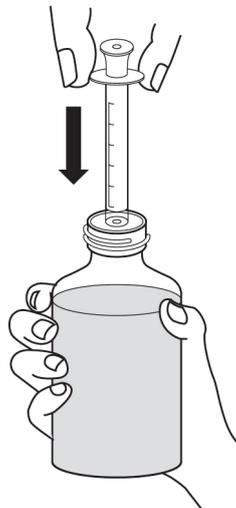


figure 7

3. Turn the bottle upside down while holding the oral dosing syringe in place. Slowly pull back the plunger of the oral dosing syringe to the graduation mark that marks the dose for you (withdrawing 1 ml provides a 10 mg dose, withdrawing 2 ml provides a 20 mg dose). To measure the dose accurately, the top edge of the plunger should be lined up with the appropriate graduated mark on the oral dosing syringe (figure 8).

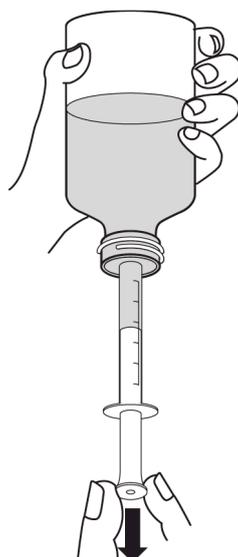


figure 8

4. If large bubbles can be seen, slowly push the plunger back into the syringe. This will force the medicine back into the bottle. Repeat step 3 again.
5. Turn the bottle back upright with the oral dosing syringe still in place. Remove the oral dosing syringe from the bottle.
6. Put the tip of the oral dosing syringe into the mouth. Point the tip of the oral dosing syringe towards the inside of the cheek. SLOWLY push down the plunger of the oral dosing syringe. Do not squirt the medicine out quickly. If the medicine is to be given to a child, make sure the child is sitting, or is held, upright before giving the medicine (figure 9).

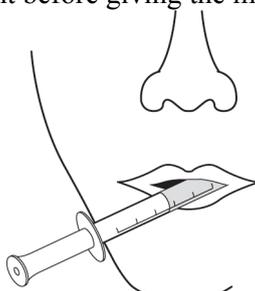


figure 9

7. Replace the cap on the bottle, leaving the bottle adaptor in place. Wash the oral dosing syringe as instructed below.

Cleaning and storing the syringe:

1. The syringe should be washed after each dose. Pull the plunger out of the syringe and wash both parts in water.
2. Dry the two parts. Push the plunger back in to the syringe. Keep it in a clean safe place with the medicine.

Once reconstituted, the oral suspension should only be administered using the oral dosing syringe supplied with each pack. Refer to the patient leaflet for more detailed instructions for use.

## 7. MARKETING AUTHORISATION HOLDER

Pfizer Limited, Sandwich, Kent CT13 9NJ, United Kingdom.

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

EU/1/05/318/003

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

Date of first authorisation: 28 October 2005

Date of latest renewal: 23 September 2010

**10. DATE OF REVISION OF THE TEXT**

Detailed information on this medicinal product is available on the website of the European Medicines Agency <http://www.ema.europa.eu>

## **ANNEX II**

- A. MANUFACTURER RESPONSIBLE FOR BATCH RELEASE**
- B. CONDITIONS OR RESTRICTIONS REGARDING SUPPLY AND USE**
- C. OTHER CONDITIONS AND REQUIREMENTS OF THE MARKETING AUTHORISATION**
- D. CONDITIONS OR RESTRICTIONS WITH REGARD TO THE SAFE AND EFFECTIVE USE OF THE MEDICINAL PRODUCT**

## **A. MANUFACTURER RESPONSIBLE FOR BATCH RELEASE**

Name and address of the manufacturer(s) responsible for batch release

Fareva Amboise  
Zone Industrielle  
29 route des Industries  
37530 Pocé-sur-Cisse  
France

## **B. CONDITIONS OR RESTRICTIONS REGARDING SUPPLY AND USE**

Medicinal product subject to restricted medical prescription (See Annex I: Summary of Product Characteristics, section 4.2).

## **C. OTHER CONDITIONS AND REQUIREMENTS OF THE MARKETING AUTHORISATION**

### **• Periodic Safety Update Reports**

The requirements for submission of periodic safety update reports for this medicinal product are set out in the list of Union reference dates (EURD list) provided for under Article 107c(7) of Directive 2001/83/EC and any subsequent updates published on the European medicines web-portal.

## **D. CONDITIONS OR RESTRICTIONS WITH REGARD TO THE SAFE AND EFFECTIVE USE OF THE MEDICINAL PRODUCT**

### **• Risk Management Plan (RMP)**

The MAH shall perform the required pharmacovigilance activities and interventions detailed in the agreed RMP presented in Module 1.8.2. of the Marketing Authorisation and any agreed subsequent updates of the RMP.

An updated RMP should be submitted:

- At the request of the European Medicine Agency;
- Whenever the risk management system is modified, especially as the result of new information being received that may lead to a significant change to the benefit/risk profile or as the result of an important (pharmacovigilance or risk minimisation) milestone being reached.

### **• Additional risk minimisation measures**

The Marketing Authorisation Holder (MAH) shall agree the details of a controlled distribution system for the 20 ml vial of Revatio 0.8 mg/ml solution for injection with the National Competent Authorities and must implement such programme nationally to ensure that prior to prescribing all healthcare professionals who intend to prescribe and/or dispense Revatio 0.8 mg/ml solution for injection are provided with the following:

- Information for healthcare professionals
- Copy of the Summary of Product Characteristics (SPC)
- Data Capture Form (DCF) designed to facilitate reporting of events of hypotension and associated problems

The Information for healthcare professionals should contain the following key elements:

- Information about the Pharmacovigilance Monitoring Programme regarding the potential risk of clinically relevant hypotension and related problems to be put into place with the use of the DCF.

The Marketing Authorisation Holder shall agree the Information for healthcare professionals, and the healthcare professionals to be targeted, with the national competent authority of each Member State prior to the launch of the 20 ml vial of Revatio 0.8 mg/ml solution for injection in that country.

**ANNEX III**  
**LABELLING AND PACKAGE LEAFLET**

## **A. LABELLING**

**PARTICULARS TO APPEAR ON THE OUTER PACKAGING**

**OUTER PACKAGING/CARTON**

**1. NAME OF THE MEDICINAL PRODUCT**

Revatio 20 mg film-coated tablets  
Sildenafil

**2. STATEMENT OF ACTIVE SUBSTANCE(S)**

Each tablet contains 20 mg of sildenafil (as citrate).

**3. LIST OF EXCIPIENTS**

Contains lactose monohydrate.  
See leaflet for further information.

**4. PHARMACEUTICAL FORM AND CONTENTS**

90 film-coated tablets  
90 x 1 film-coated tablets  
300 film-coated tablets

**5. METHOD AND ROUTE(S) OF ADMINISTRATION**

Read the package leaflet before use.  
Oral use.

**6. SPECIAL WARNING THAT THE MEDICINAL PRODUCT MUST BE STORED OUT OF THE SIGHT AND REACH OF CHILDREN**

Keep out of the sight and reach of children.

**7. OTHER SPECIAL WARNING(S), IF NECESSARY**

**8. EXPIRY DATE**

EXP

**9. SPECIAL STORAGE CONDITIONS**

Do not store above 30°C. Store in the original package in order to protect from moisture.

**10. SPECIAL PRECAUTIONS FOR DISPOSAL OF UNUSED MEDICINAL PRODUCTS OR WASTE MATERIALS DERIVED FROM SUCH MEDICINAL PRODUCTS, IF APPROPRIATE**

**11. NAME AND ADDRESS OF THE MARKETING AUTHORISATION HOLDER**

Pfizer Limited  
Sandwich  
Kent CT13 9NJ  
United Kingdom

**12. MARKETING AUTHORISATION NUMBER(S)**

EU/1/05/318/001  
EU/1/05/318/004  
EU/1/05/318/005

**13. BATCH NUMBER**

Batch

**14. GENERAL CLASSIFICATION FOR SUPPLY**

Medicinal product subject to medical prescription.

**15. INSTRUCTIONS ON USE**

**16. INFORMATION IN BRAILLE**

Revatio 20 mg

**PARTICULARS TO APPEAR ON THE OUTER PACKAGING AND THE IMMEDIATE PACKAGING**

**VIAL CARTON AND VIAL LABEL**

**1. NAME OF THE MEDICINAL PRODUCT**

Revatio 0.8 mg/ml solution for injection  
Sildenafil

**2. STATEMENT OF ACTIVE SUBSTANCE(S)**

Each ml of solution contains 0.8 mg of sildenafil (as citrate). Each 20 ml vial contains 12.5 ml (10 mg sildenafil, as citrate).

**3. LIST OF EXCIPIENTS**

Contains glucose and water for injections.

**4. PHARMACEUTICAL FORM AND CONTENTS**

Solution for injection  
1 vial 10 mg/12.5 ml

**5. METHOD AND ROUTE(S) OF ADMINISTRATION**

Read the package leaflet before use.  
Intravenous use.

**6. SPECIAL WARNING THAT THE MEDICINAL PRODUCT MUST BE STORED OUT OF THE SIGHT AND REACH OF CHILDREN**

Keep out of the sight and reach of children.

**7. OTHER SPECIAL WARNING(S), IF NECESSARY**

**8. EXPIRY DATE**

EXP

**9. SPECIAL STORAGE CONDITIONS**

**10. SPECIAL PRECAUTIONS FOR DISPOSAL OF UNUSED MEDICINAL PRODUCTS OR WASTE MATERIALS DERIVED FROM SUCH MEDICINAL PRODUCTS, IF APPROPRIATE**

**11. NAME AND ADDRESS OF THE MARKETING AUTHORISATION HOLDER**

Pfizer Limited  
Sandwich  
Kent CT13 9NJ  
United Kingdom

**12. MARKETING AUTHORISATION NUMBER(S)**

EU/1/05/318/002

**13. BATCH NUMBER**

Batch

**14. GENERAL CLASSIFICATION FOR SUPPLY**

Medicinal product subject to medical prescription.

**15. INSTRUCTIONS ON USE**

**16. INFORMATION IN BRAILLE**

Revatio 0.8 mg/ml

**MINIMUM PARTICULARS TO APPEAR ON BLISTERS**

**IMMEDIATE PACKAGING/BLISTER**

**1. NAME OF THE MEDICINAL PRODUCT**

Revatio 20 mg tablets  
Sildenafil

**2. NAME OF THE MARKETING AUTHORISATION HOLDER**

Pfizer

**3. EXPIRY DATE**

EXP

**4. BATCH NUMBER**

LOT

**5. OTHER**

**PARTICULARS TO APPEAR ON THE OUTER PACKAGING**

**OUTER CARTON**

**1. NAME OF THE MEDICINAL PRODUCT**

Revatio 10 mg/ml powder for oral suspension  
Sildenafil

**2. STATEMENT OF ACTIVE SUBSTANCE(S)**

After reconstitution each ml of the suspension contains 10 mg of sildenafil (as citrate).  
One bottle of reconstituted suspension (112 ml) contains 1.12 g of sildenafil (as citrate).

**3. LIST OF EXCIPIENTS**

Contains sorbitol.  
See leaflet for further information.

**4. PHARMACEUTICAL FORM AND CONTENTS**

Powder for oral suspension

1 bottle

1 press-in bottle adapter, 1 measuring cup and 1 oral dosing syringe

**5. METHOD AND ROUTE(S) OF ADMINISTRATION**

Shake bottle well before use.  
Read the package leaflet before use.  
Oral use.

**6. SPECIAL WARNING THAT THE MEDICINAL PRODUCT MUST BE STORED OUT OF THE SIGHT AND REACH OF CHILDREN**

Keep out of the sight and reach of children.

**7. OTHER SPECIAL WARNING(S), IF NECESSARY**

**8. EXPIRY DATE**

EXP

**9. SPECIAL STORAGE CONDITIONS**

Powder: Do not store above 30°C. Store in the original package in order to protect from moisture.

After reconstitution: Store below 30°C or in refrigerator at 2°C to 8°C. Do not freeze. Discard any remaining oral suspension 30 days after constitution.

**10. SPECIAL PRECAUTIONS FOR DISPOSAL OF UNUSED MEDICINAL PRODUCTS OR WASTE MATERIALS DERIVED FROM SUCH MEDICINAL PRODUCTS, IF APPROPRIATE**

**11. NAME AND ADDRESS OF THE MARKETING AUTHORISATION HOLDER**

Pfizer Limited  
Sandwich  
Kent CT13 9NJ  
United Kingdom

**12. MARKETING AUTHORISATION NUMBER(S)**

EU/1/05/318/003

**13. BATCH NUMBER**

Batch

**14. GENERAL CLASSIFICATION FOR SUPPLY**

Medicinal product subject to medical prescription.

**15. INSTRUCTIONS ON USE**

**16. INFORMATION IN BRAILLE**

Revatio 10 mg/ml

**PARTICULARS TO APPEAR ON THE IMMEDIATE PACKAGING**

**BOTTLE**

**1. NAME OF THE MEDICINAL PRODUCT**

Revatio 10 mg/ml powder for oral suspension  
Sildenafil

**2. STATEMENT OF ACTIVE SUBSTANCE(S)**

One bottle of reconstituted suspension (112 ml) contains 1.12 g of sildenafil (as citrate).  
After reconstitution 1 ml contains 10 mg of sildenafil (as citrate).

**3. LIST OF EXCIPIENTS**

Contains sorbitol.  
See leaflet for further information.

**4. PHARMACEUTICAL FORM AND CONTENTS**

Powder for oral suspension

**5. METHOD AND ROUTE(S) OF ADMINISTRATION**

Shake bottle well before use.  
Read the package leaflet before use.  
Oral use.

**6. SPECIAL WARNING THAT THE MEDICINAL PRODUCT MUST BE STORED OUT OF THE SIGHT AND REACH OF CHILDREN**

Keep out of the sight and reach of children.

**7. OTHER SPECIAL WARNING(S), IF NECESSARY**

**8. EXPIRY DATE**

EXP

**9. SPECIAL STORAGE CONDITIONS**

Powder: Do not store above 30°C. Store in the original package in order to protect from moisture.

After reconstitution: Store below 30°C or in refrigerator at 2°C to 8°C. Do not freeze. Discard any remaining suspension 30 days after constitution.

**10. SPECIAL PRECAUTIONS FOR DISPOSAL OF UNUSED MEDICINAL PRODUCTS OR WASTE MATERIALS DERIVED FROM SUCH MEDICINAL PRODUCTS, IF APPROPRIATE**

**11. NAME AND ADDRESS OF THE MARKETING AUTHORISATION HOLDER**

Pfizer Limited  
Sandwich  
Kent CT13 9NJ  
United Kingdom

**12. MARKETING AUTHORISATION NUMBER(S)**

EU/1/05/318/003

**13. BATCH NUMBER**

Batch

**14. GENERAL CLASSIFICATION FOR SUPPLY**

Medicinal product subject to medical prescription.

**15. INSTRUCTIONS ON USE**

**16. INFORMATION IN BRAILLE**

**B. PACKAGE LEAFLET**

## Package leaflet: Information for the patient

### Revatio 20 mg film-coated tablets Sildenafil

**Read all of this leaflet carefully before you start taking this medicine because it contains important information for you.**

- Keep this leaflet. You may need to read it again.
- If you have any further questions, ask your doctor or pharmacist.
- This medicine has been prescribed for you only. Do not pass it on to others. It may harm them, even if their signs of illness are the same as yours.
- If you get any side effects, talk to your doctor or pharmacist. This includes any possible side effects not listed in this leaflet. See section 4.

#### **What is in this leaflet**

1. What Revatio is and what it is used for
2. What you need to know before you take Revatio
3. How to take Revatio
4. Possible side effects
5. How to store Revatio
6. Contents of the pack and other information

#### **1. What Revatio is and what it is used for**

Revatio contains the active substance sildenafil which belongs to a group of medicines called phosphodiesterase type 5 (PDE5) inhibitors.

Revatio brings down blood pressure in the lungs by widening the blood vessels in the lungs.

Revatio is used to treat adults and children and adolescents from 1 to 17 years old with high blood pressure in the blood vessels in the lungs (pulmonary arterial hypertension).

#### **2. What you need to know before you take Revatio**

##### **Do not take Revatio:**

- if you are allergic to sildenafil or any of the other ingredients of this medicine (listed in section 6).
- if you are taking medicines containing nitrates, or nitric oxide donors such as amyl nitrate (“poppers”). These medicines are often given for relief of chest pain (or “angina pectoris”). Revatio can cause a serious increase in the effects of these medicines. Tell your doctor if you are taking any of these medicines. If you are not certain, ask your doctor or pharmacist.
- if you are taking riociguat. This drug is used to treat pulmonary arterial hypertension (i.e., high blood pressure in the lungs) and chronic thromboembolic pulmonary hypertension (i.e., high blood pressure in the lungs secondary to blood clots). PDE5 inhibitors, such as Revatio have been shown to increase the hypotensive effects of this medicine. If you are taking riociguat or are unsure tell your doctor.
- if you have recently had a stroke, a heart attack or if you have severe liver disease or very low blood pressure (<90/50 mmHg).
- if you are taking a medicine to treat fungal infections such as ketoconazole or itraconazole or medicines containing ritonavir (for HIV).

- if you have ever had loss of vision because of a problem with blood flow to the nerve in the eye called non-arteritic anterior ischaemic optic neuropathy (NAION).

### **Warnings and precautions**

Talk to your doctor before taking Revatio if you:

- have a disease due to a blocked or narrow vein in the lungs rather than a blocked or narrow artery.
- have a severe heart problem.
- have a problem with the pumping chambers of your heart
- have high blood pressure in the blood vessels in the lungs.
- have low blood pressure at rest.
- lose a large amount of body fluids (dehydration) which can occur when you sweat a lot or do not drink enough liquids. This can happen if you are sick with a fever, vomiting, or diarrhoea.
- have a rare inherited eye disease (*retinitis pigmentosa*).
- have an abnormality of red blood cells (sickle cell anaemia), cancer of blood cells (leukaemia), cancer of bone marrow (multiple myeloma), or any disease or deformity of the penis.
- currently have a stomach ulcer, a bleeding disorder (such as haemophilia) or problems with nose bleeds.
- take medicines for erectile dysfunction.

When used to treat male erectile dysfunction (ED), the following visual side effects have been reported with PDE5 inhibitors, including sildenafil at an unknown frequency; partial, sudden, temporary, or permanent decrease or loss of vision in one or both eyes.

If you experience sudden decrease or loss of vision, **stop taking Revatio and contact your doctor immediately** (see also section 4).

Prolonged and sometimes painful erections have been reported in men after taking sildenafil. If you have an erection, which lasts continuously for more than 4 hours, **stop taking Revatio and contact your doctor immediately** (see also section 4).

#### *Special considerations for patients with kidney or liver problems*

You should tell your doctor if you have kidney or liver problems, as your dose may need to be adjusted.

### **Children**

Revatio should not be given to children below 1 year of age.

### **Other medicines and Revatio**

Tell your doctor or pharmacist if you are taking, have recently taken or might take any other medicines.

- Medicines containing nitrates, or nitric oxide donors such as amyl nitrate (“poppers”). These medicines are often given for relief of angina pectoris or “chest pain” (see section 2. Before you take Revatio)
- Tell your doctor or pharmacist if you are already taking riociguat.
- Therapies for pulmonary hypertension (e.g. bosentan, iloprost)
- Medicines containing St. John’s Wort (herbal medicinal product), rifampicin (used to treat bacterial infections), carbamazepine, phenytoin and phenobarbital (used, among others, to treat epilepsy)
- Blood thinning medicines (for example warfarin) although these did not result in any side effect.
- Medicines containing erythromycin, clarithromycin, telithromycin (these are antibiotics used to treat certain bacterial infections), saquinavir (for HIV) or nefazodone (for mental depression), as your dose may need to be adjusted.

- Alpha-blocker therapy (e.g. doxazosin) for the treatment of high blood pressure or prostate problems, as the combination of the two medicines may cause symptoms resulting in the lowering of your blood pressure (e.g. dizziness, light headedness).

### **Revatio with food and drink**

You should not drink grapefruit juice while you are being treated with Revatio.

### **Pregnancy and breast-feeding**

If you are pregnant, or breast-feeding, think you may be pregnant or are planning to have a baby, ask your doctor or pharmacist for advice before taking this medicine. Revatio should not be used during pregnancy unless strictly necessary.

Revatio should not be given to women of child bearing potential unless using appropriate contraceptive methods.

Stop breast-feeding when you start Revatio treatment. Revatio should not be given to women who are breast-feeding since it is not known if the medicine passes into the breast milk.

### **Driving and using machines**

Revatio can cause dizziness and can affect vision. You should be aware of how you react to the medicine before you drive or use machines.

### **Revatio contains lactose**

If you have been told by your doctor that you have an intolerance to some sugars, contact your doctor before taking this -medicinal product.

## **3. How to take Revatio**

Always take this medicine exactly as your doctor has told you. Check with your doctor or pharmacist if you are not sure.

For adults, the recommended dose is 20 mg three times a day (taken 6 to 8 hours apart) taken with or without food.

### **Use in children and adolescents**

For children and adolescents aged 1 year to 17 years old, the recommended dose is either 10 mg three times a day for children and adolescents  $\leq 20$  kg or 20 mg three times a day for children and adolescents  $> 20$  kg, taken with or without food. Higher doses should not be used in children. This medicine should be used only in case of administration of 20 mg three times a day. Other pharmaceutical forms may be more appropriate for administration to patients  $\leq 20$  kg and other younger patients who are not able to swallow tablets.

### **If you take more Revatio than you should**

You should not take more medicine than your doctor tells you to.

If you take more medicine than you have been told to take contact your doctor immediately. Taking more Revatio than you should may increase the risk of known side effects.

### **If you forget to take Revatio**

If you forget to take Revatio, take a dose as soon as you remember, then continue to take your medicine at the usual times. Do not take a double dose to make up for a forgotten dose.

### **If you stop taking Revatio**

Suddenly stopping your treatment with Revatio may lead to your symptoms getting worse. Do not stop taking Revatio unless your doctor tells you to. Your doctor may tell you to reduce the dose over a few days before stopping completely.

If you have any further questions on the use of this medicine, ask your doctor or pharmacist.

#### **4. Possible side effects**

Like all medicines, Revatio can cause side effects, although not everybody gets them.

If you experience any of the following side effects you should stop taking Revatio and contact a doctor immediately (see also section 2):

- if you experience sudden decrease or loss of vision (frequency not known)
- if you have an erection, which lasts continuously for more than 4 hours. Prolonged and sometimes painful erections have been reported in men after taking sildenafil (frequency not known).

##### Adults

Side effects reported very commonly (may affect more than 1 in 10 people) were headache, facial flushing, indigestion, diarrhoea and pain in the arms or legs.

Side effects reported commonly (may affect up to 1 in 10 people) included: infection under the skin, flu-like symptoms, inflammation of the sinuses, reduced number of red blood cells (anaemia), fluid retention, difficulty sleeping, anxiety, migraine, shaking, “pins and needles”-like sensation, burning sensation, reduced sense of touch, bleeding at the back of the eye, effects on vision, blurred vision and light sensitivity, effects on colour vision, eye irritation, bloodshot eyes /red eyes, vertigo, bronchitis, nosebleed, runny nose, cough, stuffy nose, stomach inflammation, gastroenteritis, heartburn, piles, abdominal distension, dry mouth, hair loss, redness of the skin, night sweats, muscle aches, back pain and increased body temperature.

Side effects reported uncommonly (may affect 1 in 100 people) included: reduced sharpness of vision, double vision, abnormal sensation in the eye, penile bleeding, presence of blood in semen and/or urine, and breast enlargement in men.

Skin rash and sudden decrease or loss of hearing and decreased blood pressure have also been reported at an unknown frequency (frequency cannot be estimated from the available data).

##### Children and adolescents

The following serious adverse events have been reported commonly (may affect up to 1 in 10 people); pneumonia, heart failure, right heart failure, heart related shock, high blood pressure in the lungs, chest pain, fainting, respiratory infection, bronchitis, viral infection in the stomach and intestines, urinary tract infections and tooth cavities.

The following serious adverse events were considered to be treatment related and were reported uncommonly (may affect up to 1 in 100 people), allergic reaction (such as skin rash, swelling of the face, lips and tongue, wheezing, difficulty breathing or swallowing), convulsion, irregular heart-beat, hearing impairment, shortness of breath, inflammation of the digestive tract, wheezing due to disrupted airflow.

Side effects reported very commonly (may affect more than 1 in 10 people) were headache, vomiting, infection of the throat, fever, diarrhoea, flu and nosebleed.

Side effects reported commonly (may affect up to 1 in 10 people) were nausea, increased erections, pneumonia and runny nose.

##### **Reporting of side effects**

If you get any side effects, talk to your doctor or pharmacist. This includes any possible side effects not listed in this leaflet. You can also report side effects directly via the national reporting system listed in Appendix V. By reporting side effects you can help provide more information on the safety of this medicine.

## 5. How to store Revatio

Keep this medicine out of the sight and reach of children.

Do not use this medicine after the expiry date which is stated on the carton after EXP. The expiry date refers to the last day of that month.

Do not store above 30°C. Store in the original package in order to protect from moisture.

Do not throw away any medicines via wastewater or household waste. Ask your pharmacist how to throw away medicines you no longer use. These measures will help to protect the environment.

## 6. Contents of the pack and other information

### What Revatio contains

- The active substance is sildenafil. Each tablet contains 20 mg of sildenafil (as the citrate).
- The other ingredients are:  
Tablet core: microcrystalline cellulose, calcium hydrogen phosphate (anhydrous), croscarmellose sodium, magnesium stearate.  
Film coat: hypromellose, titanium dioxide (E171), lactose monohydrate, glycerol triacetate

### What Revatio looks like and contents of the pack

Revatio film-coated tablets are white and round in shape. The tablets are marked with “PFIZER” on one side and “RVT 20” on the other. The tablets are provided in blister packs containing 90 tablets, 90 x 1 tablets as perforated unit dose blisters and in blister packs containing 300 tablets. Not all pack sizes may be marketed.

### Marketing Authorisation Holder and Manufacturer

Marketing Authorisation Holder:  
Pfizer Limited, Sandwich, Kent, CT13 9NJ, United Kingdom.

Manufacturer:  
Fareva Amboise, Zone Industrielle, 29 route des Industries, 37530 Pocé-sur-Cisse, France.

For any information about this medicinal product, please contact the local representative of the Marketing Authorisation Holder.

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#### **United Kingdom**

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**This leaflet was last revised in**

#### **Other sources of information**

Detailed information on this medicine is available on the European Medicines Agency website:  
<http://www.ema.europa.eu>. There are also links to other website about rare diseases and treatments.

## **Package leaflet: Information for the user**

### **Revatio 0.8 mg/ml solution for injection** Sildenafil

**Read all of this leaflet carefully before you are given this medicine because it contains important information for you.**

- Keep this leaflet. You may need to read it again.
- If you have any further questions, ask your doctor, pharmacist or nurse.
- This medicine has been prescribed for you only. Do not pass it on to others. It may harm them, even if their signs of illness are the same as yours.
- If you get any side effects, talk to your doctor, pharmacist or nurse. This includes any possible side effects not listed in this leaflet. See section 4.

#### **What is in this leaflet**

1. What Revatio is and what it is used for
2. What you need to know before you are given Revatio
3. How Revatio is given
4. Possible side effects
5. How to store Revatio
6. Contents of the pack and other information

#### **1. What Revatio is and what it is used for**

Revatio contains the active substance sildenafil which belongs to a group of medicines called phosphodiesterase type 5 (PDE5) inhibitors.

Revatio brings down blood pressure in the lungs by widening the blood vessels in the lungs.

Revatio is used to treat adults with high blood pressure in the blood vessels in the lungs (pulmonary arterial hypertension).

Revatio solution for injection is an alternative formulation of Revatio for patients who temporarily cannot take their Revatio tablets.

#### **2. What you need to know before you are given Revatio**

##### **You should not be given Revatio:**

- if you are allergic to sildenafil or any of the other ingredients of this medicine (listed in section 6).
- if you are taking medicines containing nitrates, or nitric oxide donors such as amyl nitrate (“poppers”). These medicines are often given for relief of chest pain (or “angina pectoris”). Revatio can cause a serious increase in the effects of these medicines. Tell your doctor if you are taking any of these medicines. If you are not certain, ask your doctor or pharmacist.
- if you are taking riociguat. This drug is used to treat pulmonary arterial hypertension (i.e., high blood pressure in the lungs) and chronic thromboembolic pulmonary hypertension (i.e., high blood pressure in the lungs secondary to blood clots). PDE5 inhibitors, such as Revatio have been shown to increase the hypotensive effects of this medicine. If you are taking riociguat or are unsure tell your doctor.
- if you have recently had a stroke, a heart attack or if you have severe liver disease or very low blood pressure (< 90/50 mmHg).

- if you are taking a medicine to treat fungal infections such as ketoconazole or itraconazole or medicines containing ritonavir (for HIV).
- if you have ever had loss of vision because of a problem with blood flow to the nerve in the eye called non-arteritic anterior ischaemic optic neuropathy (NAION).

### Warnings and Precautions

Talk to your doctor before using Revatio if you:

- have a disease due to a blocked or narrow vein in the lungs rather than a blocked or narrow artery.
- have a severe heart problem.
- have a problem with the pumping chambers of your heart
- have high blood pressure in the blood vessels in the lungs.
- have low blood pressure at rest.
- lose a large amount of body fluids (dehydration) which can occur when you sweat a lot or do not drink enough liquids. This can happen if you are sick with a fever, vomiting, or diarrhoea.
- have a rare inherited eye disease (*retinitis pigmentosa*).
- have an abnormality of red blood cells (sickle cell anaemia), cancer of blood cells (leukaemia), cancer of bone marrow (multiple myeloma), or any disease or deformity of the penis.
- currently have a stomach ulcer, a bleeding disorder (such as haemophilia) or problems with nose bleeds.
- take medicines for erectile dysfunction.

When used to treat male erectile dysfunction (ED), the following visual side effects have been reported with PDE5 inhibitors, including sildenafil at an unknown frequency; partial, sudden, temporary, or permanent decrease or loss of vision in one or both eyes.

If you experience sudden decrease or loss of vision, **stop taking Revatio and contact your doctor immediately** (see also section 4).

Prolonged and sometimes painful erections have been reported in men after taking sildenafil. If you have an erection, which lasts continuously for more than 4 hours, **stop taking Revatio and contact your doctor immediately** (see also section 4).

#### *Special considerations for patients with kidney or liver problems*

You should tell your doctor if you have kidney or liver problems, as your dose may need to be adjusted.

### Children and adolescents

Revatio should not be given to children and adolescents under the age of 18.

### Other medicines and Revatio

Tell your doctor or pharmacist if you are taking, have recently taken or might take any other medicines.

- Medicines containing nitrates, or nitric oxide donors such as amyl nitrate (“poppers”). These medicines are often given for relief of angina pectoris or “chest pain” (see section 2. Before you take Revatio).
- Tell your doctor or pharmacist if you are already taking riociguat.
- Therapies for pulmonary hypertension (e.g. bosentan, iloprost).
- Medicines containing St. John’s Wort (herbal medicinal product), rifampicin (used to treat bacterial infections), carbamazepine, phenytoin and phenobarbital (used, among others, to treat epilepsy).
- Blood thinning medicines (for example warfarin) although these did not result in any side effects.

- Medicines containing erythromycin, clarithromycin, telithromycin (these are antibiotics used to treat certain bacterial infections), saquinavir (for HIV) or nefazodone (for mental depression), as your dose may need to be adjusted.
- Alpha-blocker therapy (e.g. doxazosin) for the treatment of high blood pressure or prostate problems, as the combination of the two medicines may cause symptoms of low blood pressure (e.g. dizziness, lightheadedness).

### **Revatio with food and drink**

You should not drink grapefruit juice while you are being treated with Revatio.

### **Pregnancy and breast-feeding**

If you are pregnant or breast-feeding, think you may be pregnant or are planning to have a baby, ask your doctor or pharmacist for advice before taking this medicine. Revatio should not be used during pregnancy unless strictly necessary.

Revatio should not be given to women of child bearing potential unless using appropriate contraceptive methods.

Stop breast-feeding when you start Revatio treatment. Revatio should not be given to women who are breast-feeding since it is not known if the medicine passes into the breast milk.

### **Driving and using machines**

Revatio can cause dizziness and can affect vision. You should be aware of how you react to the medicine before you drive or use machines.

## **3. How Revatio is given**

Revatio is given as an intravenous injection and will always be given to you by a doctor or a nurse. Your doctor will determine the duration of your treatment and how much Revatio intravenous injection you will receive each day and will monitor your response and condition. The usual dose is 10 mg (corresponding to 12.5 ml) three times a day.

A Revatio intravenous injection will be given to you instead of your Revatio tablets.

### **If you receive more Revatio than you should**

If you are concerned that you may have been given too much Revatio, tell your doctor or nurse immediately. Taking more Revatio than you should may increase the risk of known side effects.

### **If you miss a dose of Revatio**

As you will be given this medicine under close medical supervision, it is unlikely that a dose would be missed. However tell your doctor or pharmacist if you think that a dose has been forgotten.

A double dose should not be given to make up for a forgotten dose.

### **If you stop use of Revatio**

Suddenly stopping your treatment with Revatio may lead to your symptoms getting worse. Your doctor may reduce the dose over a few days before stopping completely.

If you have any further questions on the use of this medicine, ask your doctor or pharmacist.

## **4. Possible side effects**

Like all medicines, Revatio can cause side effects, although not everybody gets them.

If you experience any of the following side effects you should stop taking Revatio and contact a doctor immediately (see also section 2):

- if you experience sudden decrease or loss of vision (frequency not known)

- if you have an erection, which lasts continuously for more than 4 hours. Prolonged and sometimes painful erections have been reported in men after taking sildenafil (frequency not known).

### Adults

Side effects reported in a clinical trial with intravenous Revatio were similar to those reported in clinical trials with Revatio tablets. In clinical trials the side effects reported commonly (may affect up to 1 in 10 people) were facial flushing, headache, low blood pressure and nausea.

In clinical trials side effects reported commonly (may affect up to 1 in 10 people) by patients with pulmonary arterial hypertension were facial flushing and nausea.

In clinical trials with Revatio tablets side effects reported very commonly (may affect more than 1 in 10 people) were headache, facial flushing, indigestion, diarrhoea and pain in the arms or legs.

Side effects reported commonly (may affect up to 1 in 10 people) included: infection under the skin, flu-like symptoms, inflammation of the sinuses, reduced number of red blood cells (anaemia), fluid retention, difficulty sleeping, anxiety, migraine, shaking, “pins and needles”-like sensation, burning sensation, reduced sense of touch, bleeding at the back of the eye, effects on vision, blurred vision and light sensitivity, effects on colour vision, eye irritation, bloodshot eyes /red eyes, vertigo, bronchitis, nosebleed, runny nose, cough, stuffy nose, stomach inflammation, gastroenteritis, heartburn, piles, abdominal distension, dry mouth, hair loss, redness of the skin, night sweats, muscle aches, back pain and increased body temperature.

Side effects reported uncommonly (may affect up to 1 in 100 people) included: reduced sharpness of vision, double vision, abnormal sensation in the eye, penile bleeding, presence of blood in semen and/or urine, and breast enlargement in men.

Skin rash and sudden decrease or loss of hearing and decreased blood pressure have also been reported at an unknown frequency (frequency cannot be estimated from the available data).

### **Reporting of side effects**

If you get any side effects, talk to your doctor or pharmacist. This includes any possible side effects not listed in this leaflet. You can also report side effects directly via [the national reporting system listed in Appendix V](#). By reporting side effects you can help provide more information on the safety of this medicine.

## **5. How to store Revatio**

Keep this medicine out of the sight and reach of children.

Do not use this medicine after the expiry date which is stated on the vial label and carton after EXP. The expiry date refers to the last day of that month.

Revatio does not require any special storage conditions.

Do not throw away any medicines via wastewater or household waste. Ask your pharmacist how to throw away medicines you no longer use. These measures will help to protect the environment.

## **6. Contents of the pack and other information**

### **What Revatio contains**

- The active substance is sildenafil. Each ml of solution contains 0.8 mg of sildenafil (as citrate). Each 20 ml vial contains 10 mg sildenafil (as citrate).

- The other ingredients are glucose and water for injections.

### **What Revatio looks like and contents of the pack**

Each pack of Revatio solution for injection contains one 20 ml clear glass vial, which is closed with a chlorobutyl rubber stopper and an aluminium seal.

### **Marketing Authorisation Holder and Manufacturer**

Marketing Authorisation Holder:

Pfizer Limited, Sandwich, Kent, CT13 9NJ, United Kingdom.

Manufacturer:

Fareva Amboise, Zone Industrielle, 29 route des Industries, 37530 Pocé-sur-Cisse, France.

For any information about this medicinal product, please contact the local representative of the Marketing Authorisation Holder.

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**Other sources of information**

Detailed information on this medicine is available on the European Medicines Agency website:  
<http://www.ema.europa.eu>. There are also links to other website about rare diseases and treatments.

## **Package leaflet: Information for the patient**

### **Revatio 10 mg/ml powder for oral suspension Sildenafil**

**Read all of this leaflet carefully before you start taking this medicine because it contains important information for you.**

- Keep this leaflet. You may need to read it again.
- If you have any further questions, ask your doctor or pharmacist.
- This medicine has been prescribed for you only. Do not pass it on to others. It may harm them, even if their signs of illness are the same as yours.
- If you get any side effects, talk to your doctor or pharmacist. This includes any possible side effects not listed in this leaflet. See section 4.

#### **What is in this leaflet**

1. What Revatio is and what it is used for
2. What you need to know before you take Revatio
3. How to take Revatio
4. Possible side effects
5. How to store Revatio
6. Contents of the pack and other information

#### **1. What Revatio is and what it is used for**

Revatio contains the active substance sildenafil which belongs to a group of medicines called phosphodiesterase type 5 (PDE5) inhibitors.

Revatio brings down blood pressure in the lungs by widening the blood vessels in the lungs.

Revatio is used to treat adults and children and adolescents from 1 to 17 years old with high blood pressure in the blood vessels in the lungs (pulmonary arterial hypertension).

#### **2. What you need to know before you take Revatio**

##### **Do not take Revatio:**

- if you are allergic to sildenafil or any of the other ingredients of this medicine (listed in section 6)
- if you are taking medicines containing nitrates, or nitric oxide donors such as amyl nitrate (“poppers”). These medicines are often given for relief of chest pain (or “angina pectoris”). Revatio can cause a serious increase in the effects of these medicines. Tell your doctor if you are taking any of these medicines. If you are not certain, ask your doctor or pharmacist.
- if you are taking riociguat. This drug is used to treat pulmonary arterial hypertension (i.e., high blood pressure in the lungs) and chronic thromboembolic pulmonary hypertension (i.e., high blood pressure in the lungs secondary to blood clots). PDE5 inhibitors, such as Revatio have been shown to increase the hypotensive effects of this medicine. If you are taking riociguat or are unsure tell your doctor.
- if you have recently had a stroke, a heart attack or if you have severe liver disease or very low blood pressure (<90/50 mmHg).
- if you are taking a medicine to treat fungal infections such as ketoconazole or itraconazole or medicines containing ritonavir (for HIV).

- if you have ever had loss of vision because of a problem with blood flow to the nerve in the eye called non-arteritic anterior ischaemic optic neuropathy (NAION).

### Warnings and Precautions

Talk to your doctor before taking Revatio if you:

- have a disease due to a blocked or narrow vein in the lungs rather than a blocked or narrow artery.
- have a severe heart problem.
- have a problem with the pumping chambers of your heart
- have high blood pressure in the blood vessels in the lungs.
- have low blood pressure at rest.
- lose a large amount of body fluids (dehydration) which can occur when you sweat a lot or do not drink enough liquids. This can happen if you are sick with a fever, vomiting, or diarrhoea
- have a rare inherited eye disease (*retinitis pigmentosa*)
- have an abnormality of red blood cells (sickle cell anaemia), (cancer of blood cells (leukaemia), cancer of bone marrow) (multiple myeloma), or any disease or deformity of the penis.
- currently have a stomach ulcer, a bleeding disorder (such as haemophilia) or problems with nose bleeds.
- take medicines for erectile dysfunction.

When used to treat male erectile dysfunction (ED), the following visual side effects have been reported with PDE5 inhibitors, including sildenafil at an unknown frequency; partial, sudden, temporary, or permanent decrease or loss of vision in one or both eyes.

If you experience sudden decrease or loss of vision, **stop taking Revatio and contact your doctor immediately** (see also section 4).

Prolonged and sometimes painful erections have been reported in men after taking sildenafil. If you have an erection, which lasts continuously for more than 4 hours, **stop taking Revatio and contact your doctor immediately** (see also section 4).

#### *Special considerations for patients with kidney or liver problems*

You should tell your doctor if you have kidney or liver problems, as your dose may need to be adjusted.

### Children

Revatio should not be given to children below 1 year of age.

### Other medicines and Revatio

Tell your doctor or pharmacist if you are taking, have recently taken or might take any other medicines.

- Medicines containing nitrates, or nitric oxide donors such as amyl nitrate (“poppers”). These medicines are often given for relief of angina pectoris or “chest pain” (see section 2. Before you take Revatio)
- Tell your doctor or pharmacist if you are already taking riociguat.
- Therapies for pulmonary hypertension (e.g. bosentan, iloprost)
- Medicines containing St. John’s Wort (herbal medicinal product), rifampicin (used to treat bacterial infections), carbamazepine, phenytoin and phenobarbital (used, among others, to treat epilepsy)
- blood thinning medicines (for example warfarin) although these did not result in any side effect
- Medicines containing erythromycin, clarithromycin, telithromycin (these are antibiotics used to treat certain bacterial infections), saquinavir (for HIV) or nefazodone (for mental depression), as your dose may need to be adjusted.

- Alpha-blocker therapy (e.g. doxazosin) for the treatment of high blood pressure or prostate problems, as the combination of the two medicines may cause symptoms of low blood pressure (e.g. dizziness, light headedness).

#### **Revatio with food and drink**

You should not drink grapefruit juice while you are being treated with Revatio.

#### **Pregnancy and breast-feeding**

If you are pregnant or breast-feeding, think you may be pregnant or are planning to have a baby, ask your doctor or pharmacist for advice before taking this medicine. Revatio should not be used during pregnancy unless strictly necessary.

Revatio should not be given to women of child bearing potential unless using appropriate contraceptive methods.

Stop breast-feeding when you start Revatio treatment. Revatio should not be given to women who are breast-feeding since it is not known if the medicine passes into the breast milk.

#### **Driving and using machines**

Revatio can cause dizziness and can affect vision. You should be aware of how you react to the medicine before you drive or use machines.

#### **Revatio contains sorbitol**

If you have been told by your doctor that you have an intolerance to some sugars, contact your doctor before taking this medicinal product.

### **3. How to take Revatio**

Always take this medicine exactly as your doctor has told you. Check with your doctor or pharmacist if you are not sure.

For adults, the recommended dose is 20 mg three times a day (taken 6 to 8 hours apart) taken with or without food.

#### **Use in children and adolescents**

For children and adolescents aged 1 year to 17 years old, the recommended dose is either 10 mg (1 ml of oral suspension) three times a day for children and adolescents weighing 20 kg or under, or 20 mg (2 ml of oral suspension) three times a day for children and adolescents weighing over 20 kg, taken with or without food. Higher doses should not be used in children.

The oral suspension must be shaken vigorously for a minimum of 10 seconds before use.

#### **Instructions to reconstitute the oral suspension**

It is recommended that your pharmacist reconstitutes (makes up) the oral suspension before giving it to you.

If reconstituted, the oral suspension is in a liquid form. If the powder is not reconstituted, you should reconstitute the oral suspension by following the instructions below.

**Note:** A total volume of 90 ml (3 x 30 ml) of water irrespective of the dose you are taking should be used to reconstitute the contents of the bottle.

1. Tap the bottle to release the powder.
2. Remove the cap.
3. Measure 30 ml of water by filling the measuring cup (included in the carton) to the marked line then pour the water into the bottle. Using the cup measure another 30 ml of water and add this to the bottle (figure 1).

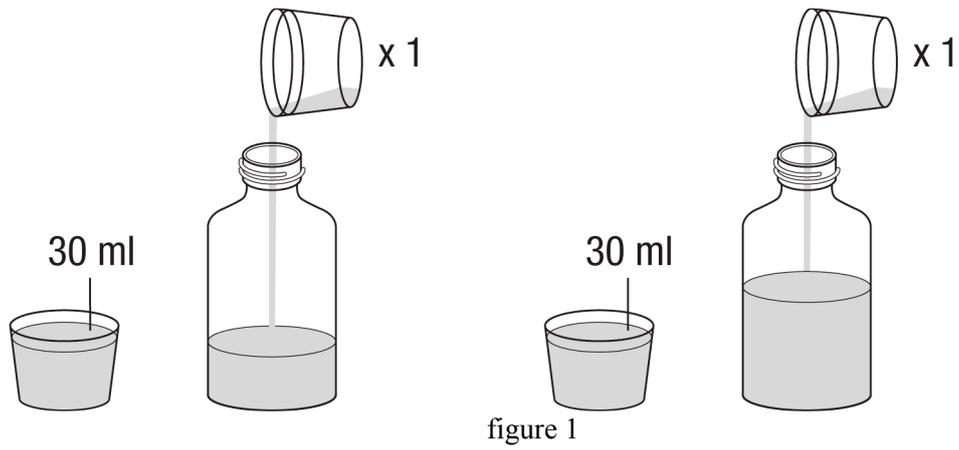


figure 1

4. Replace the cap and shake the bottle vigorously for a minimum of 30 seconds (figure 2).

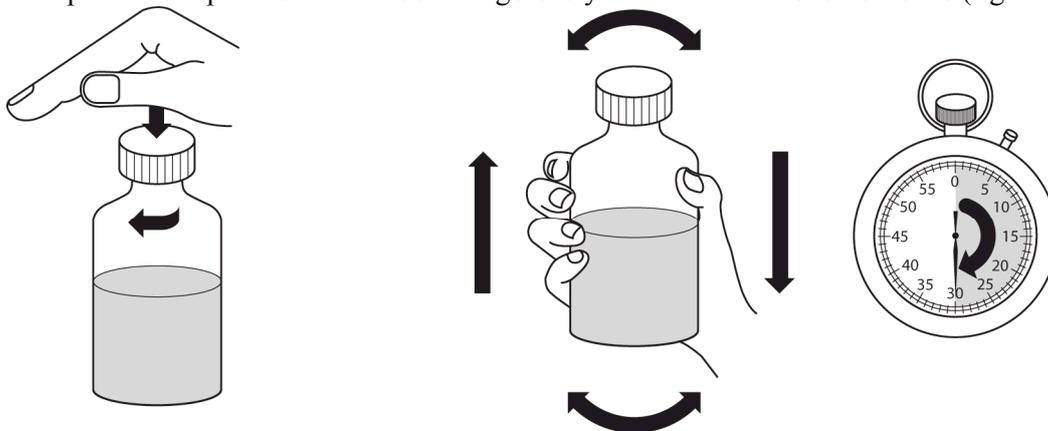


figure 2

5. Remove the cap.  
6. Using the cup measure another 30 ml of water and add this to the bottle. You should always add a total of 90 ml (3 x 30 ml) of water irrespective of the dose you are taking (figure 3).

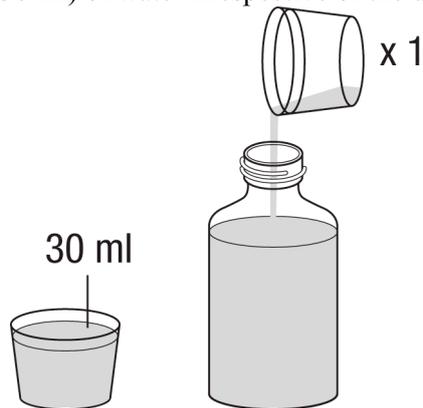


figure 3

7. Replace the cap and shake the bottle vigorously for a minimum of 30 seconds (figure 4).

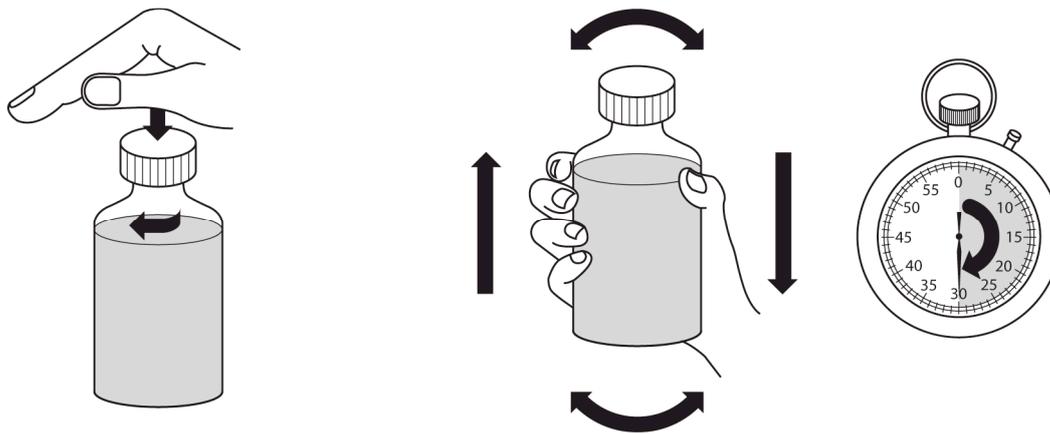


figure 4

8. Remove the cap.
9. Press the bottle adaptor into the neck of the bottle (as shown on figure 5 below). The adaptor is provided so that you can fill the oral dosing syringe with medicine from the bottle. Replace the cap on the bottle.

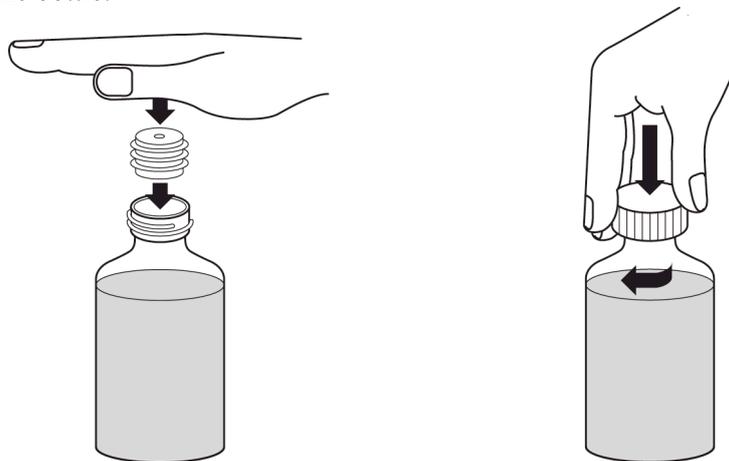


figure 5

10. Write the date of expiry of the constituted oral suspension on the bottle label (the date of expiry of the constituted oral suspension is 30 days from the date of constitution). Any unused oral suspension should be discarded or returned to your pharmacist after this date.

### Instructions for use

Your pharmacist should advise you how to measure the medicine using the oral dosing syringe provided in the pack. Once constituted, the oral suspension should only be administered using the oral dosing syringe supplied with each pack. Please see instructions below before using the oral suspension.

1. Shake the closed bottle of constituted oral suspension vigorously for a minimum of 10 seconds before use. Remove the cap (figure 6).

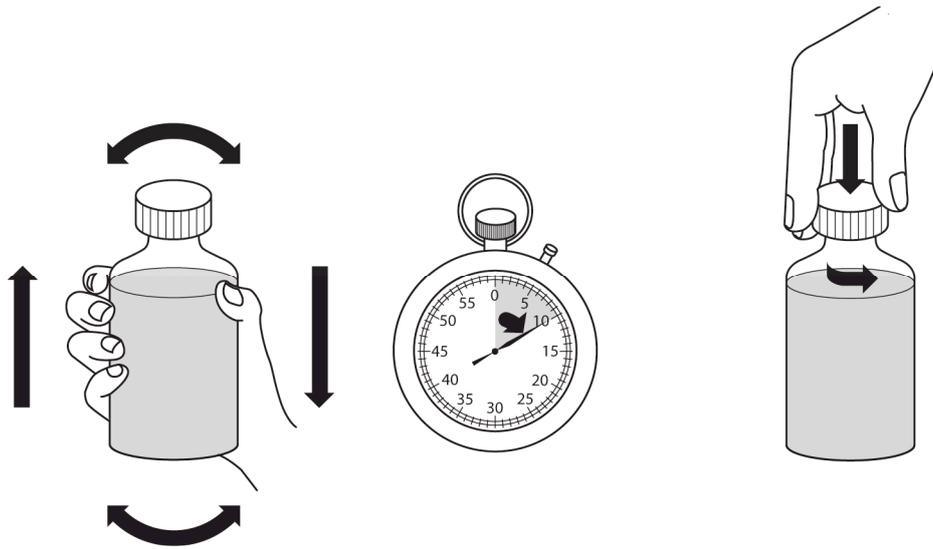


figure 6

2. While the bottle is upright, on a flat surface, insert the tip of the oral dosing syringe into the adaptor (figure 7).

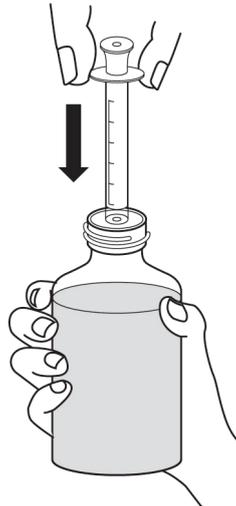


figure 7

3. Turn the bottle upside down while holding the oral dosing syringe in place. Slowly pull back the plunger of the oral dosing syringe to the graduation mark that marks the dose for you (withdrawing 1 ml provides a 10 mg dose, withdrawing 2 ml provides a 20 mg dose). To measure the dose accurately, the top edge of the plunger should be lined up with the appropriate graduated mark on the oral dosing syringe (figure 8).

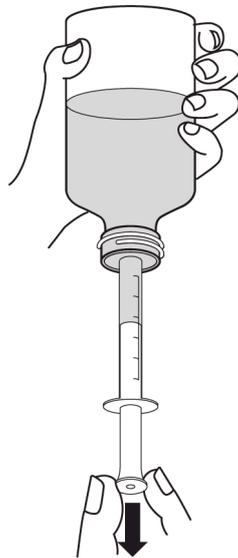


figure 8

4. If large bubbles can be seen, slowly push the plunger back into the syringe. This will force the medicine back into the bottle. Repeat step 3 again.
5. Turn the bottle back upright with the oral dosing syringe still in place. Remove the oral dosing syringe from the bottle.
6. Put the tip of the oral dosing syringe into the mouth. Point the tip of the oral dosing syringe towards the inside of the cheek. SLOWLY push down the plunger of the oral dosing syringe. Do not squirt the medicine out quickly. If the medicine is to be given to a child, make sure the child is sitting, or is held, upright before giving the medicine (figure 9).

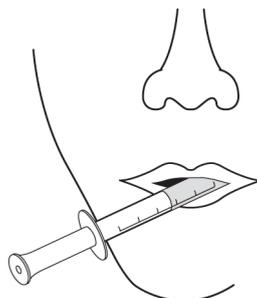


figure 9

7. Replace the cap on the bottle, leaving the bottle adaptor in place. Wash the oral dosing syringe as instructed below.

Cleaning and storing the syringe:

1. The syringe should be washed after each dose. Pull the plunger out of the syringe and wash both parts in water.
2. Dry the two parts. Push the plunger back in to the syringe. Keep it in a clean safe place with the medicine.

**If you take more Revatio than you should**

You should not take more medicine than your doctor tells you to.

If you take more medicine than you have been told to take contact your doctor immediately. Taking more Revatio than you should may increase the risk of known side effects.

**If you forget to take Revatio**

If you forget to take Revatio, take a dose as soon as you remember, then continue to take your medicine at the usual times. Do not take a double dose to make up for a forgotten dose.

**If you stop taking Revatio**

Suddenly stopping your treatment with Revatio may lead to your symptoms getting worse. Do not stop taking Revatio unless your doctor tells you to. Your doctor may tell you to reduce the dose over a few days before stopping completely.

If you have any further questions on the use of this medicine, ask your doctor or pharmacist.

**4. Possible side effects**

Like all medicines, this medicine can cause side effects, although not everybody gets them.

If you experience any of the following side effects you should stop taking Revatio and contact a doctor immediately (see also section 2):

- if you experience sudden decrease or loss of vision (frequency not known)
- if you have an erection, which lasts continuously for more than 4 hours. Prolonged and sometimes painful erections have been reported in men after taking sildenafil (frequency not known).

**Adults**

Side effects reported very commonly (may affect more than 1 in 10 people) were headache, facial flushing, indigestion, diarrhoea and pain in the arms or legs.

Side effects reported commonly (may affect up to 1 in 10 people) included: infection under the skin, flu-like symptoms, inflammation of the sinuses, reduced number of red blood cells (anaemia), fluid retention, difficulty sleeping, anxiety, migraine, shaking, “pins and needles”-like sensation, burning sensation, reduced sense of touch, bleeding at the back of the eye, effects on vision, blurred vision and light sensitivity, effects on colour vision, eye irritation, bloodshot eyes /red eyes, vertigo, bronchitis, nosebleed, runny nose, cough, stuffy nose, stomach inflammation, gastroenteritis, heartburn, piles, abdominal distension, dry mouth, hair loss, redness of the skin, night sweats, muscle aches, back pain and increased body temperature.

Side effects reported uncommonly (may affect up to 1 in 100 people) included: reduced sharpness of vision, double vision, abnormal sensation in the eye, penile bleeding, presence of blood in semen and/or urine, and breast enlargement in men.

Skin rash and sudden decrease or loss of hearing and decreased blood pressure have also been reported at an unknown frequency (frequency cannot be estimated from the available data).

**Children and adolescents**

The following serious adverse events have been reported commonly (may affect up to 1 in 10 people); pneumonia, heart failure, right heart failure, heart related shock, high blood pressure in the lungs, chest pain, fainting, respiratory infection, bronchitis, viral infection in the stomach and intestines, urinary tract infections and tooth cavities.

The following serious adverse events were considered to be treatment related and were reported uncommonly (may affect up to 1 in 100 people), allergic reaction (such as skin rash, swelling of the face, lips and tongue, wheezing, difficulty breathing or swallowing), convulsion, irregular heart-beat,

hearing impairment, shortness of breath, inflammation of the digestive tract, wheezing due to disrupted airflow.

Side effects reported very commonly (may affect more than 1 in 10 people) were headache, vomiting, infection of the throat, fever, diarrhoea, flu and nosebleed.

Side effects reported commonly (may affect up to 1 in 10 people) were nausea, increased erections, pneumonia and runny nose.

### **Reporting of side effects**

If you get any side effects, talk to your doctor or pharmacist. This includes any possible side effects not listed in this leaflet. You can also report side effects directly via [the national reporting system listed in Appendix V](#). By reporting side effects you can help provide more information on the safety of this medicine.

## **5. How to store Revatio**

Keep this medicine out of the sight and reach of children.

Do not use this medicine after the expiry date which is stated on the bottle after 'EXP'. The expiry date refers to the last day of that month.

### Powder

Do not store above 30°C.

Store in the original package in order to protect from moisture.

### Reconstituted oral suspension

Store below 30°C or in refrigerator at 2°C to 8°C. Do not freeze. Any remaining oral suspension should be discarded 30 days after constitution.

Do not throw away any medicines via wastewater or household waste. Ask your pharmacist how to throw away medicines you no longer use. These measures will help protect the environment.

## **6. Contents of the pack and other information**

### **What Revatio contains**

- The active substance is sildenafil (as sildenafil citrate).  
After reconstitution, each ml of the oral suspension contains 10 mg of sildenafil (as citrate)  
One bottle of reconstituted oral suspension (112 ml) contains 1.12 g of sildenafil (as citrate)
- The other ingredients are: Powder for oral suspension: sorbitol, citric acid anhydrous, sucralose, sodium citrate, xanthan gum, titanium dioxide (E171), sodium benzoate (E211), silica, colloidal anhydrous; Grape flavour: maltodextrin, grape juice concentrate, gum acacia, pineapple juice concentrate, citric acid anhydrous, natural flavouring

### **What Revatio looks like and contents of the pack**

Revatio is supplied as a white to off-white powder for oral suspension providing a white, grape flavoured oral suspension when constituted with water.

One 125 ml amber glass bottle (with a polypropylene screw cap) contains 32.27 g of powder for oral suspension.

Once reconstituted the bottle contains 112 ml of oral suspension, of which 90 ml is intended for dosing and administration.

Pack size: 1 bottle

Each pack also contains a polypropylene measuring cup (graduated to indicate 30 ml), polypropylene oral dosing syringe (3 ml) with HDPE plunger and a LDPE press-in bottle adaptor.

### **Marketing Authorisation Holder and Manufacturer**

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Pfizer Limited, Sandwich, Kent, CT13 9NJ, United Kingdom.

Manufacturer  
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**This leaflet was last revised in**

**Other sources of information**

Detailed information on this medicine is available on the European Medicines Agency website:  
<http://www.ema.europa.eu>. There are also links to other website about rare diseases and treatments.