Summary of Product Characteristics

1 NAME OF THE MEDICINAL PRODUCT

Macitentan MSN 10 mg film-coated tablets

2 QUALITATIVE AND QUANTITATIVE COMPOSITION

Each film-coated tablet contains 10 mg macitentan.

Excipient(s) with known effect
Each film-coated tablet contains approximately 31 mg of lactose (as monohydrate) and approximately 0.04 mg of soya bean lecithin (E322).

For the full list of excipients, see section 6.1.

3 PHARMACEUTICAL FORM

Film-coated tablet (tablet).

White colored, round shaped, biconvex, film-coated tablets, approximately 5.5 mm diameter, debossed with "M" on one side and "10" on other side.

4 CLINICAL PARTICULARS

4.1 Therapeutic indications

Adults

Macitentan MSN as monotherapy or in combination, is indicated for the long-term treatment of pulmonary arterial hypertension (PAH) in adult patients of WHO Functional Class (FC) II to III (see section 5.1).

Paediatric population

Macitentan MSN, as monotherapy or in combination, is indicated for the long-term treatment of pulmonary arterial hypertension (PAH) in paediatric patients aged less than 18 years and bodyweight ≥ 40 kg with WHO Functional Class (FC) II to III (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 PAH.

Posology

Adults and paediatric patients aged less than 18 years of age weighing at least 40 kg
The recommended dose is 10 mg once daily. Macitentan MSN should be taken every day at about the same time.

If the patient misses a dose of Macitentan MSN, the patient should be told to take it as soon as possible and then take the next dose at the regularly scheduled time. The patient should be told not to take two doses at the same time if a dose has been missed.

The 10 mg film-coated tablets are only recommended in paediatric patients weighing at least 40 kg. For paediatric patients weighing less than 40 kg, macitentan dispersible tablets with a lower strength are available under other brand names.

Special populations

Elderly
No dose adjustment is required in patients over the age of 65 years (see section 5.2).

Hepatic impairment
Based on pharmacokinetic (PK) data, no dose adjustment is required in patients with mild, moderate or severe hepatic impairment (see sections 4.4 and 5.2). However, there is no clinical experience with the use of macitentan in PAH patients with moderate or severe hepatic impairment. Macitentan MSN must not be initiated in patients with severe hepatic impairment, or clinically significant elevated hepatic aminotransferases (greater than 3 times the Upper Limit of Normal (> 3 × ULN); see sections 4.3 and 4.4).

Renal impairment
Based on PK data, no dose adjustment is required in patients with renal impairment. There is no clinical experience with the use of macitentan in PAH patients with severe renal impairment. The use of Macitentan MSN is not recommended in patients undergoing dialysis (see sections 4.4 and 5.2).

Paediatric population
Dosing and efficacy of macitentan in children below 2 years of age have not been established. Currently available data are described in sections 4.8, 5.1 and 5.2 but no recommendation on a posology can be made.

Method of administration

The film-coated tablets are not breakable and are to be swallowed whole, with water. They may be taken with or without food.

4.3 Contraindications

- Hypersensitivity to the active substance, peanuts, soya or to any of the excipients listed in section 6.1.
- Pregnancy (see section 4.6).
- Women of childbearing potential who are not using reliable contraception (see sections 4.4 and 4.6).
- Breastfeeding (see section 4.6).
- Patients with severe hepatic impairment (with or without cirrhosis) (see section 4.2).
- Baseline values of hepatic aminotransferases (aspartate aminotransferases (AST) and/or alanine aminotransferases (ALT) > 3 × ULN) (see sections 4.2 and 4.4).

4.4 Special warnings and precautions for use

The benefit/risk balance of macitentan has not been established in patients with WHO class I functional status of pulmonary arterial hypertension.

Liver function

Elevations of liver aminotransferases (AST, ALT) have been associated with PAH and with endothelin receptor antagonists (ERAs). Macitentan MSN is not to be initiated in patients with severe hepatic impairment or elevated aminotransferases (> 3 × ULN) (see sections 4.2 and 4.3) and is not recommended in patients with moderate hepatic impairment. Liver enzyme tests should be obtained prior to initiation of Macitentan MSN.

Patients should be monitored for signs of hepatic injury and monthly monitoring of ALT and AST is recommended. If sustained, unexplained, clinically relevant aminotransferase elevations occur, or if elevations are accompanied by an increase in bilirubin > 2 × ULN, or by clinical symptoms of liver injury (e.g., jaundice), Macitentan MSN treatment should be discontinued.

Reinitiation of Macitentan MSN may be considered following the return of hepatic enzyme levels to within the normal range in patients who have not experienced clinical symptoms of liver injury. The advice of a hepatologist is recommended.

Haemoglobin concentration

Decrease in haemoglobin concentrations has been associated with endothelin receptor antagonists (ERAs) including macitentan (see section 4.8). In placebo-controlled studies, macitentan-related decreases in haemoglobin concentration were not progressive, stabilised after the first 4–12 weeks of treatment and remained stable during chronic treatment. Cases of

anaemia requiring blood cell transfusion have been reported with macitentan and other ERAs. Initiation of Macitentan MSN is not recommended in patients with severe anaemia. It is recommended that haemoglobin concentrations be measured prior to initiation of treatment and tests repeated during treatment as clinically indicated.

Pulmonary veno-occlusive disease

Cases of pulmonary oedema have been reported with vasodilators (mainly prostacyclins) when used in patients with pulmonary veno-occlusive disease. Consequently, if signs of pulmonary oedema occur when macitentan is administered in patients with PAH, the possibility of pulmonary veno-occlusive disease should be considered.

Use in women of childbearing potential

Macitentan MSN treatment should only be initiated in women of childbearing potential when the absence of pregnancy has been verified, appropriate advice on contraception provided, and reliable contraception is practised (see sections 4.3 and 4.6). Women should not become pregnant for 1 month after discontinuation of Macitentan MSN. Monthly pregnancy tests during treatment with Macitentan MSN are recommended to allow the early detection of pregnancy.

Concomitant use with strong CYP3A4 inducers

In the presence of strong CYP3A4 inducers reduced efficacy of macitentan could occur. The combination of macitentan with strong CYP3A4 inducers (e.g., rifampicin, St. John's wort, carbamazepine, and phenytoin) should be avoided (see section 4.5).

Concomitant use with strong CYP3A4 inhibitors

Caution should be exercised when macitentan is administered concomitantly with strong CYP3A4 inhibitors (e.g., itraconazole, ketoconazole, voriconazole, clarithromycin, telithromycin, nefazodone, ritonavir, and saquinavir) (see section 4.5).

Concomitant use with moderate dual or combined CYP3A4 and CYP2C9 inhibitors

Caution should be exercised when macitentan is administered concomitantly with moderate dual inhibitors of CYP3A4 and CYP2C9 (e.g., fluconazole and amiodarone) (see section 4.5).

Caution should also be exercised when macitentan is administered concomitantly with both a moderate CYP3A4 inhibitor (e.g., ciprofloxacin, cyclosporine, diltiazem, erythromycin, verapamil) and moderate CYP2C9 inhibitor (e.g., miconazole, piperine) (see section 4.5).

Renal impairment

Patients with renal impairment may run a higher risk of experiencing hypotension and anaemia during treatment with macitentan. Therefore, monitoring of blood pressure and haemoglobin should be considered. There is no clinical experience with the use of macitentan in PAH patients with severe renal impairment. Caution is recommended in this population. There is no experience with the use of macitentan in patients undergoing dialysis, therefore Macitentan MSN is not recommended in this population (see sections 4.2 and 5.2).

Excipients

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

Macitentan MSN contains soya bean lecithin. If a patient is hypersensitive to peanuts or soya, Macitentan MSN must not be used (see section 4.3).

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

4.5 Interaction with other medicinal products and other forms of interaction

In vitro studies

The cytochrome P450 CYP3A4 is the main enzyme involved in the metabolism of macitentan and in the formation of its active metabolite aprocitentan, with minor contribution from CYP2C8, CYP2C9, and CYP2C19 enzymes (see section 5.2). Macitentan and its active metabolite do not have clinically relevant inhibitory or inducing effects on cytochrome P450 enzymes.

Macitentan and its active metabolite are not inhibitors of hepatic or renal uptake transporters at clinically relevant concentrations, including the organic anion transporting polypeptides (OATP1B1 and OATP1B3). Macitentan and its active metabolite are not relevant substrates of OATP1B1 and OATP1B3 but enter the liver by passive diffusion.

Macitentan and its active metabolite are not inhibitors of hepatic or renal efflux pumps at clinically relevant concentrations, including the multi-drug resistance protein (P-gp, MDR-1) and multidrug and toxin extrusion transporters (MATE1 and MATE2-K). Macitentan is not a substrate for P-gp/MDR-1.

At clinically relevant concentrations, macitentan and its active metabolite do not interact with proteins involved in hepatic bile salt transport, i.e., the bile salt export pump (BSEP) and the sodium-dependent taurocholate co-transporting polypeptide (NTCP).

In vivo studies

Strong CYP3A4 inducers
Concomitant treatment with rifampicin 600 mg daily, a potent inducer of CYP3A4, reduced the steady-state exposure to macitentan by 79% but did not affect the exposure to the active metabolite. Reduced efficacy of macitentan in the presence of a potent inducer of CYP3A4 such as rifampicin should be considered. The combination of macitentan with strong CYP3A4 inducers should be avoided (see section 4.4).

Ketoconazole
In the presence of ketoconazole 400 mg once daily, a strong CYP3A4 inhibitor, exposure to macitentan increased approximately 2-fold. The predicted increase was approximately 3-fold in the presence of ketoconazole 200 mg twice daily using physiologically based pharmacokinetic (PBPK) modelling. The uncertainties of such modelling should be considered. Exposure to the active metabolite of macitentan was reduced by 26%. Caution should be exercised when macitentan is administered concomitantly with strong CYP3A4 inhibitors (see section 4.4).

Fluconazole
In the presence of fluconazole 400 mg daily, a moderate dual inhibitor of CYP3A4 and CYP2C9, exposure to macitentan may increase approximately 3.8-fold based on PBPK modelling. However, there was no clinically relevant change in exposure to the active metabolite of macitentan. The uncertainties of such modelling should be considered. Caution should be exercised when macitentan is administered concomitantly with moderate dual inhibitors of CYP3A4 and CYP2C9 (e.g., fluconazole and amiodarone) (see section 4.4).

Caution should also be exercised when macitentan is administered concomitantly with both a moderate CYP3A4 inhibitor (e.g., ciprofloxacin, cyclosporine, diltiazem, erythromycin, verapamil) and moderate CYP2C9 inhibitor (e.g., miconazole, piperine) (see section 4.4).

Warfarin
Macitentan given as multiple doses of 10 mg once daily had no effect on exposure to S-warfarin (CYP2C9 substrate) or R-warfarin (CYP3A4 substrate) after a single dose of 25 mg warfarin. The pharmacodynamic effect of warfarin on International Normalised Ratio (INR) was not affected by macitentan. The pharmacokinetics of macitentan and its active metabolite were not affected by warfarin.

Sildenafil
At steady-state, the exposure to sildenafil 20 mg three times a day was increased by 15% during concomitant administration of macitentan 10 mg once daily. Sildenafil, a CYP3A4 substrate, did not affect the pharmacokinetics of macitentan, while there was a 15% reduction in the exposure to the active metabolite of macitentan. These changes are not considered clinically relevant. In a placebo-controlled trial in patients with PAH, the efficacy and safety of macitentan in combination with sildenafil were demonstrated.

Cyclosporine A
Concomitant treatment with cyclosporine A 100 mg twice daily, a combined CYP3A4 and OATP inhibitor, did not alter the steady-state exposure to macitentan and its active metabolite to a clinically relevant extent.

Hormonal contraceptives
Macitentan 10 mg once daily did not affect the pharmacokinetics of an oral contraceptive (norethisterone 1 mg and ethinyl estradiol 35 µg).

Breast cancer resistance protein (BCRP) substrate drugs
Macitentan 10 mg once daily did not affect the pharmacokinetics of a BCRP substrate drug (riociguat 1 mg; rosuvastatin 10 mg).

Paediatric population

Interaction studies have only been performed in adults.

4.6 Fertility, pregnancy and lactation

Use in women of childbearing potential/Contraception in males and females

Macitentan MSN treatment should only be initiated in women of childbearing potential when the absence of pregnancy has been verified, appropriate advice on contraception provided, and reliable contraception is practised (see sections 4.3 and 4.4). Women should not become pregnant for 1 month after discontinuation of Macitentan MSN. Monthly pregnancy tests during treatment with Macitentan MSN are recommended to allow the early detection of pregnancy.

Pregnancy

There are no data from the use of macitentan in pregnant women. Studies in animals have shown reproductive toxicity (see section 5.3). The potential risk for humans is still unknown. Macitentan MSN is contraindicated during pregnancy and in women of childbearing potential who are not using reliable contraception (see section 4.3).

Breast-feeding

It is unknown whether macitentan is excreted in human milk. In rats, macitentan and its metabolites are excreted into milk during lactation (see section 5.3). A risk to the breastfeeding child cannot be excluded. Macitentan MSN is contraindicated during breastfeeding (see section 4.3).

Male fertility

The development of testicular tubular atrophy in male animals was observed after treatment with macitentan (see section 5.3). Decreases in sperm count have been observed in patients taking ERAs. Macitentan, like other ERAs, may have an adverse effect on spermatogenesis in men.

4.7 Effects on ability to drive and use machines

Macitentan has minor influence on the ability to drive and use machines. No studies on the effects on the ability to drive and use machines have been performed. However, undesirable effects may occur (e.g., headache, hypotension) that may influence the ability to drive and use machines (see section 4.8).

4.8 Undesirable effects

Summary of the safety profile

The most commonly reported adverse reactions in the SERAPHIN study were nasopharyngitis (14%), headache (13.6%) and anaemia (13.2%, see section 4.4).

Tabulated list of adverse reactions

The safety of macitentan has been evaluated in a long-term placebo-controlled trial of 742 adult and adolescent patients with symptomatic PAH (SERAPHIN study). The mean treatment duration was 103.9 weeks in the macitentan 10 mg group, and 85.3 weeks in the placebo group. Adverse reactions associated with macitentan obtained from this clinical study are tabulated below. Post-marketing adverse reactions are also included.

Frequencies are defined as: very common (≥ 1/10); common (≥ 1/100 to < 1/10); uncommon (≥ 1/1 000 to < 1/100); rare (≥ 1/10 000 to < 1/1 000); very rare (< 1/10 000); not known (cannot be estimated from the available data).

System organ class	**Frequency**	**Adverse reaction**
Infections and infestations	Very common	Nasopharyngitis
	Very common	Bronchitis
	Common	Pharyngitis
	Common	Influenza
	Common	Urinary tract infection
Blood and lymphatic system disorders	Very common	Anaemia, haemoglobin decrease[5]
	Common	Leukopenia[6]
	Common	Thrombocytopenia[7]
Immune system disorders	Uncommon	Hypersensitivity reactions (e.g., angioedema, pruritus, rash)[1]
Nervous system disorders	Very common	Headache
Vascular disorders	Common	Hypotension[2], flushing
Respiratory, thoracic and mediastinal disorders	Common	Nasal congestion[1]
Hepatobiliary disorders	Common	Aminotransferase elevations[4]
Reproductive system and breast disorders	Common	Increased uterine bleeding[8]
General disorders and administration site conditions	Very common	Oedema, fluid retention[3]

[1] Data derived from pooled placebo-controlled studies.

[8] Includes PTs of heavy menstrual bleeding, abnormal uterine bleeding, intermenstrual bleeding, uterine/vaginal haemorrhage, polymennorhoea and menstruation irregular. Frequency based on exposure in females.

Description of selected adverse reactions

[2] Hypotension has been associated with the use of ERAs including macitentan. In SERAPHIN, a long-term double-blind study in patients with PAH, hypotension was reported for 7.0% and 4.4% of patients on macitentan 10 mg and placebo, respectively. This corresponded to 3.5 events / 100 patient-years on macitentan 10 mg compared to 2.7 events / 100 patient-years on placebo.

[3] Oedema/fluid retention has been associated with the use of ERAs including macitentan. In SERAPHIN, a long-term double-blind study in patients with PAH, the incidence of oedema AEs in the macitentan 10 mg and placebo treatment groups was 21.9% and 20.5%, respectively. In a double-blind study in adult patients with idiopathic pulmonary fibrosis, the incidence of peripheral oedema AEs in the macitentan and placebo treatment groups was 11.8% and 6.8%, respectively. In two double-blind clinical studies in adult patients with digital ulcers associated with systemic sclerosis, the incidences of peripheral oedema AEs ranged from 13.4% to 16.1% in the macitentan 10 mg groups and from 6.2% to 4.5% in the placebo groups.

Laboratory abnormalities

[4]Liver aminotransferases

The incidence of aminotransferase elevations (ALT/AST) > 3 × ULN was 3.4% on macitentan 10 mg and 4.5% on placebo in SERAPHIN, a double-blind study in patients with PAH. Elevations > 5 × ULN occurred in 2.5% of patients on macitentan 10 mg versus 2% of patients on placebo.

[5]Haemoglobin

In SERAPHIN, a double-blind study in patients with PAH, macitentan 10 mg was associated with a mean decrease in haemoglobin versus placebo of 1 g/dL. A decrease from baseline in haemoglobin concentration to below 10 g/dL was reported in 8.7% of patients treated with macitentan 10 mg and 3.4% of placebo-treated patients.

[6] White blood cells

In SERAPHIN, a double-blind study in patients with PAH, macitentan 10 mg was associated with a decrease in mean leucocyte count from baseline of 0.7 × 10^9/L versus no change in placebo-treated patients.

[7] Platelets

In SERAPHIN, a double-blind study in patients with PAH, macitentan 10 mg was associated with a decrease in mean platelet count of 17 × 10^9/L, versus a mean decrease of 11 × 10^9/L in placebo-treated patients.

Long-term safety

Of the 742 patients who participated in the pivotal SERAPHIN double-blind study, 550 patients entered a long-term open-label (OL) extension study. (The OL cohort included 182 patients who continued on macitentan 10 mg and 368 patients who received placebo or macitentan 3 mg and crossed over to macitentan 10 mg.)

Long-term follow-up of these 550 patients for a median exposure of 3.3 years and a maximum exposure of 10.9 years showed a safety profile that was consistent as described above during the SERAPHIN double-blind phase.

Paediatric population (aged ≥ 2 years to less than 18 years)

The safety of macitentan was evaluated in TOMORROW, a Phase 3 study in paediatric patients with PAH. A total of 72 patients aged ≥ 2 years to less than 18 years were randomised and received macitentan. The mean age at enrolment was 10.5 years (range 2.1 years-17.9 years). The median duration of treatment in the randomised study was 168.4 weeks (range 12.9 weeks-312.4 weeks) in the macitentan arm.

Overall, the safety profile in this paediatric population was consistent with that observed in the adult population. In addition to the adverse reactions tabulated above, the following paediatric adverse reactions were reported: upper respiratory tract infection (31.9%), rhinitis (8.3%), and gastroenteritis (11.1%).

Paediatric population (aged ≥ 1 month to less than 2 years)

An additional 11 patients, aged ≥ 1 month to less than 2 years old were enroled to receive macitentan without randomisation, 9 patients from the open-label arm of the TOMORROW study and 2 Japanese patients from the PAH3001 study. At enrolment, the age range of the patients from the TOMORROW study was 1.2 years to 1.9 years and the median duration of treatment was 37.1 weeks (range 7.0-72.9 weeks). At enrolment, the ages of the 2 patients from PAH3001 were 21 months and 22 months.

Overall, the safety profile in this paediatric population was consistent with that observed in the adult population and paediatric population aged ≥ 2 years to less than 18 years, however, very limited clinical safety data are available to establish a robust safety conclusion in paediatric population below 2 years.

The safety of macitentan in children below 2 years of age has not been established (see section 4.2).

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 HPRA Pharmacovigilance
Website: www.hpra.ie.

4.9 Overdose

Macitentan has been administered as a single dose of up to 600 mg to healthy adult subjects. Adverse reactions of headache, nausea, and vomiting were observed. In the event of an overdose, standard supportive measures must be taken, as required. Due to the high degree of protein binding of macitentan, dialysis is unlikely to be effective.

5 PHARMACOLOGICAL PROPERTIES

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: anti-hypertensives, anti-hypertensives for pulmonary arterial hypertension. ATC code: C02KX04.

Mechanism of action

Endothelin (ET)-1 and its receptors (ET_A and ET_B) mediate a variety of effects such as vasoconstriction, fibrosis, proliferation, hypertrophy, and inflammation. In disease conditions such as PAH, the local ET system is upregulated and is involved in vascular hypertrophy and in organ damage.

Macitentan is an orally active potent endothelin receptor antagonist, active on both ET_A and ET_B receptors and approximately 100-fold more selective for ET_A as compared to ET_B *in vitro*. Macitentan displays high affinity and sustained occupancy of the ET receptors in human pulmonary arterial smooth muscle cells. This prevents endothelin-mediated activation of second messenger systems that result in vasoconstriction and smooth muscle cell proliferation.

Clinical efficacy and safety

Efficacy in patients with pulmonary arterial hypertension

A multi-centre, double-blind, placebo-controlled, parallel-group, event-driven, Phase 3 outcome study (AC-055-302/SERAPHIN) was conducted in 742 patients with symptomatic PAH, who were randomised to three treatment groups (placebo [N = 250], 3 mg [N = 250] or 10 mg [N = 242] of macitentan once daily), to assess the long-term effect on morbidity or mortality.

At baseline, the majority of enroled patients (64%) were treated with a stable dose of specific therapy for PAH, either oral phosphodiesterase inhibitors (61%) and/or inhaled/oral prostanoids (6%).

The primary endpoint was the time to first occurrence of a morbidity or mortality event, up to the end of double-blind treatment, defined as death, or atrial septostomy, or lung transplantation, or initiation of intravenous (i.v.) or subcutaneous (s.c.) prostanoids, or other worsening of PAH. Other worsening of PAH was defined as the presence of all of the three following components: a sustained decrease in 6-minute walk distance (6MWD) of at least 15% from baseline; worsening of PAH symptoms (worsening of WHO FC or right heart failure); and need for new treatment for PAH. All events were confirmed by an independent adjudication committee, blinded to treatment allocation.

All patients were followed up to end-of-study (EOS) for vital status. EOS was declared when the predefined number of primary endpoint events was reached. In the period between end-of-treatment (EOT) and EOS, patients could receive open-label macitentan 10 mg or alternative PAH therapy. The overall median double-blind treatment duration was 115 weeks (up to a maximum of 188 weeks on macitentan).

The mean age of all patients was 46 years (range 12–85 years of age, including 20 patients below 18, 706 patients between 18–74 years, and 16 patients aged 75 and older) with the majority of subjects being Caucasian (55%) and female (77%). Approximately 52%, 46%, and 2% of patients were in WHO FC II, III, and IV, respectively.

Idiopathic or heritable PAH was the most common aetiology in the study population (57%), followed by PAH due to connective tissue disorders (31%), PAH associated with corrected simple congenital heart disease (8%), and PAH associated with other aetiologies (medicinal products and toxins [3%] and HIV [1%]).

Outcome endpoints

Treatment with macitentan 10 mg resulted in a 45% risk reduction (hazard ratio [HR] 0.55; 97.5% CI: 0.39 to 0.76; logrank $p < 0.0001$) of the composite morbidity-mortality endpoint up to EOT when compared to placebo [Figure 1 and Table 1]. The treatment effect was established early and was sustained.

Efficacy of macitentan 10 mg on the primary endpoint was consistent across subgroups of age, sex, ethnic origin, geographical region, aetiology, by monotherapy or in combination with another PAH therapy and by WHO FC (I/II and III/IV).

Figure 1 Kaplan-Meier estimates of the first morbidity-mortality event in SERAPHIN

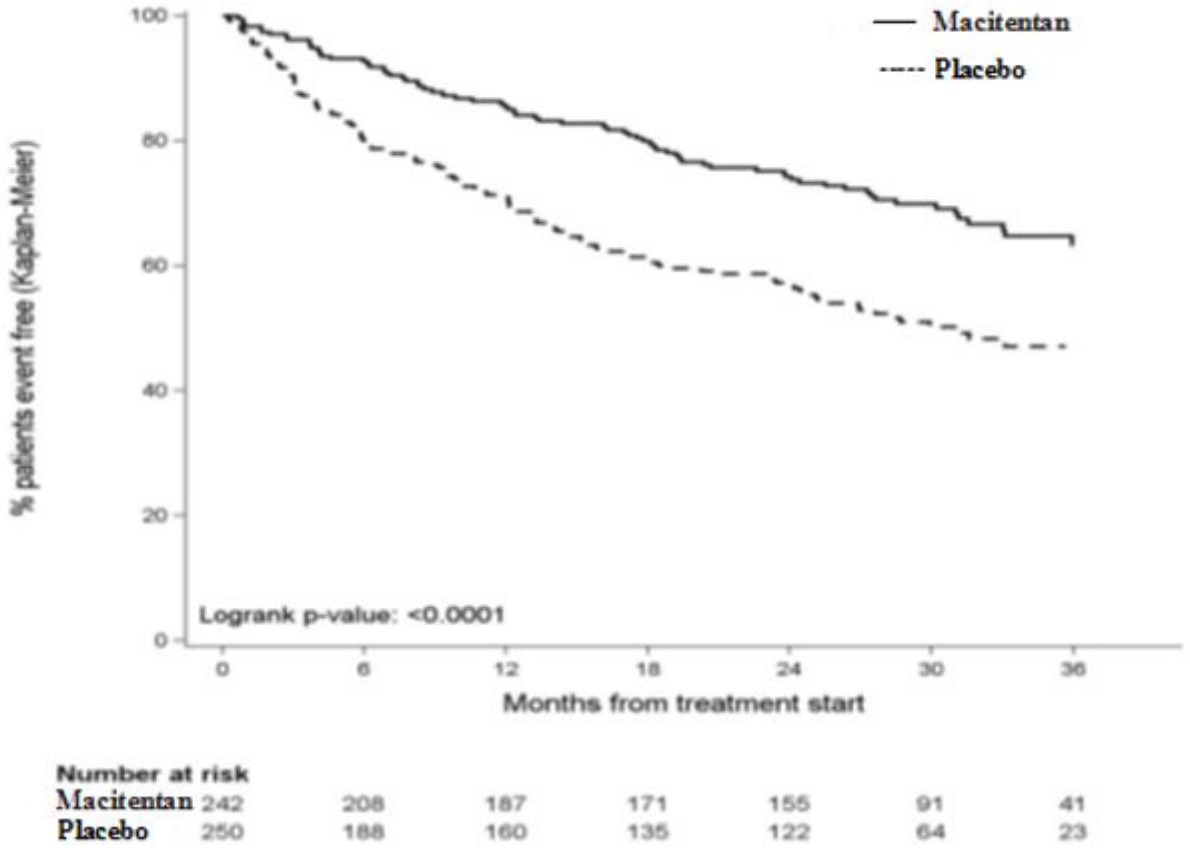


Table 1 Summary of outcome events

Endpoints & statistics	Patients with events		Treatment comparison: macitentan 10 mg vs placebo			
	Placebo (N = 250)	Macitentan 10 mg (N = 242)	Absolute risk reduction	Relative risk reduction (97.5% CI)	HR [a] (97.5% CI)	Logrank p-value
Morbidity- mortality event [b]	53%	37%	16%	45% (24%; 61%)	0.55 (0.39; 0.76)	< 0.0001
Death [c] **n (%)**	19 (7.6%)	14 (5.8%)	2%	36% (−42%; 71%)	0.64 (0.29; 1.42)	0.20
Worsening of PAH n (%)	93 (37.2%)	59 (24.4%)	13%	49% (27%; 65%)	0.51 (0.35; 0.73)	< 0.0001
i.v./s.c. prostanoid initiation n(%)	6 (2.4%)	1 (0.4%)	2%			

[a] = based on Cox's Proportional Hazards Model
[b] = % of patients with an event at 36 months = 100 × (1 - KM estimate)
[c] = all cause death up to EOT regardless of prior worsening

The number of deaths of all causes up to EOS on macitentan 10 mg was 35 versus 44 on placebo (HR 0.77; 97.5% CI: 0.46 to 1.28).

The risk of PAH-related death or hospitalisation for PAH up to EOT was reduced by 50% (HR 0.50; 97.5% CI: 0.34 to 0.75; logrank p < 0.0001) in patients receiving macitentan 10 mg (50 events) compared to placebo (84 events). At 36 months, 44.6% of patients on placebo and 29.4% of patients on macitentan 10 mg (Absolute Risk Reduction = 15.2%) had been hospitalised for PAH or died from a PAH-related cause.

Symptomatic endpoints

Exercise capacity was evaluated as a secondary endpoint. Treatment with macitentan 10 mg at Month 6 resulted in a placebo-corrected mean increase in 6MWD of 22 meters (97.5% CI: 3 to 41; p = 0.0078). Evaluation of 6MWD by functional class resulted in a placebo-corrected mean increase from baseline to Month 6 in FC III/IV patients of 37 meters (97.5% CI: 5 to 69) and in FC I/II of 12 meters (97.5% CI: -8 to 33). The increase in 6MWD achieved with macitentan was maintained for the duration of the study.

Treatment with macitentan 10 mg at Month 6 led to a 74% higher chance of WHO FC improvement relative to placebo (risk ratio 1.74; 97.5% CI: 1.10 to 2.74; p = 0.0063).

Macitentan 10 mg improved quality of life assessed by the SF-36 questionnaire.

Haemodynamic endpoints

Haemodynamic parameters were assessed in a subset of patients (placebo [N = 67], macitentan 10 mg [N = 57]) after 6 months of treatment. Patients treated with macitentan 10 mg achieved a median reduction of 36.5% (97.5% CI: 21.7 to 49.2%) in pulmonary vascular resistance and an increase of 0.58 L/min/m^2 (97.5% CI: 0.28 to 0.93 L/min/m^2) in cardiac index compared to placebo.

Long-term data in PAH

In long-term follow-up of 242 patients who were treated with macitentan 10 mg in the double-blind (DB) phase of the SERAPHIN study, 182 of which continued with macitentan in the open-label (OL) extension study (SERAPHIN OL) (DB/OL cohort), Kaplan-Meier estimates of survival at 1, 2, 5, 7 and 9 years were 95%, 89%, 73%, 63% and 53%, respectively. The median follow-up time was 5.9 years.

Paediatric population

Efficacy in paediatric population is mainly based in an extrapolation exercise based upon exposure-matching to the adult efficacious dose range given the similarity of the disease in children and adults, as well as on supportive efficacy and safety data from the TOMORROW phase 3 study described below.

A multi-center, open-label, randomised, Phase 3 study with an open-label single-arm extension period (TOMORROW) was conducted to assess pharmacokinetics, efficacy and safety of macitentan in paediatric patients with symptomatic PAH.

The primary endpoint was the characterisation of pharmacokinetics (see section 5.2).

The key secondary combined endpoint was the time to first Clinical Events Committee (CEC) confirmed disease progression occurring between randomisation and the end of the core period (EOCP) visit defined as, deaths (all causes), or atrial septostomy or Potts' anastomosis, or registration on lung transplant list, or hospitalisation due to worsening PAH or clinical worsening of PAH. Clinical worsening of PAH was defined as: need for, or initiation of new PAH-specific therapy or IV diuretics or continuous oxygen use AND at least 1 of the following: worsening in WHO FC, or new occurrence or worsening of syncope, or new occurrence or worsening of at least 2 PAH symptoms or new occurrence or worsening of signs of right heart failure not responding to oral diuretics.

Other secondary endpoints included time to first CEC-confirmed hospitalisation for PAH, time to CEC-confirmed death due to PAH both between randomisation and EOCP, time to all-cause death between randomisation and EOCP, change in WHO FC, and N-terminal prohormone of brain natriuretic peptide (NT-proBNP) data.

Paediatric population (aged ≥ 2 years to less than 18 years)

A total of 148 patients aged ≥ 2 years to < 18 years were randomised 1:1 to receive either macitentan or Standard of Care (SoC). SoC included PAH non-specific treatment and/or up to 2 PAH-specific medications (including another ERA) and excluding macitentan and IV/SC prostanoids. The mean age was 9.8 years (range 2.1 years-17.9 years), with 35 (23.6%) aged ≥ 2 to < 6 years, 61 (41.2%) aged ≥ 6 to < 12 years, and 52 (35.1%) aged ≥ 12 to < 18 years. The majority of patients were white (51.4%) and female (59.5%). Patients were either WHO FC I (25.0%), FC II (56.1%), or FC III (18.9%).

Idiopathic PAH was the most common aetiology in the study population (48.0%), followed by PAH associated with post-operative congenital heart disease (28.4%), PAH with co-incidental congenital heart disease (17.6%), heritable PAH (4.1%) and PAH associated with connective tissue disease (2.0%). Co-incidental CHD only included typically small coincidental defects such as pre-tricuspid, post-tricuspid shunts, atrial septal defect, ventricular septal defect, patent ductus arteriosus, none considered causative of the degree of PAH.

The mean treatment duration in the randomised study was 183.4 weeks in the macitentan arm and 130.6 weeks in the SoC arm.

Fewer events for the key secondary endpoint of CEC-confirmed disease progression were observed in the macitentan arm (21 events/73 patients, 29%) versus the SoC arm (24 events/75 patients, 32%), absolute risk reduction of 3%. The hazard ratio was 0.828 (95% CI 0.460; 1.492; 2-sided stratified p-value = 0.567). The numerical trend towards benefit was mainly driven by the clinical worsening of PAH.

Other secondary efficacy analyses

The same number of events for first-confirmed hospitalisation for PAH were observed in both groups (macitentan 11 vs. SoC 11; adjusted HR=0.912, 95% CI= [0.393; 2.118]). In terms of the time to CEC-confirmed death due to PAH and death from all causes, a total of 7 deaths (6 of which were due to PAH as per CEC) were observed in the macitentan arm compared to 6 deaths (4 of which were due to PAH as per CEC) in the SoC arm.

There was a numerically higher proportion of patients at WHO FC I or II reported at Week 12 in the macitentan arm compared with the SoC arm (88.7% in macitentan arm versus 81.7% in SoC arm) and at Week 24 (90.0% in macitentan arm versus 82.5% in SoC arm).

Macitentan treatment tended to reduce the percent of baseline NT-proBNP (pmol/L) at Week 12 compared with the SoC arm (geometric mean ratio: 0.72; 95% CI: 0.49 to 1.05) but the results were not statistically significant (2-sided p-value of 0.086). The non-significant trend was less pronounced at Week 24 (geometric mean ratio: 0.97;95% CI: 0.66 to 1.43;2-sided p-value of 0.884).

Efficacy results from patients aged ≥ 2 years to less than 18 years were similar to those of adult patients.

Paediatric population (aged ≥ 1 month to less than 2 years)
An additional 11 patients, aged ≥ 1 month to less than 2 years old were enroled to receive macitentan without randomisation, 9 patients from the open-label arm of the TOMORROW study and 2 Japanese patients from the PAH3001 study. PAH3001 was a multi-centre, open-label, single-arm, Phase 3 study in Japanese paediatric participants (between ≥ 3 months and < 15 years of age) with PAH, conducted to assess the pharmacokinetics and efficacy of macitentan.

At baseline, 6 patients from the TOMORROW study were on PDE5i therapy. At enrolment, the age range of the patients ranged from 1.2 years-1.9 years. Patients were either WHO FC II (4) or FC I (5). PAH associated with congenital heart disease was the most common aetiology (5 patients), followed by idiopathic PAH (4 patients). The initially administered daily dose was 2.5 mg macitentan until the patients reached the 2 years of age. After a median follow-up of 37.3 weeks, none of the patients had experienced a CEC-confirmed disease progression event, a CEC-confirmed hospitalisation for PAH, a CEC-confirmed death due to PAH, or an event of death from all causes. NT-proBNP was reduced by 42.9% (n=6) at Week 12, 53.2% (n=5) at Week 24 and 26.1% (n=6) at Week 36.

At baseline, 1 Japanese patient from the PAH3001 study was on PDE5i therapy. Both Japanese patients were male and their ages at enrolment were 21 months and 22 months. Both patients were in Panama FC I and II and the leading aetiology was post-operative PAH. At Week 24, a reduction in baseline NT-proBNP levels of -3.894 pmol/L and -16.402 pmol/L was observed.

Exposure-matching to adult patients was not established in this age group (see sections 4.2 and 5.2).

5.2 Pharmacokinetic properties

The pharmacokinetics of macitentan and its active metabolite have mainly been documented in healthy adult subjects. Exposure to macitentan in patients with PAH was approximately 1.2-fold greater than in healthy subjects. The exposure to the active metabolite in patients, which is approximately 5-fold less potent than macitentan, was approximately 1.3-fold higher

than in healthy subjects. The pharmacokinetics of macitentan in PAH patients were not influenced by the severity of the disease.

After repeated administration, the pharmacokinetics of macitentan are dose-proportional up to and including 30 mg.

Absorption

Maximum plasma concentrations of macitentan are achieved about 8-9 hours after administration. Thereafter, plasma concentrations of macitentan and its active metabolite decrease slowly, with an apparent elimination half-life of approximately 16 hours and 48 hours, respectively.

In healthy subjects, the exposure to macitentan and its active metabolite is unchanged in the presence of food and, therefore, macitentan may be taken with or without food.

Distribution

Macitentan and its active metabolite aprocitentan are highly bound to plasma proteins (> 99%), primarily to albumin and to a lesser extent to alpha1-acid glycoprotein. Macitentan and its active metabolite aprocitentan are well distributed into tissues as indicated by an apparent volume of distribution (Vss/F) of approximately 50 L and 40 L for macitentan and aprocitentan, respectively.

Biotransformation

Macitentan has four primary metabolic pathways. Oxidative depropylation of the sulfamide yields a pharmacologically active metabolite aprocitentan. This reaction is dependent on the cytochrome P450 system, mainly CYP3A4 (approximately 99%) with minor contributions of CYP2C8, CYP2C9 and CYP2C19. The active metabolite circulates in human plasma and may contribute to the pharmacological effect. Other metabolic pathways yield products without pharmacological activity.

For these pathways, CYP2C9 plays a predominant role with minor contributions from CYP2C8, CYP2C19 and CYP3A4.

Elimination

Macitentan is only excreted after extensive metabolism. The major excretion route is via urine, accounting for about 50% of the dose.

Special populations

There is no clinically relevant effect of age, sex or ethnic origin on the pharmacokinetics of macitentan and its active metabolite.

Renal impairment

Exposure to macitentan and its active metabolite was increased by 1.3- and 1.6-fold, respectively, in adult patients with severe renal impairment. This increase is not considered clinically relevant (see sections 4.2 and 4.4).

Hepatic impairment

Exposure to macitentan was decreased by 21%, 34%, and 6% and, for the active metabolite by 20%, 25%, and 25% in adult subjects with mild, moderate or severe hepatic impairment, respectively. This decrease is not considered clinically relevant (see sections 4.2 and 4.4).

Paediatric population (aged ≥ 1 month to less than 18 years)

Pharmacokinetics of macitentan and its active metabolite aprocitentan were characterised in 47 paediatric patients who were ≥ 2 years and in 11 patients who were ≥ 1 month to less than 2 years old.
Weight-based dose regimens of macitentan resulted in observed / simulated exposures in paediatric patients aged 2 years to less than 18 years that were comparable to exposures observed in adult PAH patients and healthy subjects who received 10 mg once daily.
Exposures of macitentan comparable to that of adult PAH patients receiving 10 mg once daily were not achieved for the age group of ≥ 1 month to less than 2 years old (see section 4.2).

5.3 Preclinical safety data

In dogs, macitentan decreased blood pressure at exposures similar to the therapeutic human exposure. Intimal thickening of coronary arteries was observed at 17-fold the human exposure after 4 to 39 weeks of treatment. Due to the species-specific sensitivity and the safety margin, this finding is considered not relevant for humans.

Increased liver weight and hepatocellular hypertrophy were observed in mice, rats and dogs after treatment with macitentan. These changes were largely reversible and considered non-adverse adaptations of the liver to increased metabolic demand.

Macitentan induced minimal to slight mucosal hyperplasia and inflammatory infiltration in the submucosa of the nasal cavity in the mouse carcinogenicity study at all doses. No nasal cavity findings were noted in the 3-month mouse toxicity study or in rat and dog studies.

Macitentan was not genotoxic in a standard battery of *in vitro* and in vivo assays. Macitentan was not phototoxic in vivo after single dose at exposures of up to 24-fold the human exposure. Carcinogenicity studies of 2 years' duration did not reveal a carcinogenic potential at exposures 18-fold and 116-fold the human exposure in rats and mice, respectively.

Testicular tubular dilatation was observed in chronic toxicity studies with male rats and dogs with safety margins of 11.6 and 5.8, respectively. Tubular dilatation was fully reversible. After 2 years of treatment, testicular tubular atrophy was seen in rats at 4-fold the human exposure. Hypospermatogenesis was observed in the life-long carcinogenicity study in rats and in the repeat-dose toxicity studies in dogs at exposures that provide safety margins of 9.7 in rats and 23 in dogs. The safety margins for fertility were 18 for male and 44 for female rats. No testicular findings were noted in mice after treatment up to 2 years.

Macitentan was teratogenic in rabbits and rats at all doses tested. In both species there were cardiovascular and mandibular arch fusion abnormalities.

Administration of macitentan to female rats from late pregnancy through lactation at maternal exposures 5-fold the human exposure, caused reduced pup survival and impairment of the reproductive capability of the offspring, which was exposed to macitentan during late intrauterine life and via the milk during the suckling period.

Treatment of juvenile rats from postnatal Day 4 to Day 114 caused reduced body weight gain leading to secondary effects on development (slight delay of descensus testis, reversible reduction of long bone length, prolonged estrous cycle). Slightly increased pre- and post-implantation loss, decreased mean number of pups, and decreased testis and epididymis weights, were observed at exposures 7-fold the human exposure. Testicular tubular atrophy, and minimal effects on reproductive variables and sperm morphology were recorded at exposures 3.8-fold the human exposure.

6 PHARMACEUTICAL PARTICULARS

6.1 List of excipients

Tablet core:
Lactose monohydrate
Cellulose, microcrystalline
Sodium starch glycolate (Type A)
Sodium laurilsulfate
Povidone K30
Magnesium stearate

Film coating:
Poly (vinyl alcohol) (E1203)
Titanium dioxide (E171)
Talc (E553b)
Soya bean lecithin (E322)
Xanthan gum (E415)

6.2 Incompatibilities

Not applicable

6.3 Shelf life

3 years.

6.4 Special precautions for storage

This medicinal product does not require anyspecial storage conditions.

6.5 Nature and contents of container

PVC/PE/PVdC/Aluminium blisters in cartons containing 30 film-coated tablets or perforated unit-dose
PVC/PE/PVdC/Aluminium blisters in cartons containing 30 x 1 film-coated tablets.
Not all pack sizes may be marketed.

6.6 Special precautions for disposal

No special requirements for disposal.

7 MARKETING AUTHORISATION HOLDER

MSN Labs Europe Limited
Kw20a Corradino Park
Paola
PLA 3000
Malta

8 MARKETING AUTHORISATION NUMBER

PA23250/017/001

9 DATE OF FIRST AUTHORISATION/RENEWAL OF THE AUTHORISATION

Date of first authorisation: 19th June 2026

10 DATE OF REVISION OF THE TEXT