

**ANNEX I**

**SUMMARY OF PRODUCT CHARACTERISTICS**

## **1. NAME OF THE MEDICINAL PRODUCT**

Appref 5 mg/850 mg filmomhulde tabletten  
Appref 5 mg/1000 mg filmomhulde tabletten  
Appref 12,5 mg/850 mg filmomhulde tabletten  
Appref 12,5 mg/1000 mg filmomhulde tabletten

## **2. QUALITATIVE AND QUANTITATIVE COMPOSITION**

### Appref 5 mg/850 mg film-coated tablets

Each tablet contains 5 mg empagliflozin and 850 mg metformin hydrochloride.

### Appref 5 mg/1 000 mg film-coated tablets

Each tablet contains 5 mg empagliflozin and 1 000 mg metformin hydrochloride.

### Appref 12.5 mg/850 mg film-coated tablets

Each tablet contains 12.5 mg empagliflozin and 850 mg metformin hydrochloride.

### Appref 12.5 mg/1 000 mg film-coated tablets

Each tablet contains 12.5 mg empagliflozin and 1 000 mg metformin hydrochloride.

For the full list of excipients, see section 6.1.

## **3. PHARMACEUTICAL FORM**

Film-coated tablet (tablet).

### Appref 5 mg/850 mg film-coated tablets

White or almost white, 22 mm\*11 mm, oval biconvex, film-coated tablet with 5-850 printed on one side and unprinted on the other side.

### Appref 5 mg/1 000 mg film-coated tablets

Pink, 22 mm\*11 mm, oval biconvex, film-coated tablet printed 5-1 000 on one side and unprinted on the other side.

### Appref 12.5 mg/850 mg film-coated tablets

Brownish orange. 22 mm\*11 mm, oval biconvex, film-coated tablet with 12.5-850 printed on one side and unprinted on the other side.

### Appref 12.5 mg/1 000 mg film-coated tablets

Yellow, 22 mm\*11 mm, oval biconvex, film-coated tablet with 12.5-1 000 printed on one side and unprinted on the other side.

## 4. CLINICAL PARTICULARS

### 4.1 Therapeutic indications

Appref is indicated in adults and children aged 10 years and above for the treatment of type 2 diabetes mellitus as an adjunct to diet and exercise:

- in patients insufficiently controlled on their maximally tolerated dose of metformin alone
- in combination with other medicinal products for the treatment of diabetes, in patients insufficiently controlled with metformin and these medicinal products
- in patients already being treated with the combination of empagliflozin and metformin as separate tablets.

For study results with respect to combinations, effects on glycaemic control and cardiovascular events, and the population studied, see sections 4.4, 4.5 and 5.1.

### 4.2 Posology and method of administration

#### Posology

#### Adults with normal renal function ( $eGFR \geq 90 \text{ ml/min/1.73 m}^2$ )

The recommended dose is one tablet twice daily. The dosage should be individualised on the basis of the patient's current regimen, effectiveness, and tolerability using the recommended daily dose of 10 mg or 25 mg of empagliflozin, while not exceeding the maximum recommended daily dose of metformin.

#### For patients insufficiently controlled on metformin (either alone or in combination with other medicinal products for the treatment of diabetes)

In patients insufficiently controlled on metformin alone or in combination with other medicinal products for the treatment of diabetes, the recommended starting dose of empagliflozin/metformin should provide empagliflozin 5 mg twice daily (10 mg daily dose) and the dose of metformin similar to the dose already being taken. In patients tolerating a total daily dose of empagliflozin 10 mg and who need tighter glycaemic control, the dose can be increased to a total daily dose of empagliflozin 25 mg. When the medicinal product is used in combination with a sulphonylurea and/or insulin, a lower dose of sulphonylurea and/or insulin may be required to reduce the risk of hypoglycemia (see sections 4.5 and 4.8).

#### For patients switching from separate tablets of empagliflozin and metformin

Patients switching from separate tablets of empagliflozin (10 mg or 25 mg total daily dose) and metformin to Appref should receive the same daily dose of empagliflozin and metformin already being taken or the nearest therapeutically appropriate dose of metformin (for available strengths see section 2).

#### Missed dose

If a dose is missed, it should be taken as soon as the patient remembers; however, a double dose should not be taken on the same time. In that case, the missed dose should be skipped.

#### Special populations

##### *Renal impairment*

The glycaemic efficacy of empagliflozin is dependent on renal function. For cardiovascular risk reduction as add on to standard of care, a dose of 10 mg empagliflozin daily should be used in patients with an  $eGFR$  below  $60 \text{ ml/min/1.73 m}^2$  (see Table 1). Because the glycaemic lowering efficacy of empagliflozin is reduced in patients with moderate renal impairment and likely absent in patients with

severe renal impairment, if further glycaemic control is needed, the addition of other anti-hyperglycaemic agents should be considered.

For dose adjustment recommendations according to eGFR or CrCL refer to Table 1.

A eGFR should be assessed before initiation of treatment with metformin containing products and at least annually thereafter. In patients at increased risk of further progression of renal impairment and in the elderly, renal function should be assessed more frequently, e.g. every 3-6 months.

If no adequate strength of empagliflozin/metformin is available, individual monocomponents should be used instead of the fixed dose combination.

For dosing recommendations in the paediatric population see subsection paediatric patients below.

**Table 1:** Posology for renally impaired adult patients<sup>a</sup>

eGFR [ml/min/1.73 m <sup>2</sup> ] or CrCL [ml/min]	Metformin	Empagliflozin
≥60	Maximum daily dose is 3 000 mg. Dose reduction may be considered in relation to declining renal function.	Initiate with 10 mg. In patients tolerating 10 mg and requiring additional glycaemic control, the dose can be increased to 25 mg.
45 to <60	Maximum daily dose is 2 000 mg. The starting dose is at most half of the maximum dose.	Initiate with 10 mg <sup>b</sup> . Continue with 10 mg in patients already taking empagliflozin.
30 to <45	Maximum daily dose is 1 000 mg. The starting dose is at most half of the maximum dose.	Initiate with 10 mg <sup>b</sup> . Continue with 10 mg in patients already taking empagliflozin <sup>b</sup> .
<30	Metformin is contraindicated.	Empagliflozin is not recommended.

<sup>a</sup> See sections 4.4, 4.8, 5.1 and 5.2

<sup>b</sup> patients with type 2 diabetes mellitus and established cardiovascular disease

### *Hepatic impairment*

This medicinal product must not be used in patients with hepatic impairment (see sections 4.3, 4.4 and 5.2).

### *Elderly*

Due to the mechanism of action, decreased renal function will result in reduced glycaemic efficacy of empagliflozin. Because metformin is excreted by the kidney and elderly patients are more likely to have decreased renal function, this medicinal product should be used with caution in these patients. Monitoring of renal function is necessary to aid in prevention of metformin-associated lactic acidosis, particularly in elderly patients (see sections 4.3 and 4.4). In patients 75 years and older, an increased risk for volume depletion should be taken into account (see sections 4.4 and 4.8).

### *Paediatric population*

The dosage should be individualised on the basis of the patient's current regimen, effectiveness, and tolerability.

If empagliflozin is added in patients already receiving metformin, the metformin dose should remain the same as the patient is already taking. The recommended empagliflozin starting dose is 5 mg twice daily (10 mg total daily doses). In patients tolerating empagliflozin 5 mg twice daily and requiring additional glycaemic control, the dose can be increased to 12.5 mg twice daily (25 mg total daily dose).

If patients switching from separate tablets of empagliflozin and metformin to this medicinal product, the same daily dose of empagliflozin and metformin should remain as already being taken or the nearest therapeutically appropriate dose of metformin.

The maximum recommended daily dose of Appref is 25 mg of empagliflozin and 2 000 mg of metformin (see general information above in section 4.2).

No data are available for children with eGFR <60 ml/min/1.73 m<sup>2</sup> and children below 10 years of age.

#### Method of administration

Empagliflozin/metformin tablets should be taken twice daily with meals to reduce the gastrointestinal adverse reactions associated with metformin. The tablets should be swallowed whole with water. All patients should continue their diet with an adequate distribution of carbohydrate intake during the day. Overweight patients should continue their energy restricted diet.

### **4.3 Contraindications**

- Hypersensitivity to the active substances or to any of the excipients listed in section 6.1.
- Any type of acute metabolic acidosis (such as lactic acidosis, diabetic ketoacidosis) (see section 4.4).
- Diabetic pre-coma.
- Severe renal failure (eGFR <30 ml/min/1.73 m<sup>2</sup>) (see sections 4.2 and 4.4).
- Acute conditions with the potential to alter renal function such as: dehydration, severe infection, shock (see sections 4.4 and 4.8).
- Disease which may cause tissue hypoxia (especially acute disease, or worsening of chronic disease) such as: decompensated heart failure, respiratory failure, recent myocardial infarction, shock (see section 4.4).
- Hepatic impairment, acute alcohol intoxication, alcoholism (see sections 4.2 and 4.5).

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

#### General

Empagliflozin should not be used in patients with type 1 diabetes mellitus (see “Diabetic ketoacidosis” in section 4.4)

#### Lactic acidosis

Lactic acidosis, a very rare but serious metabolic complication, most often occurs at acute worsening of renal function or cardiorespiratory illness or sepsis. Metformin accumulation occurs at acute worsening of renal function and increases the risk of lactic acidosis.

In case of dehydration (severe diarrhoea or vomiting, fever or reduced fluid intake), metformin should be temporarily discontinued and contact with a health care professional is recommended.

Medicinal products that can acutely impair renal function (such as antihypertensives, diuretics and NSAIDs) should be initiated with caution in metformin-treated patients. Other risk factors for lactic acidosis are excessive alcohol intake, hepatic insufficiency, inadequately controlled diabetes, ketosis, prolonged fasting and any conditions associated with hypoxia, as well as concomitant use of medicinal products that may cause lactic acidosis (see sections 4.3 and 4.5).

Patients and/or care-givers should be informed of the risk of lactic acidosis. Lactic acidosis is characterised by acidotic dyspnea, abdominal pain, muscle cramps, asthenia and hypothermia followed by coma. In case of suspected symptoms, the patient should stop taking metformin and seek immediate medical attention. Diagnostic laboratory findings are decreased blood pH (<7.35), increased plasma lactate levels (>5 mmol/l) and an increased anion gap and lactate/pyruvate ratio.

#### *Patients with known or suspected mitochondrial diseases*

In patients with known mitochondrial diseases such as Mitochondrial Encephalopathy with Lactic Acidosis, and Stroke-like episodes (MELAS) syndrome and Maternal inherited diabetes and deafness (MIDD), metformin is not recommended due to the risk of lactic acidosis exacerbation and neurologic complications which may lead to worsening of the disease.

In case of signs and symptoms suggestive of MELAS syndrome or MIDD after the intake of metformin, treatment with metformin should be withdrawn immediately and prompt diagnostic evaluation should be performed.

#### Diabetic ketoacidosis

Rare cases of diabetic ketoacidosis (DKA), including life-threatening and fatal cases, have been reported in patients treated with SGLT2 inhibitors, including empagliflozin. In a number of cases, the presentation of the condition was atypical with only moderately increased blood glucose values, below 14 mmol/l (250 mg/dl). It is not known if DKA is more likely to occur with higher doses of empagliflozin.

The risk of diabetic ketoacidosis must be considered in the event of non-specific symptoms such as nausea, vomiting, anorexia, abdominal pain, excessive thirst, difficulty breathing, confusion, unusual fatigue or sleepiness. Patients should be assessed for ketoacidosis immediately if these symptoms occur, regardless of blood glucose level.

In patients where DKA is suspected or diagnosed, treatment with empagliflozin should be discontinued immediately.

Treatment should be interrupted in patients who are hospitalised for major surgical procedures or acute serious medical illnesses. Monitoring of ketones is recommended in these patients. Measurement of blood ketone levels is preferred to urine. Treatment with empagliflozin may be restarted when the ketone values are normal and the patient's condition has stabilised.

Before initiating empagliflozin, factors in the patient history that may predispose to ketoacidosis should be considered.

Prolonged diabetic ketoacidosis and prolonged glucosuria have been observed with empagliflozin. Diabetic ketoacidosis may last longer after discontinuation of empagliflozin than expected from the plasma half-life (see section 5.2). Empagliflozin-independent factors, such as insulin deficiency, might be involved in prolonged periods of diabetic ketoacidosis.

Patients who may be at higher risk of DKA include patients with a low beta-cell function reserve (e.g. type 2 diabetes patients with low C-peptide or latent autoimmune diabetes in adults (LADA) or patients with a history of pancreatitis), patients with conditions that lead to restricted food intake or severe dehydration, patients for whom insulin doses are reduced and patients with increased insulin requirements due to acute medical illness, surgery or alcohol abuse. SGLT2 inhibitors should be used with caution in these patients.

Restarting SGLT2 inhibitor treatment in patients with previous DKA while on SGLT2 inhibitor treatment is not recommended, unless another clear precipitating factor is identified and resolved.

This medicinal product should not be used in patients with type 1 diabetes. Data from a clinical trial program in patients with type 1 diabetes showed increased DKA occurrence with common frequency in patients treated with empagliflozin 10 mg and 25 mg as an adjunct to insulin compared to placebo.

#### Administration of iodinated contrast agent

Intravascular administration of iodinated contrast agents may lead to contrast induced nephropathy, resulting in metformin accumulation and an increased risk of lactic acidosis. Metformin should be

discontinued prior to or at the time of the imaging procedure and not restarted until at least 48 hours after, provided that renal function has been re-evaluated and found to be stable (see sections 4.2 and 4.5).

### Renal impairment

Due to the mechanism of action, decreased renal function will result in reduced glycaemic efficacy of empagliflozin. Empagliflozin/metformin is contraindicated in patients with  $\text{eGFR} < 30 \text{ ml/min/1.73 m}^2$  and should be temporarily discontinued in the presence of conditions that alter renal function (see section 4.3).

#### Monitoring of renal function

Assessment of renal function is recommended as follows:

- Prior to empagliflozin/metformin initiation and periodically during treatment, i.e. at least yearly (see section 4.2).
- Prior to initiation of any concomitant medicinal product that may have a negative impact on renal function.

### Cardiac function

Patients with heart failure are more at risk of hypoxia and renal insufficiency. In patients with stable chronic heart failure, empagliflozin/metformin tablets may be used with a regular monitoring of cardiac and renal function. For patients with acute and unstable heart failure, empagliflozin/metformin is contraindicated due to the metformin component (see section 4.3).

### Surgery

Metformin must be discontinued at the time of surgery under general, spinal or epidural anaesthesia. Therapy may be restarted no earlier than 48 hours following surgery or resumption of oral nutrition and provided that renal function has been re-evaluated and found to be stable.

### Risk for volume depletion

Based on the mode of action of SGLT2 inhibitors, osmotic diuresis accompanying therapeutic glucosuria may lead to a modest decrease in blood pressure (see section 5.1). Therefore, caution should be exercised in patients for whom a empagliflozin-induced drop in blood pressure could pose a risk, such as patients with known cardiovascular disease, patients on anti-hypertensive therapy with a history of hypotension or patients aged 75 years and older.

In case of conditions that may lead to fluid loss (e.g. gastrointestinal illness), careful monitoring of volume status (e.g. physical examination, blood pressure measurements, laboratory tests including haematocrit) and electrolytes is recommended for patients receiving empagliflozin/metformin. Temporary interruption of treatment with this medicinal product should be considered until the fluid loss is corrected.

### Elderly

The effect of empagliflozin on urinary glucose excretion is associated with osmotic diuresis, which could affect the hydration status. Patients aged 75 years and older may be at an increased risk of volume depletion. Therefore, special attention should be given to their volume intake in case of co-administered medicinal products which may lead to volume depletion (e.g. diuretics, ACE inhibitors).

### Urinary tract infections

Post marketing cases of complicated urinary tract infections including pyelonephritis and urosepsis have been reported in patients treated with empagliflozin (see section 4.8). Temporary interruption of treatment should be considered in patients with complicated urinary tract infections.

### Necrotising fasciitis of the perineum (Fournier's gangrene)

Cases of necrotising fasciitis of the perineum, (also known as Fournier's gangrene), have been reported in female and male patients taking SGLT2 inhibitors, including empagliflozin. This is a rare but serious and potentially life-threatening event that requires urgent surgical intervention and antibiotic treatment.

Patients should be advised to seek medical attention if they experience a combination of symptoms of pain, tenderness, erythema, or swelling in the genital or perineal area, with fever or malaise. Be aware that either uro-genital infection or perineal abscess may precede necrotising fasciitis. If Fournier's gangrene is suspected, empagliflozin/metformin therapy should be discontinued and prompt treatment (including antibiotics and surgical debridement) should be instituted.

### Lower limb amputations

An increase in cases of lower limb amputation (primarily of the toe) has been observed in long-term clinical studies with another SGLT2 inhibitor. It is unknown whether this constitutes a class effect. Like for all diabetic patients it is important to counsel patients on routine preventative foot-care.

### Hepatic injury

Cases of hepatic injury have been reported with empagliflozin in clinical trials. A causal relationship between empagliflozin and hepatic injury has not been established.

### Elevated haematocrit

Haematocrit increase was observed with empagliflozin treatment (see section 4.8). Patients with pronounced elevations in haematocrit should be monitored and investigated for underlying haematological disease.

### Chronic kidney disease

There is experience with empagliflozin for the treatment of diabetes in patients with chronic kidney disease ( $\text{eGFR} \geq 30 \text{ mL/min/1.73 m}^2$ ) both with and without albuminuria. Patients with albuminuria may benefit more from treatment with empagliflozin.

### Urine laboratory assessments

Due to its mechanism of action, patients taking this medicinal product will test positive for glucose in their urine.

### Interference with 1,5-anhydroglucitol (1,5-AG) assay

Monitoring glycaemic control with 1,5-AG assay is not recommended as measurements of 1,5-AG are unreliable in assessing glycaemic control in patients taking SGLT2 inhibitors. Use of alternative methods to monitor glycaemic control is advised.

### Vitamin B12

Metformin may reduce vitamin B12 levels. The risk of low vitamin B12 levels increases with increasing metformin dose, treatment duration, and/or in patients with risk factors known to cause



vitamin B12 deficiency. In case of suspicion of vitamin B12 deficiency (such as anaemia or neuropathy), vitamin B12 serum levels should be monitored. Periodic vitamin B12 monitoring could be necessary in patients with risk factors for vitamin B12 deficiency. Metformin therapy should be continued for as long as it is tolerated and not contra-indicated and appropriate corrective treatment for vitamin B12 deficiency provided in line with current clinical guidelines.

#### Paediatric population

In the DINAMO trial (see section 5.1), the overall safety profile in children and adolescents was similar with the known safety profile seen in adult patients and there were no relevant differences between placebo and empagliflozin regarding growth assessments or concerning the sexual maturation after 26 weeks of treatment.

No effect of metformin on growth and puberty has been detected during controlled clinical studies of one-year duration but no long-term data on these specific points are available. Therefore, a careful follow-up of the effect of metformin on these parameters in metformin-treated children, especially prepubescent children, is recommended.

#### *Children aged between 10 and 12*

In metformin studies, only 15 patients aged between 10 and 12 years were included in the controlled clinical studies conducted in children and adolescents.

The DINAMO trial included 157 patients and 91% were on metformin as background therapy, 25 of these patients were between 10 and 12 years old.

Although efficacy and safety of metformin in these children did not differ from efficacy and safety in older children and adolescents, particular caution is recommended when prescribing to children aged between 10 and 12 years.

#### Sodium content

This medicinal product contains less than 1 mmol sodium (23 mg) per tablet, i.e. essentially 'sodium-free'.

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

Co-administration of multiple doses of empagliflozin and metformin does not meaningfully alter the pharmacokinetics of either empagliflozin or metformin in healthy subjects.

No interaction studies have been performed for empagliflozin/metformin. The following statements reflect the information available on the individual active substances.

#### Empagliflozin

##### Pharmacodynamic interactions

##### *Diuretics*

Empagliflozin may add to the diuretic effect of thiazide and loop diuretics and may increase the risk of dehydration and hypotension (see section 4.4).

##### *Insulin and insulin secretagogues*

Insulin and insulin secretagogues, such as sulphonylureas, may increase the risk of hypoglycaemia. Therefore, a lower dose of insulin or an insulin secretagogue may be required to reduce the risk of hypoglycaemia when used in combination with empagliflozin (see sections 4.2 and 4.8).

##### Pharmacokinetic interactions

##### *Effects of other medicinal products on empagliflozin*

*In vitro* data suggest that the primary route of metabolism of empagliflozin in humans is glucuronidation by uridine 5'-diphosphoglucuronosyltransferases UGT1A3, UGT1A8, UGT1A9, and UGT2B7. Empagliflozin is a substrate of the human uptake transporters OAT3, OATP1B1, and

OATP1B3, but not OAT1 and OCT2. Empagliflozin is a substrate of P-glycoprotein (P-gp) and breast cancer resistance protein (BCRP).

Co-administration of empagliflozin with probenecid, an inhibitor of UGT enzymes and OAT3, resulted in a 26% increase in peak empagliflozin plasma concentrations ( $C_{\max}$ ) and a 53% increase in area under the concentration-time curve (AUC). These changes were not considered to be clinically meaningful.

The effect of UGT induction (e.g. induction by rifampicin or phenytoin) on empagliflozin has not been studied. Co-treatment with known inducers of UGT enzymes is not recommended due to a potential risk of decreased efficacy. If an inducer of these UGT enzymes must be co-administered, monitoring of glycaemic control to assess response to empagliflozin/metformin is appropriate.

An interaction study with gemfibrozil, an *in vitro* inhibitor of OAT3 and OATP1B1/1B3 transporters, showed that empagliflozin  $C_{\max}$  increased by 15% and AUC increased by 59% following co-administration. These changes were not considered to be clinically meaningful.

Inhibition of OATP1B1/1B3 transporters by co-administration with rifampicin resulted in a 75% increase in  $C_{\max}$  and a 35% increase in AUC of empagliflozin. These changes were not considered to be clinically meaningful.

Empagliflozin exposure was similar with and without co-administration with verapamil, a P-gp inhibitor, indicating that inhibition of P-gp does not have any clinically relevant effect on empagliflozin.

Interaction studies suggest that the pharmacokinetics of empagliflozin were not influenced by co-administration with metformin, glimepiride, pioglitazone, sitagliptin, linagliptin, warfarin, verapamil, ramipril, simvastatin, torasemide and hydrochlorothiazide.

#### *Effects of empagliflozin on other medicinal products*

Empagliflozin may increase renal lithium excretion and the blood lithium levels may be decreased. Serum concentration of lithium should be monitored more frequently after empagliflozin initiation and dose changes. Please refer the patient to the lithium prescribing doctor in order to monitor serum concentration of lithium.

Based on *in vitro* studies, empagliflozin does not inhibit, inactivate, or induce CYP450 isoforms. Empagliflozin does not inhibit UGT1A1, UGT1A3, UGT1A8, UGT1A9, or UGT2B7. Drug-drug interactions involving the major CYP450 and UGT isoforms with empagliflozin and concomitantly administered substrates of these enzymes are therefore considered unlikely.

Empagliflozin does not inhibit P-gp at therapeutic doses. Based on *in vitro* studies, empagliflozin is considered unlikely to cause interactions with active substances that are P-gp substrates. Co-administration of digoxin, a P-gp substrate, with empagliflozin resulted in a 6% increase in AUC and 14% increase in  $C_{\max}$  of digoxin. These changes were not considered to be clinically meaningful.

Empagliflozin does not inhibit human uptake transporters such as OAT3, OATP1B1, and OATP1B3 *in vitro* at clinically relevant plasma concentrations and, as such, drug-drug interactions with substrates of these uptake transporters are considered unlikely.

Interaction studies conducted in healthy volunteers suggest that empagliflozin had no clinically relevant effect on the pharmacokinetics of metformin, glimepiride, pioglitazone, sitagliptin, linagliptin, simvastatin, warfarin, ramipril, digoxin, diuretics and oral contraceptives.

## Metformin

### Concomitant use not recommended

#### *Alcohol*

Alcohol intoxication is associated with an increased risk of lactic acidosis, particularly in cases of fasting, malnutrition or hepatic impairment.

#### *Organic cation transporters (OCT)*

Metformin is a substrate of both transporters OCT1 and OCT2. Co-administration of metformin with:

- Inhibitors of OCT1 (such as verapamil) may reduce efficacy of metformin.
- Inducers of OCT1 (such as rifampicin) may increase gastrointestinal absorption and efficacy of metformin.
- Inhibitors of OCT2 (such as cimetidine, dolutegravir, ranolazine, trimethoprim, vandetanib, isavuconazole) may decrease the renal elimination of metformin and thus lead to an increase in metformin plasma concentration.
- Inhibitors of both OCT1 and OCT2 (such as crizotinib, olaparib) may alter efficacy and renal elimination of metformin.

Caution is therefore advised, especially in patients with renal impairment, when these drugs are co-administered with metformin, as metformin plasma concentration may increase. If needed, dose adjustment of metformin may be considered as OCT inhibitors/inducers may alter the efficacy of metformin (see sections 4.2 and 4.4).

#### *Iodinated contrast agents*

Metformin must be discontinued prior to or at the time of the imaging procedure and not restarted until at least 48 hours after, provided that renal function has been re-evaluated and found to be stable (see sections 4.2 and 4.4).

### Combination requiring precautions for use

Some medicinal products can adversely affect renal function which may increase the risk of lactic acidosis, e.g. NSAIDs, including selective cyclo-oxygenase (COX) II inhibitors, ACE inhibitors, angiotensin II receptor antagonists and diuretics, especially loop diuretics. When starting or using such products in combination with metformin, close monitoring of renal function is necessary.

Glucocorticoids (given by systemic and local routes), beta 2 agonists, and diuretics have intrinsic hyperglycaemic activity. The patient should be informed and more frequent blood glucose monitoring performed, especially at the beginning of treatment with such medicinal products. If necessary, the dose of the anti hyperglycaemic medicinal product should be adjusted during therapy with the other medicinal product and on its discontinuation.

#### *Insulin and insulin secretagogues*

Insulin and insulin secretagogues, such as sulphonylureas, may increase the risk of hypoglycaemia. Therefore, a lower dose of insulin or an insulin secretagogue may be required to reduce the risk of hypoglycaemia when used in combination with metformin (see sections 4.2 and 4.8).

### Paediatric population

Interaction studies have only been performed in adults.

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

### Pregnancy

There are no data from the use of this medicinal product or empagliflozin in pregnant women. Animal studies show that empagliflozin crosses the placenta during late gestation to a very limited extent but

do not indicate direct or indirect harmful effects with respect to early embryonic development. However, animal studies have shown adverse effects on postnatal development. A limited amount of data suggests that the use of metformin in pregnant women is not associated with an increased risk of congenital malformations. Animal studies with the combination of empagliflozin and metformin or with metformin alone have shown reproductive toxicity at higher doses of metformin only (see section 5.3).

When the patient plans to become pregnant, and during pregnancy, it is recommended that diabetes is not treated with this medicinal product, but insulin be used to maintain blood glucose levels as close to normal as possible, to reduce the risk of malformations of the foetus associated with abnormal blood glucose levels.

#### Breast-feeding

Metformin is excreted into human milk. No effects have been shown in breastfed newborns/infants of treated women. No data in humans are available on excretion of empagliflozin into milk. Available animal data have shown excretion of empagliflozin and metformin in milk. A risk to the newborns/infants cannot be excluded.

This medicinal product should not be used during breast feeding.

#### Fertility

No studies on the effect on human fertility have been conducted for this medicinal product or empagliflozin. Animal studies with empagliflozin and metformin do not indicate direct or indirect harmful effects with respect to fertility (see section 5.3).

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

Appref has minor influence on the ability to drive and use machines. Patients should be advised to take precautions to avoid hypoglycaemia while driving and using machines, in particular when Appref is used in combination with a sulphonylurea and/or insulin.

### **4.8 Undesirable effects**

#### Summary of the safety profile

The most commonly reported adverse reactions in clinical trials were hypoglycaemia in combination with insulin and/or sulphonylurea and gastrointestinal symptoms (nausea, vomiting, diarrhoea, abdominal pain and loss of appetite). No additional adverse reactions were identified in clinical trials with empagliflozin as add-on to metformin compared to the side effects of the single components.

#### Tabulated list of adverse reactions

The adverse reactions are listed by absolute frequency. Frequencies are defined as very common ( $\geq 1/10$ ), common ( $\geq 1/100$  to  $< 1/10$ ), uncommon ( $\geq 1/1\,000$  to  $< 1/100$ ), rare ( $\geq 1/10\,000$  to  $< 1/1\,000$ ), or very rare ( $< 1/10\,000$ ), and not known (cannot be estimated from the available data).

**Table 2:** Tabulated list of adverse reactions (MedDRA) from placebo-controlled studies and from post-marketing experience

System organ class	Very common	Common	Uncommon	Rare	Very rare
<i>Infections and infestations</i>		Vaginal moniliasis, vulvovaginitis, balanitis and other genital infection <sup>1, 2</sup> Urinary tract infection (including pyelonephritis and urosepsis) <sup>1, 2</sup>		Necrotising fasciitis of the perineum (Fournier's gangrene) <sup>a</sup>	
<i>Metabolism and nutrition disorders</i>	Hypoglycaemia (when used with sulphonylurea or insulin) <sup>1</sup>	Thirst <sup>2</sup> Vitamin B12 decrease/deficiency <sup>3, a</sup>		Diabetic ketoacidosis <sup>a</sup>	Lactic acidosis <sup>3</sup>
<i>Nervous system disorders</i>		Taste disturbance <sup>3</sup>			
<i>Vascular disorders</i>			Volume depletion <sup>1, 2, d</sup>		
<i>Gastrointestinal disorders</i>	Gastrointestinal symptoms <sup>3, 4</sup>	Constipation			
<i>Hepatobiliary disorders</i>					Liver function tests abnormalities <sup>3</sup> Hepatitis <sup>3</sup>
<i>Skin and subcutaneous tissue disorders</i>		Pruritus (generalised) <sup>2, 3</sup> Rash	Urticaria Angioedema		Erythema <sup>3</sup>
<i>Renal and urinary disorders</i>		Increased urination <sup>1, 2</sup>	Dysuria <sup>2</sup>		Tubulointerstitial nephritis
<i>Investigations</i>		Serum lipids increased <sup>2, b</sup>	Blood creatinine increased/ Glomerular filtration rate decreased <sup>1</sup> Haematocrit increased <sup>2, c</sup>		

<sup>1</sup> See subsections below for additional information

<sup>2</sup> Identified adverse reactions of empagliflozin monotherapy

<sup>3</sup> Identified adverse reactions of metformin monotherapy

<sup>4</sup> Gastrointestinal symptoms such as nausea, vomiting, diarrhoea, abdominal pain and loss of appetite occur most frequently during initiation of therapy and resolve spontaneously in most cases.

<sup>a</sup> See section 4.4

<sup>b</sup> Mean percent increases from baseline for empagliflozin 10 mg and 25 mg versus placebo, respectively, were total cholesterol 5.0% and 5.2% versus 3.7%; HDL-cholesterol 4.6% and 2.7% versus -0.5%; LDL-cholesterol 9.1% and 8.7% versus 7.8%; triglycerides 5.4% and 10.8% versus 12.1%.

<sup>c</sup> Mean changes from baseline in haematocrit were 3.6% and 4.0% for empagliflozin 10 mg and 25 mg, respectively, compared to 0% for placebo. In the EMPA-REG Outcome study, haematocrit values returned towards baseline values after a follow-up period of 30 days after treatment stop.

<sup>d</sup> Pooled data of empagliflozin trials in patients with heart failure (where half of the patients had type 2 diabetes mellitus) showed a higher frequency of volume depletion ("very common": 11.4% for empagliflozin versus 9.7% for placebo).

## Description of selected adverse reactions

### Hypoglycaemia

The frequency of hypoglycaemia depended on the background therapy in the respective studies and was similar for empagliflozin and placebo as add-on to metformin, as add-on to linagliptin and metformin, for the combination of empagliflozin with metformin in drug-naïve patients compared to those treated with empagliflozin and metformin as individual components, and as adjunct to standard care therapy. An increased frequency was noted when empagliflozin given as add-on to metformin and a sulfonylurea (empagliflozin 10 mg: 16.1%, empagliflozin 25 mg: 11.5% and placebo: 8.4%), or as add-on to metformin and insulin (empagliflozin 10 mg: 31.3%, empagliflozin 25 mg: 36.2% and placebo: 34.7%).

#### *Major hypoglycaemia (events requiring assistance)*

The overall frequency of patients with major hypoglycaemic events was low (<1%) and similar for empagliflozin and placebo as add-on to metformin, and for the combination of empagliflozin with metformin in drug-naïve patients compared to those treated with empagliflozin and metformin as individual components, and as adjunct to standard care therapy. Major hypoglycaemic events occurred in 0.5%, 0% and 0.5% of patients treated with empagliflozin 10 mg, empagliflozin 25 mg and placebo when added on to metformin and insulin, respectively. No patient had a major hypoglycaemic event in the combination with metformin and a sulphonylurea and as add-on to linagliptin and metformin.

### Urinary tract infection

The overall frequency of urinary tract infection adverse events was higher in metformin-treated patients who received empagliflozin 10 mg (8.8%) compared to empagliflozin 25 mg (6.6%) or placebo (7.8%). Similar to placebo, urinary tract infection was reported more frequently for empagliflozin in patients with a history of chronic or recurrent urinary tract infections. The intensity of urinary tract infections (i.e. mild/moderate/severe) was similar to placebo. Urinary tract infection events were reported more frequently for empagliflozin 10 mg compared with placebo in female patients, but not for empagliflozin 25 mg. The frequencies of urinary tract infections were low for male patients and were balanced across treatment groups.

### Vaginal moniliasis, vulvovaginitis, balanitis and other genital infection

Vaginal moniliasis, vulvovaginitis, balanitis and other genital infections were reported more frequently in metformin-treated patients who received empagliflozin 10 mg (4.0%) and empagliflozin 25 mg (3.9%) compared to placebo (1.3%), and were reported more frequently for empagliflozin compared to placebo in female patients. The difference in frequency was less pronounced in male patients. Genital tract infections were mild and moderate in intensity, none was severe in intensity.

Cases of phimosis/acquired phimosis have been reported concurrent with genital infections and in some cases, circumcision was required.

### Increased urination

As expected from the mechanism of action, increased urination (as assessed by PT search including pollakiuria, polyuria, nocturia) was observed at higher frequencies in metformin-treated patients who received empagliflozin 10 mg (3.0%) and empagliflozin 25 mg (2.9%) compared to placebo (1.4%) as add-on to metformin therapy. Increased urination was mostly mild or moderate in intensity. The frequency of reported nocturia was comparable between placebo and empagliflozin (<1%).

### Volume depletion

The overall frequency of volume depletion (including the predefined terms blood pressure (ambulatory) decreased, blood pressure systolic decreased, dehydration, hypotension, hypovolaemia,

orthostatic hypotension, and syncope) in metformin-treated patients who received empagliflozin was low: 0.6% for empagliflozin 10 mg, 0.3% for empagliflozin 25 mg and 0.1% for placebo. The effect of empagliflozin on urinary glucose excretion is associated with osmotic diuresis, which could affect hydration status of patients age 75 years and older. In patients  $\geq 75$  years of age volume depletion events have been reported in a single patient treated with empagliflozin 25 mg as add-on to metformin therapy.

#### Blood creatinine increased/Glomerular filtration rate decreased

The overall frequency of patients with increased blood creatinine and decreased glomerular filtration rate were similar between empagliflozin and placebo as add-on to metformin (blood creatinine increased: empagliflozin 10 mg 0.5%, empagliflozin 25 mg 0.1%, placebo 0.4%; glomerular filtration rate decreased: empagliflozin 10 mg 0.1%, empagliflozin 25 mg 0%, placebo 0.2%).

Initial increases in creatinine and initial decreases in estimated glomerular filtration rates in patients treated with empagliflozin as add-on to metformin therapy were generally transient during continuous treatment or reversible after drug discontinuation of treatment.

Consistently, in the EMPA-REG OUTCOME study, patients treated with empagliflozin experienced an initial fall in eGFR (mean: 3 ml/min/1.73 m<sup>2</sup>). Thereafter, eGFR was maintained during continued treatment. Mean eGFR returned to baseline after treatment discontinuation suggesting acute haemodynamic changes may play a role in these renal function changes.

#### Paediatric population

In the DINAMO trial 157 children aged 10 years and above with type 2 diabetes were treated, in which 52 patients received empagliflozin, 52 linagliptin and 53 placebo (see section 5.1). During the placebo-controlled phase, the most frequent adverse drug reaction was hypoglycaemia (empagliflozin 10 mg and 25 mg, pooled: 23.1%, placebo: 9.4%). None of these events was severe or required assistance.

Overall, the safety profile in children was similar to the safety profile in adults with type 2 diabetes mellitus.

#### 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**

### Symptoms

#### Empagliflozin

In controlled clinical studies single doses of up to 800 mg empagliflozin (equivalent to 32-times the highest recommended daily dose) in healthy volunteers and multiple daily doses of up to 100 mg empagliflozin (equivalent to 4-times the highest recommended daily dose) in patients with type 2 diabetes did not show any toxicity. Empagliflozin increased urine glucose excretion leading to an increase in urine volume. The observed increase in urine volume was not dose-dependent and is not clinically meaningful. There is no experience with doses above 800 mg in humans.

#### Metformin

Hypoglycaemia has not been seen with metformin doses of up to 85 g, although lactic acidosis has occurred in such circumstances. High overdose of metformin or concomitant risks may lead to lactic acidosis. Lactic acidosis is a medical emergency and must be treated in hospital (see sections 4.4 and 4.5).

## Therapy

In the event of an overdose, treatment should be initiated as appropriate to the patient's clinical status. The most effective method to remove lactate and metformin is haemodialysis. The removal of empagliflozin by haemodialysis has not been studied.

## **5. PHARMACOLOGICAL PROPERTIES**

### **5.1 Pharmacodynamic properties**

Pharmacotherapeutic group: Drugs used in diabetes, combinations of oral blood glucose lowering drugs, ATC code: A10BD20

#### Mechanism of action

This medicinal product combines two antihyperglycaemic medicinal products with complementary mechanisms of action to improve glycaemic control in patients with type 2 diabetes: empagliflozin, an inhibitor of sodium-glucose co-transporter 2 (SGLT2), and metformin hydrochloride, a member of the biguanide class.

#### Empagliflozin

Empagliflozin is a reversible, highly potent ( $IC_{50}$  of 1.3 nmol) and selective competitive inhibitor of SGLT2. Empagliflozin does not inhibit other glucose transporters important for glucose transport into peripheral tissues and is 5 000-times more selective for SGLT2 versus SGLT1, the major transporter responsible for glucose absorption in the gut. SGLT2 is highly expressed in the kidney, whereas expression in other tissues is absent or very low. It is responsible, as the predominant transporter, for the reabsorption of glucose from the glomerular filtrate back into the circulation. In patients with type 2 diabetes and hyperglycaemia a higher amount of glucose is filtered and reabsorbed.

Empagliflozin improves glycaemic control in patients with type 2 diabetes by reducing renal glucose reabsorption. The amount of glucose removed by the kidney through this glucuretic mechanism is dependent on blood glucose concentration and GFR. Inhibition of SGLT2 in patients with type 2 diabetes and hyperglycaemia leads to excess glucose excretion in the urine. In addition, initiation of empagliflozin increases excretion of sodium resulting in osmotic diuresis and reduced intravascular volume.

In patients with type 2 diabetes, urinary glucose excretion increased immediately following the first dose of empagliflozin and is continuous over the 24 hour dosing interval. Increased urinary glucose excretion was maintained at the end of the 4-week treatment period, averaging approximately 78 g/day with empagliflozin 25 mg. Increased urinary glucose excretion resulted in an immediate reduction in plasma glucose levels in patients with type 2 diabetes.

Empagliflozin improves both fasting and post-prandial plasma glucose levels. The mechanism of action of empagliflozin is independent of beta cell function and insulin pathway and this contributes to a low risk of hypoglycaemia. Improvement of surrogate markers of beta cell function including Homeostasis Model Assessment- $\beta$  (HOMA- $\beta$ ) was noted. In addition, urinary glucose excretion triggers calorie loss, associated with body fat loss and body weight reduction. The glucosuria observed with empagliflozin is accompanied by mild diuresis which may contribute to sustained and moderate reduction of blood pressure. The glucosuria, natriuresis and osmotic diuresis observed with empagliflozin may contribute to the improvement in cardiovascular outcomes.



## Metformin

Metformin is a biguanide with antihyperglycaemic effects, lowering both basal and postprandial plasma glucose. It does not stimulate insulin secretion and therefore does not produce hypoglycaemia.

Metformin may act via 3 mechanisms:

- reduction of hepatic glucose production by inhibiting gluconeogenesis and glycogenolysis,
- in muscle, by increasing insulin sensitivity, improving peripheral glucose uptake and utilization,
- and delay of intestinal glucose absorption.

Metformin stimulates intracellular glycogen synthesis by acting on glycogen synthase. Metformin increases the transport capacity of all types of membrane glucose transporters (GLUTs) known to date.

In humans, independently of its action on glycaemia, metformin has favourable effects on lipid metabolism. This has been shown at therapeutic doses in controlled, medium-term or long-term clinical studies: metformin reduces total cholesterol, LDL cholesterol and triglyceride levels.

## Clinical efficacy and safety

Both improvement of glycaemic control and reduction of cardiovascular morbidity and mortality are an integral part of the treatment of type 2 diabetes.

Glycaemic efficacy and cardiovascular outcomes have been assessed in a total of 10 366 patients with type 2 diabetes who were treated in 9 double-blind, placebo or active-controlled clinical studies of at least 24 weeks duration, of which 2 950 patients received empagliflozin 10 mg and 3 701 received empagliflozin 25 mg as add-on to metformin therapy. Of these, 266 or 264 patients were treated with empagliflozin 10 mg or 25 mg as add-on to metformin plus insulin, respectively.

Treatment with empagliflozin in combination with metformin with or without other antidiabetic medicinal products (pioglitazone, sulphonylurea, DPP-4 inhibitors, and insulin) led to clinically relevant improvements in HbA1c, fasting plasma glucose (FPG), body weight, systolic and diastolic blood pressure. Administration of empagliflozin 25 mg resulted in a higher proportion of patients achieving HbA1c goal of less than 7% and fewer patients needing glycaemic rescue compared to empagliflozin 10 mg and placebo. In patients aged 75 years and older, numerically lower reductions in HbA1c were observed with empagliflozin treatment. Higher baseline HbA1c was associated with a greater reduction in HbA1c. In addition, empagliflozin as adjunct to standard care therapy reduced cardiovascular mortality in patients with type 2 diabetes and established cardiovascular disease.

## Empagliflozin as add-on to metformin, sulphonylurea, pioglitazone

Empagliflozin as add-on to metformin, metformin and a sulphonylurea, or pioglitazone and metformin resulted in statistically significant ( $p < 0.0001$ ) reductions in HbA1c and body weight compared to placebo (Table 3). In addition it resulted in a clinically meaningful reduction in FPG, systolic and diastolic blood pressure compared to placebo.

In the double-blind placebo-controlled extension of these studies, reduction of HbA1c, body weight and blood pressure were sustained up to Week 76.

**Table 3:** Efficacy results of 24-week placebo-controlled studies

Add-on to metformin therapy <sup>a</sup>			
	Placebo	Empagliflozin	
		10 mg	25 mg
N	207	217	213
<b>HbA1c (%)</b>			
Baseline (mean)	7.90	7.94	7.86
Change from baseline <sup>1</sup>	-0.13	-0.70	-0.77

Difference from placebo <sup>1</sup> (97.5% CI)		-0.57* (-0.72, -0.42)	-0.64* (-0.79, -0.48)
N	184	199	191
<b>Patients (%) achieving HbA1c &lt;7% with baseline HbA1c ≥7%<sup>2</sup></b>	12.5	37.7	38.7
N	207	217	213
<b>Body Weight (kg)</b>			
Baseline (mean)	79.73	81.59	82.21
Change from baseline <sup>1</sup>	-0.45	-2.08	-2.46
Difference from placebo <sup>1</sup> (97.5% CI)		-1.63* (-2.17, -1.08)	-2.01* (-2.56, -1.46)
N	207	217	213
<b>SBP (mmHg)<sup>2</sup></b>			
Baseline (mean)	128.6	129.6	130.0
Change from baseline <sup>1</sup>	-0.4	-4.5	-5.2
Difference from placebo <sup>1</sup> (95% CI)		-4.1* (-6.2, -2.1)	-4.8* (-6.9, -2.7)
<b>Add-on to metformin and a sulphonylurea therapy<sup>a</sup></b>			
	<b>Placebo</b>	<b>Empagliflozin</b>	
		<b>10 mg</b>	<b>25 mg</b>
N	225	225	216
<b>HbA1c (%)</b>			
Baseline (mean)	8.15	8.07	8.10
Change from baseline <sup>1</sup>	-0.17	-0.82	-0.77
Difference from placebo <sup>1</sup> (97.5% CI)		-0.64* (-0.79, -0.49)	-0.59* (-0.74, -0.44)
N	216	209	202
<b>Patients (%) achieving HbA1c &lt;7% with baseline HbA1c ≥7%<sup>2</sup></b>	9.3	26.3	32.2
N	225	225	216
<b>Body Weight (kg)</b>			
Baseline (mean)	76.23	77.08	77.50
Change from baseline <sup>1</sup>	-0.39	-2.16	-2.39
Difference from placebo <sup>1</sup> (97.5% CI)		-1.76* (-2.25, -1.28)	-1.99* (-2.48, -1.50)
N	225	225	216
<b>SBP (mmHg)<sup>2</sup></b>			
Baseline (mean)	128.8	128.7	129.3
Change from baseline <sup>1</sup>	-1.4	-4.1	-3.5
Difference from placebo <sup>1</sup> (95% CI)		-2.7 (-4.6, -0.8)	-2.1 (-4.0, -0.2)

Add-on to pioglitazone + metformin therapy <sup>b</sup>			
	Placebo	Empagliflozin	
		10 mg	25 mg
N	124	125	127
<b>HbA1c (%)</b>			
Baseline (mean)	8.15	8.07	8.10
Change from baseline <sup>1</sup>	-0.11	-0.55	-0.70
Difference from placebo <sup>1</sup> (97.5% CI)		-0.45* (-0.69, -0.21)	-0.60* (-0.83, -0.36)
N	118	116	123
<b>Patients (%) achieving HbA1c &lt;7% with baseline HbA1c ≥7%<sup>2</sup></b>	8.5	22.4	28.5
N	124	125	127
<b>Body Weight (kg)</b>			
Baseline (mean)	79.45	79.44	80.98
Change from baseline <sup>1</sup>	0.40	-1.74	-1.59
Difference from placebo <sup>1</sup> (97.5% CI)		-2.14* (-2.93, -1.35)	-2.00* (-2.78, -1.21)
N	124	125	127
<b>SBP (mmHg)<sup>2, 3</sup></b>			
Baseline (mean)	125.5	126.3	126.3
Change from baseline <sup>1</sup>	0.8	-3.5	-3.3
Difference from placebo <sup>1</sup> (95% CI)		-4.2** (-6.94, -1.53)	-4.1** (-6.76, -1.37)

<sup>a</sup> Full analysis set (FAS) using last observation carried forward (LOCF) prior to glycaemic rescue therapy

<sup>b</sup> Subgroup analysis for patients on additional background of metformin (FAS, LOCF)

<sup>1</sup> Mean adjusted for baseline value

<sup>2</sup> Not evaluated for statistical significance as a part of the sequential confirmatory testing procedure

<sup>3</sup> LOCF, values after antihypertensive rescue censored

\* p-value <0.0001

\*\* p-value <0.01

#### Empagliflozin in combination with metformin in drug-naïve patients

A factorial design study of 24 weeks duration was conducted to evaluate the efficacy and safety of empagliflozin in drug-naïve patients. Treatment with empagliflozin in combination with metformin (5 mg and 500 mg; 5 mg and 1 000 mg; 12.5 mg and 500 mg, and 12.5 mg and 1 000 mg given twice daily) provided statistically significant improvements in HbA1c (Table 4) and led to greater reductions in FPG (compared to the individual components) and body weight (compared to metformin).

**Table 4:** Efficacy results at 24 week comparing empagliflozin in combination with metformin to the individual components<sup>a</sup>

	Empagliflozin 10 mg <sup>b</sup>			Empagliflozin 25 mg <sup>b</sup>			Metformin <sup>c</sup>	
	+ Met 1 000 mg <sup>c</sup>	+ Met 2 000 mg <sup>c</sup>	No Met	+ Met 1 000 mg <sup>c</sup>	+ Met 2 000 mg <sup>c</sup>	No Met	1 000 mg	2 000 mg
N	161	167	169	165	169	163	167	162
<b>HbA1c (%)</b>								
Baseline (mean)	8.68	8.65	8.62	8.84	8.66	8.86	8.69	8.55
Change from baseline <sup>1</sup>	-1.98	-2.07	-1.35	-1.93	-2.08	-1.36	-1.18	-1.75
Comparison vs. empa (95% CI) <sup>1</sup>	-0.63* (-0.86, -0.40)	-0.72* (-0.96, -0.49)		-0.57* (-0.81, -0.34)	-0.72* (-0.95, -0.48)			
Comparison vs. met (95% CI) <sup>1</sup>	-0.79* (-1.03, -0.56)	-0.33* (-0.56, -0.09)		-0.75* (-0.98 - 0.51)	-0.33* (-0.56, -0.10)			

Met=metformin; empa= empagliflozin

<sup>1</sup> mean adjusted for baseline value

<sup>a</sup> Analyses were performed on the full analysis set (FAS) using an observed cases (OC) approach

<sup>b</sup> Given in two equally divided doses per day when given together with metformin

<sup>c</sup> Given in two equally divided doses per day

\* p≤0.0062 for HbA1c

#### Empagliflozin in patients inadequately controlled with metformin and linagliptin

In patients inadequately controlled with metformin and linagliptin 5 mg, treatment with both empagliflozin 10 mg or 25 mg resulted in statistically significant (p<0.0001) reductions in HbA1c and body weight compared to placebo (Table 5). In addition it resulted in clinically meaningful reductions in FPG, systolic and diastolic blood pressure compared to placebo.

**Table 5:** Efficacy results of a 24-week placebo-controlled study in patients inadequately controlled with metformin and linagliptin 5 mg

Add-on to metformin and linagliptin 5 mg			
	Placebo <sup>5</sup>	Empagliflozin <sup>6</sup>	
		10 mg	25 mg
N	106	109	110
<b>HbA1c (%)<sup>3</sup></b>			
Baseline (mean)	7.96	7.97	7.97
Change from baseline <sup>1</sup>	0.14	-0.65	-0.56
Difference from placebo (95% CI)		-0.79* (-1.02, -0.55)	-0.70* (-0.93, -0.46)
N	100	100	107
<b>Patients (%) achieving HbA1c &lt;7% with baseline HbA1c ≥7%<sup>2</sup></b>	17.0	37.0	32.7
N	106	109	110
<b>Body Weight (kg)<sup>3</sup></b>			
Baseline (mean)	82.3	88.4	84.4
Change from baseline <sup>1</sup>	-0.3	-3.1	-2.5
Difference from placebo (95% CI)		-2.8* (-3.5, -2.1)	-2.2* (-2.9, -1.5)
N	106	109	110
<b>SBP (mmHg)<sup>4</sup></b>			
Baseline (mean)	130.1	130.4	131.0
Change from baseline <sup>1</sup>	-1.7	-3.0	-4.3
Difference from placebo (95% CI)		-1.3 (-4.2, 1.7)	-2.6 (-5.5, 0.4)

<sup>1</sup> Mean adjusted for baseline value

<sup>2</sup> Not evaluated for statistical significance; not part of sequential testing procedure for the secondary endpoints

<sup>3</sup> MMRM model on FAS (OC) included baseline HbA1c, baseline eGFR (MDRD), geographical region, visit, treatment, and treatment by visit interaction. For weight, baseline weight was included.

<sup>4</sup> MMRM model included baseline SBP and baseline HbA1c as linear covariate(s), and baseline eGFR, geographical region, treatment, visit, and visit by treatment interaction as fixed effects.

<sup>5</sup> Patients randomized to the placebo group were receiving the placebo plus linagliptin 5 mg with background metformin

<sup>6</sup> Patients randomized to the empagliflozin 10 mg or 25 mg groups were receiving empagliflozin 10 mg or 25 mg and linagliptin 5 mg with background metformin

\* p-value <0.0001

In a prespecified subgroup of patients with baseline HbA1c greater or equal than 8.5% the reduction from baseline in HbA1c was -1.3% with empagliflozin 10 mg or 25 mg at 24 weeks (p<0.0001) compared to placebo.

#### Empagliflozin 24 months data, as add-on to metformin in comparison to glimepiride

In a study comparing the efficacy and safety of empagliflozin 25 mg versus glimepiride (up to 4 mg per day) in patients with inadequate glycaemic control on metformin alone, treatment with empagliflozin daily resulted in superior reduction in HbA1c (Table 6), and a clinically meaningful reduction in FPG, compared to glimepiride. Empagliflozin daily resulted in a statistically significant reduction in body weight, systolic and diastolic blood pressure and a statistically significantly lower

proportion of patients with hypoglycaemic events compared to glimepiride (2.5% for empagliflozin, 24.2% for glimepiride,  $p < 0.0001$ ).

**Table 6:** Efficacy results at 104 week in an active controlled study comparing empagliflozin to glimepiride as add on to metformin<sup>a</sup>

	<b>Empagliflozin 25 mg</b>	<b>Glimepiride<sup>b</sup></b>
N	765	780
<b>HbA1c (%)</b>		
Baseline (mean)	7.92	7.92
Change from baseline <sup>1</sup>	-0.66	-0.55
Difference from glimepiride <sup>1</sup> (97.5% CI)	-0.11* (-0.20, -0.01)	
N	690	715
<b>Patients (%) achieving HbA1c &lt;7% with baseline HbA1c ≥7%<sup>2</sup></b>	33.6	30.9
N	765	780
<b>Body Weight (kg)</b>		
Baseline (mean)	82.52	83.03
Change from baseline <sup>1</sup>	-3.12	1.34
Difference from glimepiride <sup>1</sup> (97.5% CI)	-4.46** (-4.87, -4.05)	
N	765	780
<b>SBP (mmHg)<sup>3</sup></b>		
Baseline (mean)	133.4	133.5
Change from baseline <sup>1</sup>	-3.1	2.5
Difference from glimepiride <sup>1</sup> (97.5% CI)	-5.6** (-7.0, -4.2)	

<sup>a</sup> Full analysis set (FAS) using last observation carried forward (LOCF) prior to glycaemic rescue therapy

<sup>b</sup> Up to 4 mg glimepiride

<sup>1</sup> Mean adjusted for baseline value

<sup>2</sup> Not evaluated for statistical significance as a part of the sequential confirmatory testing procedure

<sup>3</sup> LOCF, values after antihypertensive rescue censored

\* p-value <0.0001 for non-inferiority, and p-value = 0.0153 for superiority

\*\* p-value <0.0001

### Add-on to insulin therapy

#### *Empagliflozin as add-on to multiple daily insulin*

The efficacy and safety of empagliflozin as add-on to multiple daily insulin with concomitant metformin therapy was evaluated in a double-blind, placebo-controlled trial of 52 weeks duration.

During the initial 18 weeks and the last 12 weeks, the insulin dose was kept stable, but was adjusted to achieve pre-prandial glucose levels <100 mg/dl [5.5 mmol/l], and post-prandial glucose levels <140 mg/dl [7.8 mmol/l] between Weeks 19 and 40.

At Week 18, empagliflozin provided statistically significant improvement in HbA1c compared with placebo (Table 7).

At Week 52, treatment with empagliflozin resulted in a statistically significant decrease in HbA1c and insulin sparing compared with placebo and a reduction in body weight.

**Table 7:** Efficacy results at 18 and 52 weeks in a placebo-controlled study of empagliflozin as add-on to multiple daily doses of insulin with concomitant metformin therapy

	Placebo	Empagliflozin	
		10 mg	25 mg
N	135	128	137
<b>HbA1c (%) at week 18<sup>a</sup></b>			
Baseline (mean)	8.29	8.42	8.29
Change from baseline <sup>1</sup>	-0.58	-0.99	-1.03
Difference from placebo <sup>1</sup> (97.5% CI)		-0.41* (-0.61, -0.21)	-0.45* (-0.65, -0.25)
N	86	84	87
<b>HbA1c (%) at week 52<sup>b</sup></b>			
Baseline (mean)	8.26	8.43	8.38
Change from baseline <sup>1</sup>	-0.86	-1.23	-1.31
Difference from placebo <sup>1</sup> (97.5% CI)		-0.37** (-0.67, -0.08)	-0.45* (-0.74, -0.16)
N	84	84	87
<b>Patients (%) achieving HbA1c &lt;7% with baseline HbA1c ≥7% at week 52<sup>b, 2</sup></b>	27.4	41.7	48.3
N	86	83	86
<b>Insulin dose (IU/day) at week 52<sup>b, 3</sup></b>			
Baseline (mean)	91.01	91.77	90.22
Change from baseline <sup>1</sup>	12.84	0.22	-2.25
Difference from placebo <sup>1</sup> (97.5% CI)		-12.61** (-21.43, -3.80)	-15.09** (-23.79, -6.40)
N	86	84	87
<b>Body Weight (kg) at week 52<sup>b</sup></b>			
Baseline (mean)	97.78	98.86	94.93
Change from baseline <sup>1</sup>	0.42	-2.47	-1.94
Difference from placebo <sup>1</sup> (97.5% CI)		-2.89* (-4.29, -1.49)	-2.37* (-3.75, -0.98)

<sup>a</sup> Subgroup analysis for patients on additional background of metformin (FAS, LOCF)

<sup>b</sup> Subgroup analysis for patients on additional background of metformin (PPS-Completers, LOCF)

<sup>1</sup> Mean adjusted for baseline value

<sup>2</sup> not evaluated for statistical significance as a part of the sequential confirmatory testing procedure

<sup>3</sup> Week 19-40: treat-to-target regimen for insulin dose adjustment to achieve pre-defined glucose target levels (pre-prandial <100 mg/dl (5.5 mmol/l), post-prandial <140 mg/dl (7.8 mmol/l))

\* p-value ≤0.0005

\*\* p-value <0.005

#### *Empagliflozin as add on to basal insulin*

The efficacy and safety of empagliflozin as add on to basal insulin with concomitant metformin therapy was evaluated in a double-blind, placebo-controlled trial of 78 weeks duration. During the initial 18 weeks the insulin dose was kept stable, but was adjusted to achieve a FPG <110 mg/dl in the following 60 weeks.

At week 18, empagliflozin provided statistically significant improvement in HbA1c. A greater proportion of patients treated with empagliflozin and with a baseline HbA1c  $\geq 7.0\%$  achieved a target HbA1c of  $<7\%$  compared to placebo (Table 8).

At 78 weeks, the decrease in HbA1c and insulin sparing effect of empagliflozin was maintained. Furthermore, empagliflozin resulted in a reduction in FPG, body weight and blood pressure.

**Table 8:** Efficacy results at 18 and 78 weeks in a placebo-controlled study of empagliflozin as add on to basal insulin with metformin<sup>a</sup>

	Placebo	Empagliflozin 10 mg	Empagliflozin 25 mg
N	96	107	99
<b>HbA1c (%) at week 18</b>			
Baseline (mean)	8.02	8.21	8.35
Change from baseline <sup>1</sup>	-0.09	-0.62	-0.72
Difference from placebo <sup>1</sup> (97.5% CI)		-0.54* (-0.77, -0.30)	-0.63* (-0.88, -0.39)
N	89	105	94
<b>HbA1c (%) at week 78</b>			
Baseline (mean)	8.03	8.24	8.29
Change from baseline <sup>1</sup>	-0.08	-0.42	-0.71
Difference from placebo <sup>1</sup> (97.5% CI)		-0.34** (-0.64, -0.05)	-0.63* (-0.93, -0.33)
N	89	105	94
<b>Basal insulin dose (IU/day) at week 78</b>			
Baseline (mean)	49.61	47.25	49.37
Change from baseline <sup>1</sup>	4.14	-2.07	-0.28
Difference from placebo <sup>1</sup> (97.5% CI)		-6.21** (-11.81, -0.61)	-4.42 (-10.18, 1.34)

<sup>a</sup> Subgroup analysis of full analysis set (FAS) for patients on additional background of metformin - Completers using last observation carried forward (LOCF) prior to glycaemic rescue therapy

<sup>1</sup> mean adjusted for baseline value

\* p-value  $<0.0001$

\*\* p-value  $\leq 0.025$

#### Empagliflozin and linagliptin as add-on therapy to metformin

In a double-blind trial in patients with inadequate glycemic control, 24-weeks treatment with both doses of empagliflozin plus linagliptin as add-on to metformin therapy provided statistically significant ( $p<0.0001$ ) reductions in HbA1c (change from baseline of -1.08% for empagliflozin 10 mg plus linagliptin 5 mg, -1.19% for empagliflozin 25 mg plus linagliptin 5 mg, -0.70% for linagliptin 5 mg). Compared to linagliptin 5 mg, both doses of empagliflozin plus linagliptin 5 mg provided statistically significant reductions in FPG and blood pressure. Both doses provided similar statistically significant reductions in body weight, expressed as kg and percentage change. A greater proportion of patients with a baseline HbA1c  $\geq 7.0\%$  and treated with empagliflozin plus linagliptin achieved a target HbA1c of  $<7\%$  compared to linagliptin 5 mg. Clinically meaningful reductions in HbA1c were maintained for 52 weeks.



### Empagliflozin twice daily versus once daily as add on to metformin therapy

The efficacy and safety of empagliflozin twice daily versus once daily (daily dose of 10 mg and 25 mg) as add-on therapy in patients with insufficient glycemic control on metformin monotherapy was evaluated in a double-blind placebo-controlled study of 16 weeks duration. All treatments with empagliflozin resulted in significant reductions in HbA1c from baseline (total mean 7.8%) after 16 weeks of treatment compared with placebo. Empagliflozin twice daily dose regimens on a background of metformin led to comparable reductions in HbA1c versus once daily dose regimens with a treatment difference in HbA1c reductions from baseline to week 16 of -0.02% (95% CI -0.16, 0.13) for empagliflozin 5 mg twice daily versus 10 mg once daily, and -0.11% (95% CI -0.26, 0.03) for empagliflozin 12.5 mg twice daily versus 25 mg once daily.

### Cardiovascular outcome

The double-blind, placebo-controlled EMPA-REG OUTCOME study compared pooled doses of empagliflozin 10 mg and 25 mg with placebo as adjunct to standard care therapy in patients with type 2 diabetes and established cardiovascular disease. A total of 7 020 patients were treated (empagliflozin 10 mg: 2 345, empagliflozin 25 mg: 2 342, placebo: 2 333) and followed for a median of 3.1 years. The mean age was 63 years, the mean HbA1c was 8.1%, and 71.5% were male. At baseline, 74% of patients were being treated with metformin, 48% with insulin, and 43% with a sulfonylurea. About half of the patients (52.2%) had an eGFR of 60-90 ml/min/1.73 m<sup>2</sup>, 17.8% of 45-60 ml/min/1.73 m<sup>2</sup> and 7.7% of 30-45 ml/min/1.73 m<sup>2</sup>.

At week 12, an adjusted mean (SE) improvement in HbA1c when compared to baseline of 0.11% (0.02) in the placebo group, 0.65% (0.02) and 0.71% (0.02) in the empagliflozin 10 and 25 mg groups was observed. After the first 12 weeks glycaemic control was optimized independent of investigative treatment. Therefore the effect was attenuated at week 94, with an adjusted mean (SE) improvement in HbA1c of 0.08% (0.02) in the placebo group, 0.50% (0.02) and 0.55% (0.02) in the empagliflozin 10 and 25 mg groups.

Empagliflozin was superior in preventing the primary combined endpoint of cardiovascular death, non-fatal myocardial infarction, or non-fatal stroke, as compared with placebo. The treatment effect was driven by a significant reduction in cardiovascular death with no significant change in non-fatal myocardial infarction, or non-fatal stroke. The reduction of cardiovascular death was comparable for empagliflozin 10 mg and 25 mg (see Figure 1) and confirmed by an improved overall survival (Table 9). The effect of empagliflozin on the primary combined endpoint of CV death, non-fatal MI, or non-fatal stroke was largely independent of glycaemic control or renal function (eGFR) and generally consistent across eGFR categories down to an eGFR of 30 ml/min/1.73 m<sup>2</sup> in the EMPA-REG OUTCOME study.

The efficacy for preventing cardiovascular mortality has not been conclusively established in patients using empagliflozin concomitantly with DPP-4 inhibitors or in Black patients because the representation of these groups in the EMPA-REG OUTCOME study was limited.

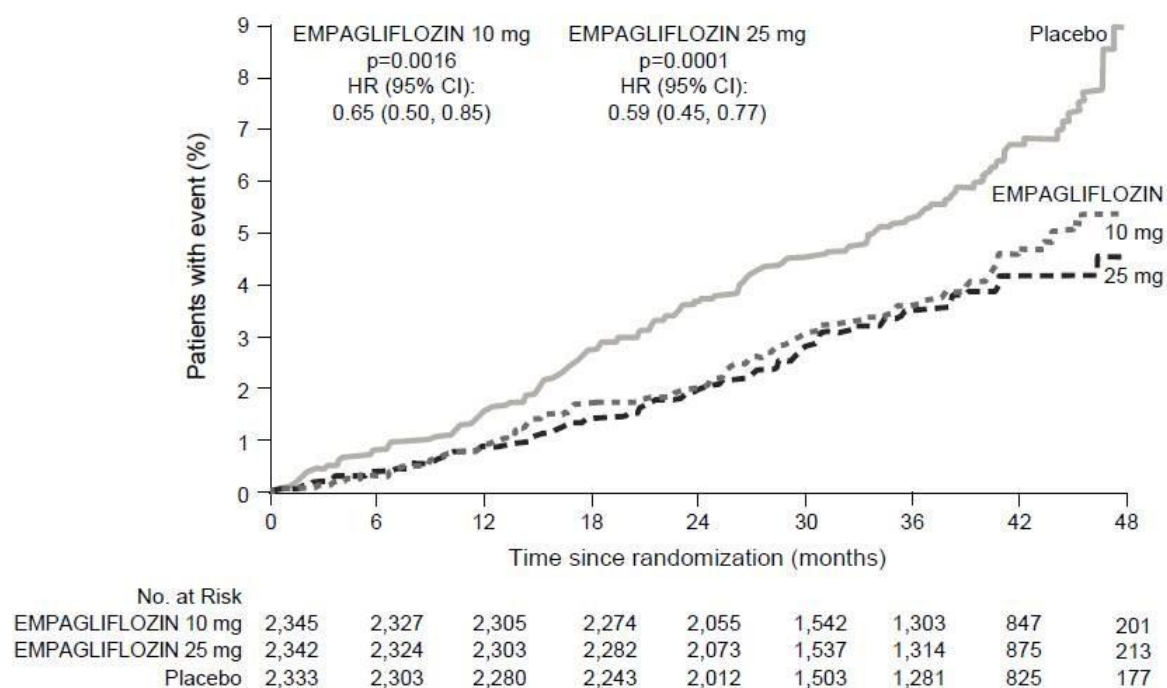
**Table 9:** Treatment effect for the primary composite endpoint, its components and mortality<sup>a</sup>

	Placebo	Empagliflozin <sup>b</sup>
N	2 333	4 687
<b>Time to first event of CV death, non-fatal MI, or non-fatal stroke N (%)</b>	282 (12.1)	490 (10.5)
Hazard ratio vs. placebo (95.02% CI)*		0.86 (0.74, 0.99)
p-value for superiority		0.0382
<b>CV Death N (%)</b>	137 (5.9)	172 (3.7)
Hazard ratio vs. placebo (95% CI)		0.62 (0.49, 0.77)
p-value		<0.0001
<b>Non-fatal MI N (%)</b>	121 (5.2)	213 (4.5)
Hazard ratio vs. placebo (95% CI)		0.87 (0.70, 1.09)
p-value		0.2189
<b>Non-fatal stroke N (%)</b>	60 (2.6)	150 (3.2)
Hazard ratio vs. placebo (95% CI)		1.24 (0.92, 1.67)
p-value		0.1638
<b>All-cause mortality N (%)</b>	194 (8.3)	269 (5.7)
Hazard ratio vs. placebo (95% CI)		0.68 (0.57, 0.82)
p-value		<0.0001
<b>Non-CV mortality N (%)</b>	57 (2.4)	97 (2.1)
Hazard ratio vs. placebo (95% CI)		0.84 (0.60, 1.16)

CV = cardiovascular, MI = myocardial infarction

<sup>a</sup>Treated set (TS), i.e. patients who had received at least one dose of study drug<sup>b</sup>Pooled doses of empagliflozin 10 mg and 25 mg

\*Since data from the trial were included in an interim analysis, a two-sided 95.02% confidence interval applied which corresponds to a p-value of less than 0.0498 for significance.

**Figure 1.** Time to occurrence of cardiovascular death in the EMPA-REG OUTCOME study  
**Individual Empagliflozin Doses versus Placebo**

### *Heart failure requiring hospitalization*

In the EMPA-REG OUTCOME study, empagliflozin reduced the risk of heart failure requiring hospitalization compared with placebo (empagliflozin 2.7%; placebo 4.1%; HR 0.65, 95% CI 0.50, 0.85).

### *Nephropathy*

In the EMPA-REG OUTCOME study, for time to first nephropathy event, the HR was 0.61 (95% CI 0.53, 0.70) for empagliflozin (12.7%) vs placebo (18.8%).

In addition, empagliflozin showed a higher (HR 1.82, 95% CI 1.40, 2.37) occurrence of sustained normo- or micro-albuminuria (49.7%) in patients with baseline macro-albuminuria compared with placebo (28.8%).

### *2 hour post-prandial glucose*

Treatment with empagliflozin as add-on to metformin or metformin plus sulfonylurea resulted in clinically meaningful improvement of 2-hour post-prandial glucose (meal tolerance test) at 24 weeks (add-on to metformin, placebo: +5.9 mg/dl, empagliflozin 10 mg: -46.0 mg/dl, empagliflozin 25 mg: -44.6 mg/dl; add-on to metformin plus sulphonylurea, placebo: -2.3 mg/dl, empagliflozin 10 mg: -35.7 mg/dl, empagliflozin 25 mg: -36.6 mg/dl).

### *Patients with baseline HbA1c $\geq 9\%$*

In a pre-specified analysis of subjects with baseline HbA1c  $\geq 9.0\%$ , treatment with empagliflozin 10 mg or 25 mg as add-on to metformin resulted in statistically significant reductions in HbA1c at Week 24 (adjusted mean change from baseline of -1.49% for empagliflozin 25 mg, -1.40% for empagliflozin 10 mg, and -0.44% for placebo).

### *Body weight*

In a pre-specified pooled analysis of 4 placebo controlled studies, treatment with empagliflozin (68% of all patients were on metformin background) resulted in body weight reduction compared to placebo at week 24 (-2.04 kg for empagliflozin 10 mg, -2.26 kg for empagliflozin 25 mg and -0.24 kg for placebo) that was maintained up to week 52 (-1.96 kg for empagliflozin 10 mg, -2.25 kg for empagliflozin 25 mg and -0.16 kg for placebo).

### *Blood pressure*

The efficacy and safety of empagliflozin was evaluated in a double-blind, placebo controlled study of 12 weeks duration in patients with type 2 diabetes and high blood pressure on different antidiabetic and up to 2 antihypertensive therapies. Treatment with empagliflozin once daily resulted in statistically significant improvement in HbA1c, and 24 hour mean systolic and diastolic blood pressure as determined by ambulatory blood pressure monitoring (Table 10). Treatment with empagliflozin provided reductions in seated SBP and DBP.

**Table 10:** Efficacy results at 12 week in a placebo-controlled study of empagliflozin in patients with type 2 diabetes and uncontrolled blood pressure<sup>a</sup>

	Placebo	Empagliflozin	
		10 mg	25 mg
N	271	276	276
<b>HbA1c (%) at week 12<sup>1</sup></b>			
Baseline (mean)	7.90	7.87	7.92
Change from baseline <sup>2</sup>	0.03	-0.59	-0.62
Difference from placebo <sup>1</sup> (95% CI) <sup>2</sup>		-0.62* (-0.72, -0.52)	-0.65* (-0.75, -0.55)
<b>24 hour SBP at week 12<sup>3</sup></b>			
Baseline (mean)	131.72	131.34	131.18
Change from baseline <sup>4</sup>	0.48	-2.95	-3.68
Difference from placebo <sup>4</sup> (95% CI)		-3.44* (-4.78, -2.09)	-4.16* (-5.50, -2.83)
<b>24 hour DBP at week 12<sup>3</sup></b>			
Baseline (mean)	75.16	75.13	74.64
Change from baseline <sup>5</sup>	0.32	-1.04	-1.40
Difference from placebo <sup>5</sup> (95% CI)		-1.36** (-2.15, -0.56)	-1.72* (-2.51, -0.93)

<sup>a</sup> Full analysis set (FAS)

<sup>1</sup> LOCF, values after taking antidiabetic rescue therapy censored

<sup>2</sup> Mean adjusted for baseline HbA1c, baseline eGFR, geographical region and number of antihypertensive medicinal products

<sup>3</sup> LOCF, values after taking antidiabetic rescue therapy or changing antihypertensive rescue therapy censored

<sup>4</sup> Mean adjusted for baseline SBP, baseline HbA1c, baseline eGFR, geographical region and number of antihypertensive medicinal products

<sup>5</sup> Mean adjusted for baseline DBP, baseline HbA1c, baseline eGFR, geographical region and number of antihypertensive medicinal products

\* p-value <0.0001

\*\* p-value <0.001

In a pre-specified pooled analysis of 4 placebo-controlled studies, treatment with empagliflozin (68% of all patients were on metformin background) resulted in a reduction in systolic blood pressure (empagliflozin 10 mg: -3.9 mmHg, empagliflozin 25 mg: -4.3 mmHg) compared with placebo (-0.5 mmHg), and in diastolic blood pressure (empagliflozin 10 mg: -1.8 mmHg, empagliflozin 25 mg: -2.0 mmHg) compared with placebo (-0.5 mmHg), at week 24, that were maintained up to week 52.

### Metformin

The prospective randomised (UKPDS) study has established the long-term benefit of intensive blood glucose control in type 2 diabetes. Analysis of the results for overweight patients treated with metformin after failure of diet alone showed:

- a significant reduction of the absolute risk of any diabetes-related complication in the metformin group (29.8 events/1 000 patient-years) versus diet alone (43.3 events/1 000 patient-years), p=0.0023, and versus the combined sulphonylurea and insulin monotherapy groups (40.1 events/1 000 patient-years), p=0.0034,
- a significant reduction of the absolute risk of any diabetes-related mortality: metformin 7.5 events/1 000 patient-years, diet alone 12.7 events/1 000 patient-years, p=0.017,

- a significant reduction of the absolute risk of overall mortality: metformin 13.5 events/1 000 patient-years versus diet alone 20.6 events/1 000 patient-years, (p=0.011), and versus the combined sulphonylurea and insulin monotherapy groups 18.9 events/1 000 patient-years (p=0.021),
- a significant reduction in the absolute risk of myocardial infarction: metformin 11 events/1 000 patient-years, diet alone 18 events/1 000 patient-years, (p=0.01).

### Paediatric population

The European Medicines Agency has waived the obligation to submit the results of studies with the reference medicinal product containing empagliflozin and metformin in all subsets of the paediatric population from birth to less than 10 years of age in type 2 diabetes (see section 4.2 for information on paediatric use).

The clinical efficacy and safety of empagliflozin (10 mg with a possible dose-increase to 25 mg) and linagliptin (5 mg) once daily has been studied in children and adolescents from 10 to 17 years of age with type 2 diabetes mellitus in a placebo-controlled study (DINAMO) over 26 weeks, with a safety extension period up to 52 weeks. Background therapies as adjunct to diet and exercise included metformin (51%), a combination of metformin and insulin (40.1%), insulin (3.2%), or none (5.7%). The adjusted mean changes in HbA1c at week 26 between empagliflozin (N=52) and placebo (N=53) of -0.84% was clinically meaningful and statistically significant (95% CI -1.50, -0.19; p=0.0116). In addition, treatment with empagliflozin versus placebo resulted in a clinically meaningful adjusted mean change in FPG of -35.2 mg/dl (95% CI -58.6, -11.7) [-1.95 mmol/l (-3.25, -0.65)]. These were -0.76% (95% CI -1.45%, -0.08%) for HbA1c and -38.28 mg/dL (95% CI: -60.47 to -16.10) for FPG in the metformin subgroup (N=48 empagliflozin, N=47 placebo).

## **5.2 Pharmacokinetic properties**

### Empagliflozin and metformin

The results of bioequivalence studies in healthy subjects demonstrated that empagliflozin/metformin hydrochloride 5 mg/850 mg, 5 mg/1 000 mg, 12.5 mg/850 mg, and 12.5 mg/1 000 mg combination tablets are bioequivalent to co-administration of corresponding doses of empagliflozin and metformin as individual tablets.

Administration of empagliflozin/metformin 12.5 mg/1 000 mg under fed conditions resulted in 9% decrease in AUC and a 28% decrease in  $C_{max}$  for empagliflozin, when compared to fasted conditions. For metformin, AUC decreased by 12% and  $C_{max}$  decreased by 26% compared to fasting conditions. The observed effect of food on empagliflozin and metformin is not considered to be clinically relevant. However, as metformin is recommended to be given with meals, this medicinal product is also proposed to be given with food.

The following statements reflect the pharmacokinetic properties of the individual active substances of this medicinal product.

### Empagliflozin

#### Absorption

The pharmacokinetics of empagliflozin have been extensively characterised in healthy volunteers and patients with type 2 diabetes. After oral administration, empagliflozin was rapidly absorbed with peak plasma concentrations occurring at a median  $t_{max}$  of 1.5 hours post-dose. Thereafter, plasma concentrations declined in a biphasic manner with a rapid distribution phase and a relatively slow terminal phase. The steady state mean plasma AUC and  $C_{max}$  were 1870 nmol.h/l and 259 nmol/l with empagliflozin 10 mg and 4 740 nmol.h/l and 687 nmol/l with empagliflozin 25 mg once daily. Systemic exposure of empagliflozin increased in a dose-proportional manner. The single-dose and steady-state pharmacokinetic parameters of empagliflozin were similar suggesting linear

pharmacokinetics with respect to time. There were no clinically relevant differences in empagliflozin pharmacokinetics between healthy volunteers and patients with type 2 diabetes.

The pharmacokinetics of 5 mg empagliflozin twice daily and 10 mg empagliflozin once daily were compared in healthy subjects. Overall exposure (AUC<sub>ss</sub>) of empagliflozin over a 24-hour period with empagliflozin 5 mg administered twice daily was similar to empagliflozin 10 mg administered once daily. As expected, empagliflozin 5 mg administered twice daily compared with 10 mg empagliflozin once daily resulted in lower C<sub>max</sub> and higher trough plasma empagliflozin concentrations (C<sub>min</sub>).

Administration of empagliflozin 25 mg after intake of a high-fat and high calorie meal resulted in slightly lower exposure; AUC decreased by approximately 16% and C<sub>max</sub> by approximately 37% compared to fasted condition. The observed effect of food on empagliflozin pharmacokinetics was not considered clinically relevant and empagliflozin may be administered with or without food. Similar results were obtained when empagliflozin/metformin combination tablets were administered with high-fat and high calorie meal.

### Distribution

The apparent steady-state volume of distribution was estimated to be 73.8 l based on the population pharmacokinetic analysis. Following administration of an oral [<sup>14</sup>C]-empagliflozin solution to healthy volunteers, the red blood cell partitioning was approximately 37% and plasma protein binding was 86%.

### Biotransformation

No major metabolites of empagliflozin were detected in human plasma, as defined by at least 10% of total drug-related material, and the most abundant metabolites were three glucuronide conjugates (2-, 3-, and 6-O-glucuronide). *In vitro* studies suggested that the primary route of metabolism of empagliflozin in humans is glucuronidation by the uridine 5'-diphospho-glucuronosyltransferases UGT2B7, UGT1A3, UGT1A8, and UGT1A9.

### Elimination

Based on the population pharmacokinetic analysis, the apparent terminal elimination half-life of empagliflozin was estimated to be 12.4 hours and apparent oral clearance was 10.6 l/hour. The inter-subject and residual variabilities for empagliflozin oral clearance were 39.1% and 35.8%, respectively. With once-daily dosing, steady-state plasma concentrations of empagliflozin were reached by the fifth dose. Consistent with the half-life, up to 22% accumulation, with respect to plasma AUC, was observed at steady-state. Following administration of an oral [<sup>14</sup>C]-empagliflozin solution to healthy volunteers, approximately 96% of the drug-related radioactivity was eliminated in faeces (41%) or urine (54%). The majority of drug-related radioactivity recovered in faeces was unchanged parent drug and approximately half of drug-related radioactivity excreted in urine was unchanged parent drug.

### Special populations

#### *Renal impairment*

In patients with mild, moderate or severe renal impairment (creatinine clearance <30 - <90 ml/min) and patients with kidney failure/end stage renal disease (ESRD), AUC of empagliflozin increased by approximately 18%, 20%, 66%, and 48%, respectively compared to subjects with normal renal function. Peak plasma levels of empagliflozin were similar in subjects with moderate renal impairment and kidney failure/ESRD compared to patients with normal renal function. Peak plasma levels of empagliflozin were roughly 20% higher in subjects with mild and severe renal impairment as compared to subjects with normal renal function. The population pharmacokinetic analysis showed that the apparent oral clearance of empagliflozin decreased with a decrease in creatinine clearance leading to an increase in drug exposure.

### *Hepatic impairment*

In subjects with mild, moderate, and severe hepatic impairment according to the Child-Pugh classification, AUC of empagliflozin increased approximately by 23%, 47%, and 75% and  $C_{\max}$  by approximately 4%, 23%, and 48%, respectively, compared to subjects with normal hepatic function.

### *Body Mass Index*

Body mass index had no clinically relevant effect on the pharmacokinetics of empagliflozin based on the population pharmacokinetic analysis. In this analysis, AUC was estimated to be 5.82%, 10.4%, and 17.3% lower in subjects with BMI of 30, 35, and 45 kg/m<sup>2</sup>, respectively, compared to subjects with a body mass index of 25 kg/m<sup>2</sup>.

### *Gender*

Gender had no clinically relevant effect on the pharmacokinetics of empagliflozin based on the population pharmacokinetic analysis.

### *Race*

In the population pharmacokinetic analysis, AUC was estimated to be 13.5% higher in Asians with a body mass index of 25 kg/m<sup>2</sup> compared to non-Asians with a body mass index of 25 kg/m<sup>2</sup>.

### *Elderly*

Age did not have a clinically meaningful impact on the pharmacokinetics of empagliflozin based on the population pharmacokinetic analysis.

### *Paediatric population*

A paediatric Phase 1 study examined the pharmacokinetics and pharmacodynamics of empagliflozin (5 mg, 10 mg and 25 mg) in children and adolescents  $\geq 10$  to  $<18$  years of age with type 2 diabetes mellitus. The observed pharmacokinetic and pharmacodynamic responses were consistent with those found in adult subjects.

A paediatric Phase 3 study examined the pharmacokinetics and pharmacodynamics (HbA1c change from baseline) of empagliflozin 10 mg with a possible dose-increase to 25 mg in children and adolescents 10 to 17 years of age with type 2 diabetes mellitus. The observed exposure-response relationship was overall comparable in adults and children and adolescents. Oral administration of empagliflozin resulted in an exposure within the range observed in adult patients. The observed geometric mean trough concentrations and geometric mean concentrations at 1.5 hours post-administration at steady state were 26.6 nmol/l and 308 nmol/l with empagliflozin 10 mg once daily and 67.0 nmol/l and 525 nmol/l with empagliflozin 25 mg once daily

## Metformin

### Absorption

After an oral dose of metformin,  $t_{\max}$  is reached in 2.5 hours. Absolute bioavailability of a 500 mg or 850 mg metformin hydrochloride tablet is approximately 50-60% in healthy subjects. After an oral dose, the non-absorbed fraction recovered in faeces was 20-30%. After oral administration, metformin absorption is saturable and incomplete. It is assumed that the pharmacokinetics of metformin absorption are non-linear. At the recommended metformin doses and dosing schedules, steady-state plasma concentrations are reached within 24 to 48 hours and are generally less than 1 microgram/ml. In controlled clinical trials, maximum metformin plasma levels ( $C_{\max}$ ) did not exceed 5 microgram/ml, even at maximum doses.

Food decreases the extent and slightly delays the absorption of metformin. Following administration of a dose of 850 mg metformin hydrochloride, a 40% lower plasma peak concentration, a 25% decrease in AUC and a 35 minute prolongation of the time to peak plasma concentration were observed. The clinical relevance of these decreases is unknown.

### Distribution

Plasma protein binding is negligible. Metformin partitions into erythrocytes. The blood peak is lower than the plasma peak and appears at approximately the same time. The red blood cells most likely represent a secondary compartment of distribution. The mean volume of distribution (Vd) ranged between 63-276 l.

### Biotransformation

Metformin is excreted unchanged in the urine. No metabolites have been identified in humans.

### Elimination

Renal clearance of metformin is >400 ml/min, indicating that metformin is eliminated by glomerular filtration and tubular secretion. Following an oral dose, the apparent terminal elimination half-life is approximately 6.5 hours.

When renal function is impaired, renal clearance is decreased in proportion to that of creatinine and thus the elimination half-life is prolonged, leading to increased levels of metformin in plasma.

### Special populations

#### *Paediatric population*

Single dose study: after single doses of metformin hydrochloride 500 mg, paediatric patients have shown a similar pharmacokinetic profile to that observed in healthy adults.

Multiple-dose study: After repeated doses of 500 mg twice daily for 7 days in paediatric patients the peak plasma concentration ( $C_{max}$ ) and systemic exposure ( $AUC_{0-t}$ ) were approximately 33% and 40% lower, respectively, compared to diabetic adults who received repeated doses of 500 mg twice daily for 14 days. As the dose is individually titrated based on glycaemic control, this is of limited clinical relevance

## **5.3 Preclinical safety data**

### Empagliflozin and metformin

General toxicity studies in rats of up to 13 weeks were performed with the combination of empagliflozin and metformin and did not reveal any additional target organs when compared to empagliflozin or metformin alone. Some responses were increased by the combination treatment, such as effects on renal physiology, electrolyte balance and acid/base state. However, only hypochloremia was considered adverse at exposures of approximately 9- and 3-times the clinical AUC exposure of the maximum recommended dose of empagliflozin and metformin, respectively.

An embryofetal development study in pregnant rats did not indicate a teratogenic effect attributed to the co-administration of empagliflozin and metformin at exposures of approximately 14-times the clinical AUC exposure of empagliflozin associated with the highest dose, and 4-times the clinical AUC exposure of metformin associated with the 2 000 mg dose.

### Empagliflozin

Non-clinical data reveal no special hazard for humans based on conventional studies of safety pharmacology, genotoxicity, fertility and early embryonic development.

In long term toxicity studies in rodents and dogs, signs of toxicity were observed at exposures greater than or equal to 10-times the clinical dose of empagliflozin. Most toxicity was consistent with secondary pharmacology related to urinary glucose loss and electrolyte imbalances including decreased body weight and body fat, increased food consumption, diarrhoea, dehydration, decreased



serum glucose and increases in other serum parameters reflective of increased protein metabolism and gluconeogenesis, urinary changes such as polyuria and glucosuria, and microscopic changes including mineralisation in kidney and some soft and vascular tissues. Microscopic evidence of the effects of exaggerated pharmacology on the kidney observed in some species included tubular dilatation, and tubular and pelvic mineralisation at approximately 4-times the clinical AUC exposure of empagliflozin associated with the 25 mg dose.

Empagliflozin is not genotoxic.

In a 2-year carcinogenicity study, empagliflozin did not increase the incidence of tumours in female rats up to the highest dose of 700 mg/kg/day, which corresponds to approximately 72-times the maximal clinical AUC exposure to empagliflozin. In male rats, treatment-related benign vascular proliferative lesions (haemangiomas) of the mesenteric lymph node were observed at the highest dose, but not at 300 mg/kg/day, which corresponds to approximately 26-times the maximal clinical exposure to empagliflozin. Interstitial cell tumours in the testes were observed with a higher incidence in rats at 300 mg/kg/day and above, but not at 100 mg/kg/day which corresponds to approximately 18 times the maximal clinical exposure to empagliflozin. Both tumours are common in rats and are unlikely to be relevant to humans.

Empagliflozin did not increase the incidence of tumours in female mice at doses up to 1 000 mg/kg/day, which corresponds to approximately 62-times the maximal clinical exposure to empagliflozin. Empagliflozin induced renal tumours in male mice at 1 000 mg/kg/day, but not at 300 mg/kg/day, which corresponds to approximately 11-times the maximal clinical exposure to empagliflozin. The mode of action for these tumours is dependent on the natural predisposition of the male mouse to renal pathology and a metabolic pathway not reflective of humans. The male mouse renal tumours are considered not relevant to humans.

At exposures sufficiently in excess of exposure in humans after therapeutic doses, empagliflozin had no adverse effects on fertility or early embryonic development. Empagliflozin administered during the period of organogenesis was not teratogenic. Only at maternally toxic doses, empagliflozin also caused bent limb bones in the rat and increased embryofetal loss in the rabbit.

In pre- and postnatal toxicity studies in rats, reduced weight gain of offspring was observed at maternal exposures approximately 4 times the maximal clinical exposure to empagliflozin. No such effect was seen at systemic exposure equal to the maximal clinical exposure to empagliflozin. The relevance of this finding to humans is unclear.

In a juvenile toxicity study in the rat, when empagliflozin was administered from postnatal day 21 until postnatal day 90, non-adverse, minimal to mild renal tubular and pelvic dilation in juvenile rats was seen only at 100 mg/kg/day, which approximates 11-times the maximum clinical dose of 25 mg. These findings were absent after a 13 weeks drug-free recovery period.

### Metformin

Preclinical data for metformin reveal no special hazard for humans based on conventional studies of safety pharmacology, repeated dose toxicity, genotoxicity, or carcinogenic potential or reproductive toxicity. At dose levels of 500 mg/kg/day administered to Wistar Hannover rats, associated with 7-times the maximum recommended human dose (MRHD) of metformin, teratogenicity of metformin was observed, mostly evident as an increase in the number of skeletal malformations.

## **6. PHARMACEUTICAL PARTICULARS**

### **6.1 List of excipients**

#### Tablet core

Maize starch  
Cellulose, Microcrystalline  
Croscarmellose Sodium  
Hydroxypropylcellulose  
Silica, Colloidal Anhydrous  
Magnesium Stearate

#### Film-coating

*Appref 5 mg/850 mg film-coated tablets*

Poly(vinyl alcohol) partial hydrolyzed (E1203)  
Talc (E553b)  
Titanium Dioxide (E171)  
Glycerol monocaprylocaprate  
Sodium Lauryl Sulfate

*Appref 5 mg/1 000 mg film-coated tablets*

Poly(vinyl alcohol) partial hydrolyzed (E1203)  
Talc (E553b)  
Titanium Dioxide (E171)  
Glycerol monocaprylocaprate  
Sodium Lauryl Sulfate  
Iron Oxide Red (E172)

*Appref 12.5 mg/850 mg film-coated tablets*

Poly(vinyl alcohol) partial hydrolyzed (E1203)  
Talc (E553b)  
Titanium Dioxide (E171)  
Iron Oxide Yellow (E172)  
Glycerol monocaprylocaprate  
Sodium Lauryl Sulfate  
Iron Oxide Red (E172)

*Appref 12.5 mg/1 000 mg film-coated tablets*

Poly(vinyl alcohol) partial hydrolyzed (E1203)  
Talc (E553b)  
Titanium Dioxide (E171)  
Glycerol monocaprylocaprate  
Sodium Lauryl Sulfate  
Iron Oxide Yellow (E172)

### **6.2 Incompatibilities**

Not applicable.

### **6.3 Shelf life**

2 years

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

Do not store above 30°C.

## 6.5 Nature and contents of container

The product is packed in opaque PVC/PVDC /Aluminum foil blisters.

*Appref 5 mg/850 mg film-coated tablets*

Pack sizes:

56 film-coated tablets

60 film-coated tablets

180 film-coated tablets

*Appref 5 mg/1 000 mg film-coated tablets*

Pack sizes:

10 film-coated tablets

30 film-coated tablets

60 film-coated tablets

*Appref 12.5 mg/850 mg film-coated tablets*

Pack sizes:

56 film-coated tablets

60 film-coated tablets

*Appref 12.5 mg/1 000 mg film-coated tablets*

Pack sizes:

10 film-coated tablets

30 film-coated tablets

56 film-coated tablets

60 film-coated tablets

180 film-coated tablets

Not all pack sizes may be marketed.

## 6.6 Special precautions for disposal

No special requirements.

## 7. MARKETING AUTHORISATION HOLDER

Adalvo Limited  
Malta Life Science Park, Building 1, Level 4  
Sir Temi Zammit Buildings  
SGN 3000, San Gwann  
Malta

## 8. MARKETING AUTHORISATION NUMBER(S)

Appref 5 mg/850 mg filmomhulde tabletten	RVG 133828
Appref 5 mg/1000 mg filmomhulde tabletten	RVG 133829
Appref 12,5 mg/850 mg filmomhulde tabletten	RVG 133830
Appref 12,5 mg/1000 mg filmomhulde tabletten	RVG 133831

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

Datum van eerste verlening van de vergunning: 24 september 2025

## 10. DATE OF REVISION OF THE TEXT

<{MM/YYYY}>

<{DD/MM/YYYY}>

<{DD month YYYY}>

[To be completed nationally]

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