Doripenam 250mg/500mg powder for solution for infusion

1. NAME OF THE MEDICINAL PRODUCT

Doripenam 250mg powder for solution for infusion Taj Pharma
Doripenam 500mg powder for solution for infusion Taj Pharma

2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Each vial contains
Doripenem monohydrate equivalent to 250mg doripenem.

Each vial contains
Doripenem monohydrate equivalent to 500mg doripenem.

3. PHARMACEUTICAL FORM

Powder for solution for infusion (powder for infusion) White to slightly yellowish off-white crystalline powder

4. CLINICAL PARTICULARS

Therapeutic indications

Doripenam is indicated for the treatment of the following infections in adults (see sections 4.4 and 5.1):
Nosocomial pneumonia (including ventilator–associated pneumonia)
Complicated intra-abdominal infections
Complicated urinary tract infections

Consideration should be given to official guidance on the appropriate use of antibacterial agents.

Posology and method of administration

Posology

The recommended dose and administration by infection is shown in the following table:

Infection	Dose	Frequency	Infusion time
Nosocomial pneumonia including ventilator–associated pneumonia	500mg or 1g*	every 8 hours	1 or 4 hours**
Complicated intra-abdominal infection	500mg	every 8 hours	1 hour
Complicated UTI, including pyelonephritis 500mg every 8 hours1 hour	500mg	every 8 hours	1 hour

Duration of treatment
The usual treatment duration of doripenem therapy ranges from 5-14 days and should be guided by the severity, site of the infection, infecting pathogen and the patient's clinical response. The usual treatment duration for patients with nosocomial pneumonia, including ventilator-associated pneumonia is 10 to 14 days and is often in the upper range for patients infected with non-fermenting gram-negative pathogens (such as *Pseudomonas* spp. and *Acinetobacter* spp.) (see section 5.1).

Doripenem was given for up to 14 days in clinical studies and the safety of longer durations of therapy has not been established. After commencing treatment with intravenous doripenem, a switch to appropriate oral therapy to complete the treatment course is possible once clinical improvement has been established.
Elderly patients (≥ 65 years of age)
No dose adjustment is necessary in elderly patients, except in cases of moderate to

severe renal impairment (see *Renal impairment* below and section 5.2).

Renal impairment
In patients with mild renal impairment (i.e. creatinine clearance (CrCl) is > 50 to ≤ 80 ml/min), no dose adjustment is necessary.

In patients with moderate renal impairment (CrCl ≥ 30 to ≤ 50 ml/min), the dose of doripenem should be 250mg every 8 hours (see section 6.6). In patients with severe renal impairment
(CrCl < 30 ml/min), the dose of doripenem should be 250mg every 12 hours (see section 6.6). In patients prescribed 1 g every 8 hours as a 4-hour infusion, the dose should be similarly adjusted (moderate renal impairment: 500mg every 8 hours; severe renal impairment: 500mg every 12 hours).

Due to limited clinical data and an expected increased exposure to doripenem and its metabolite (doripenem-M-1), Doripenam should be used with caution in patients with severe renal impairment (see section 5.2).

Dose in patients on dialysis
Doripenam dosing and administration recommendations for patients on continuous renal replacement therapies are shown in the following table.

CRRT procedure	Glomerular filtration rate	Dose	Frequency	Target attainment(MIC)
CVVH	≤ 30 ml/min	25mg	every 12 hours 4 hours	≤ 1mg/l
CVVHDF	< 5 ml/min	250mg	every 12 hours 4 hours	≤ 1mg/l
CVVHDF	5-30 ml/min	500mg	every 12 hours 4 hours	≤ 1mg/l

CRRT: continuous renal replacement therapy; CVVH: continuous venovenous haemofiltration; CVVHDF: continuous venovenous haemodiafiltration; MIC: minimum inhibitory concentration

For patients with acute renal insufficiency on CRRT, an infusion time of 4 hours is required, taking into consideration the possible
increases in non-renal clearance of carbapenems in patients with acute renal insufficiency.
Patients with chronic renal impairment on CRRT can be treated with either a 1 or 4-hour infusion time. Based mainly on PK/PD considerations, a 4-hour infusion time may be more suitable to maximize the percentage time during the dosing interval that the plasma concentration of doripenem exceeds the minimum inhibitory concentration (%T > MIC), (see section 5.1).

Dosing recommendations for pathogens with MIC > 1mg/l have not been established for continuous renal replacement therapy due to the potential for accumulation of doripenem and doripenem-M-1 metabolite (see sections 4.4 and 5.2). Close safety monitoring is advised for patients on continuous renal replacement therapy, due to limited clinical data and an expected increased exposure to doripenem-M-1 metabolite (see section 4.4).

There is insufficient information to make dose adjustment recommendations for patients on other forms of dialysis (see section 5.2).

Hepatic impairment
No dose adjustment is necessary.

Paediatric patients
The safety and efficacy of Doripenam in children aged less than 18 years have not yet been established. No data are available.

Method of administration
Doripenam is to be reconstituted and then further diluted (see section 6.6) prior to administration by intravenous infusion over a period of 1 or 4 hours.

Contraindications

Hypersensitivity to the active substance
Hypersensitivity to any other carbapenem antibacterial agent
Severe hypersensitivity (e.g. anaphylactic reaction, severe skin reaction) to any other type of beta-lactam antibacterial agent (e.g. penicillins or cephalosporins).

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Special warnings and precautions for use

General
The selection of doripenem to treat an individual patient should take into account the appropriateness of using a carbapenem antibacterial agent based on factors such as severity of the infection, the prevalence of resistance to other suitable antibacterial agents and the risk of selecting for carbapenem-resistant bacteria.

Caution on the choice of antibiotic agent and dose should be taken when treating patients with late-onset ventilator-associated pneumonia (> 5 days hospitalisation) and in other nosocomial
pneumonia cases where pathogens with decreased susceptibility are suspected or confirmed, such as
Pseudomonas spp. and *Acinetobacter* spp. (see sections 4.2 and 5.1).

Concomitant use of an aminoglycoside may be indicated when *Pseudomonas aeruginosa* infections are suspected or proven to be involved in the approved indications (see section 4.1).

Hypersensitivity reactions
Serious and occasionally fatal hypersensitivity (anaphylactic) reactions have occurred in patients receiving beta-lactam antibiotics. Before therapy with Doripenam is started, careful inquiry should be made concerning a previous history of hypersensitivity reactions to other active substances in this class or to beta-lactam antibiotics. Doripenam should be used with caution in patients with such a history. Should a hypersensitivity reaction to doripenem occur, it should be discontinued immediately and appropriate measures taken. Serious acute hypersensitivity (anaphylactic) reactions require immediate emergency treatment.

Seizures
Seizures have been reported during treatment with carbapenems, including doripenem (see section 4.8). Seizures in clinical trials with doripenem occurred most commonly in those with pre-existing central nervous system (CNS) disorders (e.g. stroke or history of seizures), compromised renal function and at doses greater than 500mg.

Pseudomembranous colitis
Pseudomembranous colitis due to *Clostridium difficile* has been reported with Doripenam and may range in severity from mild to life-threatening. Therefore, it is important to consider this diagnosis in patients who present with diarrhoea during or subsequent to the administration of Doripenam (see section 4.8).

Overgrowth of non-susceptible bacteria
Administration of doripenem, like other antibiotics, has been associated with emergence and selection of strains with reduced susceptibility. Patients should be carefully monitored during therapy. If superinfection occurs, appropriate measures should be taken. Prolonged use of Doripenam should be avoided.

Drug interaction with valproic acid
The concomitant use of doripenem and valproic acid/sodium valproate is not recommended (see section 4.5).

Pneumonitis with inhalational use
When Doripenam was used investigationally via inhalation, pneumonitis occurred. Therefore, doripenem should not be administered by this route.
Continuous renal replacement therapy
The exposure to the metabolite doripenem-M-1 in patients on continuous renal replacement therapy may be increased to levels where no *in vivo* safety data are presently available. The metabolite lacks target pharmacological activity but other possible pharmacological effects are unknown. Therefore, close safety monitoring is advised. (see sections 4.2 and 5.2)

Description of the patient population treated in clinical studies

In two clinical trials of patients with nosocomial pneumonia (N=979), 60% of the clinically-evaluable Doripenam-treated patients had ventilator-associated pneumonia (VAP). Of these, 50% had late-onset VAP (defined as that occurring after five days of mechanical ventilation), 54% had an APACHE (Acute Physiology And Chronic Health Evaluation) II score > 15 and 32% received concomitant aminoglycosides (76% for more than 3 days).

In two clinical trials of patients with complicated intra-abdominal infections (N=962) the most common anatomical site of infection in microbiologically-evaluable Doripenam-treated patients was the appendix (62%). Of these, 51% had generalised peritonitis at baseline. Other sources of infection included colon perforation (20%), complicated cholecystitis (5%) and infections at other sites (14%). Eleven percent had an APACHE II score of > 10, 9.5% had post-operative infections, 27% had single or multiple intra-abdominal abscesses and 4% had concurrent bacteraemia at baseline.

In two clinical trials of patients with complicated urinary tract infections (N=1,179), 52% of microbiologically-evaluable Doripenam-treated patients had complicated lower urinary tract infections and 48% had pyelonephritis, of which 16% were complicated. Overall, 54% of patients had a persistent complication, 9% had concurrent bacteraemia and 23% were infected with a levofloxacin resistant uropathogen at baseline.

The experience in patients who are severely immunocompromised, receiving immunosuppressive therapy, and patients with severe neutropenia is limited since this population was excluded from phase III trials.

Interaction with other medicinal products and other forms of interaction

Doripenem undergoes little to no Cytochrome P450 (CYP450) mediated metabolism. Based on *in vitro* studies it is not expected that doripenem will inhibit or induce the activities ofCYP450.
Therefore, no CYP450-related drug interactions are to be expected (see section 5.2).

It has been shown that co-administration of doripenem and valproic acid significantly reduces serum valproic acid levels below the therapeutic range. The lowered valproic acid levels can lead to inadequate seizure control. In an interaction study, the serum concentrations of valproic acid were markedly reduced (AUC was reduced by 63%) following co-administration of doripenem and valproic acid. The interaction had a fast onset. Since patients were administered only four doses of doripenem, a further decrease of valproic acid levels with longer concomitant administration cannot be excluded. Decreases in valproic acid levels have also been reported when co-administered with other carbapenem agents, achieving a 60-100% decrease in valproic acid levels in about two days.
Therefore, alternative antibacterial or supplemental anticonvulsant therapies should be considered.

Probenecid competes with doripenem for renal tubular secretion and reduces the renal clearance of doripenem. In an interaction study, the mean doripenem AUC increased by 75% following co-administration with probenecid. Therefore, co-administration of probenecid with Doripenam is not recommended. An interaction with other medicinal products eliminated by renal tubular secretion cannot be excluded.

Fertility, pregnancy and lactation

Pregnancy
For doripenem, limited clinical data on exposed pregnancies are available. Animal studies are insufficient with respect to pregnancy, embryonal/foetal development, parturition or postnatal
development (see section 5.3). The potential risk for humans is unknown. Doripenam should not be used during pregnancy unless clearly necessary.

Breast-feeding
It is unknown whether doripenem is excreted in human breast milk. A study in rats has shown that doripenem and its metabolite are transferred to milk. A decision on whether to continue/discontinue breast-feeding or to continue/discontinue therapy with Doripenam should be made taking into account the benefit of breast-feeding to the child and the benefit of Doripenam therapy to the woman.

Fertility
There are no clinical data available regarding potential effects of doripenem treatment on male or female fertility. Intravenous injection of doripenem had no adverse effects on general fertility of treated male and female rats or on postnatal development and reproductive performance of the offspring at doses as high as 1 g/kg/day (based on AUC, at least equal to the exposure to humans at the dose of 500mg administered every 8 hours).

Effects on ability to drive and use machines

No studies on the effects of Doripenam on the ability to drive and use machines have been performed. Based on reported adverse drug reactions, it is not anticipated that Doripenam will affect the ability to drive and use machines.

Undesirable effects

Summary of the safety profile
In 3,142 adult patients (1,817 of which received Doripenam) evaluated for safety in phase II and phase III clinical trials, adverse reactions due to Doripenam 500mg every 8 hours occurred at a rate of 32%.
Doripenam was discontinued because of adverse drug reactions in 0.1% of patients overall. Adverse drug reactions that led to Doripenam discontinuation were nausea (0.1%), diarrhoea (0.1%), pruritus (0.1%), vulvomycotic infection (0.1%), hepatic enzyme increased (0.2%) and rash (0.2%). The most common adverse reactions were headache (10%), diarrhoea (9%) and nausea (8%).

The safety profile in approximately 500 patients who received Doripenam 1 g every 8 hours as a 4-hour infusion in phase I, II and III clinical trials, was consistent with the safety profile for patients receiving 500mg every 8 hours.

Tabulated list of adverse reactions
Adverse drug reactions identified during clinical trials and post-marketing experience with Doripenam are listed below by frequency category. Frequency categories are defined as follows: Very common (≥ 1/10); Common (≥ 1/100 to < 1/10); Uncommon (≥ 1/1,000 to < 1/100); Not known (cannot be estimated from the available data).

Within each frequency grouping, undesirable effects are presented in order of decreasing seriousness.

Adverse drug reactions identified during clinical trials and post-marketing experience with Doripenam	
Infections and infestation	Common: oral candidiasis, vulvomycotic infection
Blood and lymphatic system disorders	Uncommon: thrombocytopenia, neutropenia
Immune system disorders	Uncommon: hypersensitivity reactions (see section

	4.4) Not known: anaphylaxis (see section 4.4)
Nervous system disorders	Very common: headache Uncommon: seizures (see section 4.4)
Vascular disorders	Common: phlebitis
Gastrointestinal disorders	Common: nausea, diarrhoea Uncommon: *C. difficile* colitis (see section 4.4)
Hepatobiliary disorders	Common: hepatic enzyme increased
Skin and subcutaneous tissue disorders	Common: pruritus, rash Not known: toxic epidermal necrolysis, Stevens-Johnson syndrome

Overdose

In a phase I study in healthy subjects receiving doripenem 2 g infused over 1 hour every 8 hours for 10 to 14 days, the incidence of rash was very common (5 of 8 subjects). The rash resolved within 10 days after doripenem administration was discontinued.

In the event of overdose, Doripenam should be discontinued and general supportive treatment given until renal elimination takes place. Doripenam can be removed by continuous renal replacement therapy or haemodialysis (see section 5.2). However, no information is available on the use of either of these therapies to treat overdose.

5. PHARMACOLOGICAL PROPERTIES

Pharmacodynamic properties

Pharmacotherapeutic group: Antibacterials for systemic use, carbapenems,

Mechanism of action

Doripenem is a synthetic carbapenem antibacterial agent.

Doripenem exerts its bactericidal activity by inhibiting bacterial cell wall biosynthesis. Doripenem inactivates multiple essential penicillin-binding proteins (PBPs) resulting in inhibition of cell wall synthesis with subsequent cell death.

In vitro doripenem showed little potential to antagonise or be antagonised by other antibacterial agents. Additive activity or weak synergy with amikacin and levofloxacin has been seen for *Pseudomonas aeruginosa* and for gram-positive bacteria with daptomycin, linezolid, levofloxacin, and vancomycin.

Pharmacokinetic/pharmacodynamic relationship

Similar to other beta-lactam antimicrobial agents, the time that the plasma concentration of doripenem exceeds the minimum inhibitory concentration (%T>MIC) of the infecting organism has been shown to best correlate with efficacy in pre-clinical pharmacokinetic/pharmacodynamic (PK/PD) studies.

Monte Carlo simulations using pathogen susceptibility results from completed phase III trials and population PK data indicated that the %T>MIC target of 35% was achieved in greater than 90% of patients with nosocomial pneumonia, complicated urinary tract infections and complicated intra-abdominal infections, for all degrees of renal function.

Extending the infusion time of doripenem to 4 hours maximises the % T>MIC for a given dose and is the basis for the option to administer 4-hour infusions in patients with nosocomial pneumonia including ventilator-associated pneumonia. In seriously ill patients or those with an impaired immune response, a 4-hour infusion time may be more suitable when the MIC of doripenem for the known or suspected pathogen(s) has been shown or is expected to be > 0.5mg/l, in order to reach a target attainment of 50% T>MIC in at least 95% of the patients (see

section 4.2). Monte Carlo simulations supported the use of 500mg 4-hour infusions every 8 hours in subjects with normal renal function for target pathogens with doripenem MICs ≤ 4mg/l.

Mechanisms of resistance

Bacterial resistance mechanisms that effect doripenem include active substance inactivation by carbapenem-hydrolysing enzymes, mutant or acquired PBPs, decreased outer membrane permeability and active efflux. Doripenem is stable to hydrolysis by most beta-lactamases, including penicillinases and cephalosporinases produced by gram-positive and gram-negative bacteria, with the exception of
relatively rare carbapenem hydrolysing beta-lactamases. Species resistant to other carbapenems do generally express co-resistance to doripenem. Methicillin-resistant staphylococci should always be considered as resistant to doripenem. As with other antimicrobial agents, including carbapenems, doripenem has been shown to select for resistant bacterial strains.

Breakpoints

Minimum inhibitory concentration (MIC) breakpoints established by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) are as follows:

Non species related S ≤ 1mg/l and R > 4mg/l
Staphylococci inferred from the methicillin breakpoint
Enterobacteriaceae S ≤ 1mg/l and R > 4mg/l
Acinetobacter spp. S ≤ 1mg/l and R > 4mg/l
Pseudomonas spp. S ≤ 1mg/l and R > 4mg/l
Streptococcus spp. other than *S. pneumoniae* S ≤ 1mg/l and R > 1mg/l
S. pneumoniae S ≤ 1mg/l and R > 1mg/l
Enterococci "inappropriate target"
Haemophilus spp. S ≤ 1mg/l and R > 1mg/l
N. gonorrhoeae IE (insufficient evidence)
Anaerobes S ≤ 1mg/l and R > 1mg/l

Susceptibility

The prevalence of acquired resistance may vary geographically and with time for selected species and local information on resistance is desirable, particularly when treating severe infections. As necessary, expert advice should be sought when the local prevalence of resistance is such that the utility of the agent in at least some types of infections is questionable.

Localised clusters of infections due to carbapenem-resistant organisms have been reported in the European Union. The information below gives only approximate guidance on the probability as to whether the micro-organism will be susceptible to doripenem or not.

Commonly susceptible species:

Gram-positive aerobes
Enterococcus faecalis[*$]
Staphylococcus aureus (methicillin susceptible strains only)[*^] *Staphylococcus* spp. (methicillin susceptible strains only)[^]
Streptococcus pneumoniae[*]
Streptococcus spp.

Gram-negative aerobes *Citrobacter diversus Citrobacter freundii Enterobacter aerogenes Enterobacter cloacae*[*] *Haemophilus influenzae*[*] *Escherichia coli*[*] *Klebsiella pneumoniae*[*] *Klebsiella oxytoca Morganella morganii Proteus mirabilis*[*] *Proteus vulgaris Providencia rettgeri Providencia stuartii Salmonella* spp.
Serratia marcescens Shigella spp.
Anaerobes
Bacteroides fragilis[*] *Bacteroides caccae*[*] *Bacteroides ovatus Bacteroides uniformis*[*] *Bacteroides thetaiotaomicron*[*] *Bacteroides vulgatus*[*] *Bilophila wadsworthia Peptostreptococcus magnus*

Peptostreptococcus micros[*] *Porphyromonas* spp.
Prevotella spp.
Sutterella wadsworthensis

Species for which acquired resistance may be a problem:
Acinetobacter baumannii[*] *Acinetobacter* spp. *Burkholderia cepacia*[$+] *Pseudomonas aeruginosa*[*]

Inherently resistant organisms:
Gram-positive aerobes
Enterococcus faecium

Gram-negative aerobes *Stenotrophomonas maltophilia Legionella* spp.

* species against which activity has been demonstrated in clinical studies
$ species that show natural intermediate susceptibility
+ species with > 50% acquired resistance in one or more Member State
^ all methicillin-resistant staphylococci should be regarded as resistant to doripenem

Data from clinical studies
Ventilator-associated pneumonia
A study of 233 patients with late-onset VAP failed to demonstrate the non-inferiority of an investigational 7-day course of doripenem (1 g every 8 hours as a 4 hour infusion) compared to a
10-day course of imipenem/cilastatin (1 g every 8 hours as a 1 hour infusion). In addition, the patients were allowed to receive specified adjunctive therapies. The study was stopped early based on the recommendation of an independent data monitoring committee. The clinical cure rate at the end of treatment visit on day 10 was numerically lower for subjects in the doripenem arm of the primary microbiological intent-to-treat (MITT) (45.6% versus 56.8%; 95% CI: -26.3%; 3.8%) and co-primary microbiologically evaluable (ME) (49.1% [28/57] versus 66.1% [39/59]); 95% CI: -34.7%; 0.8%) analysis sets. The overall 28-day all cause mortality rate was numerically higher for doripenem treated subjects in the MITT analysis set (21.5% versus 14.8%; 95% CI: -5.0%; 18.5%).The difference in clinical cure rate between doripenem versus imipenem/cilastatin was greater in patients with APACHE score > 15 (16/45 [36%] versus 23/46 [50%]) and in patients infected with *Pseudomonas aeruginosa* 7/17 [41%] versus 6/10 [60%]).

Pharmacokinetic properties

The mean C_{max} and $AUC_{0-\infty}$ of doripenem in healthy subjects across studies following administration of 500mg over 1 hour are approximately 23 µg/ml and 36 µg.h/ml, respectively. The mean C_{max} and $AUC_{0-\infty}$ of doripenem in healthy subjects across studies following administration of 500mg and 1 g over 4 hours are approximately 8 µg/ml and 17 µg/ml, and 34 µg.h/ml and 68 µg.h/ml, respectively. There is no accumulation of doripenem following multiple intravenous infusions of either 500mg or 1 g administered every 8 hours for 7 to 10 days in subjects with normal renal function.
Doripenem single dose pharmacokinetics after a 4-hour infusion in adults with cystic fibrosis are consistent with those in adults without cystic fibrosis. Adequate and well controlled studies to establish the safety and efficacy of doripenem in patients with cystic fibrosis have not been conducted.

Distribution
The average binding of doripenem to plasma proteins was approximately 8.1% and is independent of plasma concentrations. The volume of distribution at steady state is approximately 16.8 l, similar to extracellular fluid volume in man. Doripenem penetrates well into several body fluids and tissues, such as uterine tissue, retroperitoneal fluid, prostatic tissue, gallbladder tissue and urine.

Biotransformation

Metabolism of doripenem to a microbiologically inactive ring-opened metabolite occurs primarily via dehydropeptidase-I. Doripenem undergoes little to no Cytochrome P450 (CYP450) mediated metabolism. *In vitro* studies have determined that doripenem does not inhibit or induce the activities of CYP isoforms 1A2, 2A6, 2C9, 2C19, 2D6, 2E1 or 3A4.

Elimination

Doripenem is primarily eliminated unchanged by the kidneys. Mean plasma terminal elimination half-life of doripenem in healthy young adults is approximately 1 hour and plasma clearance is approximately 15.9 l/hour. Mean renal clearance is 10.3 l/hour. The magnitude of this value, coupled with the significant decrease in the elimination of doripenem seen with concomitant probenecid administration, suggests that doripenem undergoes glomerular filtration, tubular secretion and
re-absorption. In healthy young adults given a single 500mg dose of Doripenam, 71% and 15% of the dose was recovered in urine as unchanged active substance and ring-opened metabolite, respectively. Following the administration of a single 500mg dose of radiolabeled doripenem to healthy young adults, less than 1% of the total radioactivity was recovered in faeces. The pharmacokinetics of doripenem are linear over a dose range of 500mg to 2 g when intravenously infused over 1 hour and 500mg to 1 g when intravenously infused over 4 hours.

Renal impairment

Following a single 500mg dose of Doripenam, doripenem AUC increased 1.6-fold, 2.8-fold, and 5.1-fold in subjects with mild (CrCl 51-79 ml/min), moderate (CrCl 31-50 ml/min), and severe renal impairment (CrCl ☐ 30 ml/min), respectively, compared to age-matched healthy subjects with normal renal function (CrCl > 80 ml/min). AUC of the microbiologically inactive ring-opened metabolite (doripenem-M-1) is expected to be considerably increased in patients with severe renal impairment compared with healthy subjects. Dose adjustment is necessary in patients with moderate and severe renal impairment (see section 4.2).

Doripenam dosage adjustment is necessary in patients receiving continuous renal replacement therapy (see section 4.2). In a study where 12 subjects with end stage renal disease received a single 500mg dose of doripenem as a 1-hour i.v. infusion, the systemic exposure to doripenem and doripenem-M-1 were increased compared with healthy subjects. The amount of doripenem and doripenem-M-1 removed during a 12-hour CVVH session was approximately 28% and 10% of the dose, respectively; and during a 12-hour CVVHDF session was approximately 21% and 8% of the dose, respectively.
Dosing recommendations for patients on continuous renal replacement therapy were developed to achieve doripenem systemic exposures similar to subjects with normal renal function who receive doripenem 500mg as a 1-hour infusion, to maintain doripenem concentrations above a minimum inhibitory concentration of 1mg/l for at least 35% of the dosing interval, and to maintain doripenem and doripenem-M-1 metabolite exposures below those observed with a 1-hour infusion of 1 g doripenem every 8 hours in healthy subjects. These dosing recommendations were derived by modeling data from subjects with end stage renal disease receiving continuous renal replacement therapy, and take into consideration the potential increases in non-renal clearance of carbapenems in patients with acute renal insufficiency compared to patients with chronic renal impairment.
Doripenem-M-1 had a slow elimination in the patient group and the half-life (and AUC) has not been satisfactorily determined. Therefore, it may not be excluded that the exposure obtained in patients receiving continuous renal replacement therapy will be

higher than estimated and thus higher than metabolite exposures observed with a 1-hour infusion of 1 g doripenem every 8 hours in healthy subjects. The *in vivo* consequences of the increased exposures to the metabolite are unknown as data on pharmacological activity, except for antimicrobiological activity, are lacking (see section 4.4). If the doripenem dose is increased beyond the recommended dose for continuous renal replacement therapy, the systemic exposure of the doripenem-M-1 metabolite is even further increased. The clinical consequences of such an increase in exposure are unknown.

The systemic exposures to doripenem and doripenem-M-1 are substantially increased in patients with end stage renal disease receiving haemodialysis compared with healthy subjects. In a study where six subjects with end stage renal disease received a single dose of 500mg doripenem by i.v. infusion, the amount of doripenem and doripenem-M-1 removed during a 4-hour haemodialysis session was approximately 46% and 6% of the dose, respectively. There is insufficient information to make dose adjustment recommendations in patients on intermittent haemodialysis or dialysis methods other than continuous renal replacement therapy (see section 4.2).

Hepatic impairment
The pharmacokinetics of doripenem in patients with hepatic impairment have not been established. As doripenem does not appear to undergo hepatic metabolism, the pharmacokinetics of doripenem are not expected to be affected by hepatic impairment.

Elderly
The impact of age on the pharmacokinetics of doripenem was evaluated in healthy elderly male and female subjects (66-84 years of age). Doripenem AUC increased 49% in elderly adults relative to young adults. These changes were mainly attributed to age-related changes in renal function. No dose adjustment is necessary in elderly patients, except in cases of moderate to severe renal insufficiency (see section 4.2).

Gender
The effect of gender on the pharmacokinetics of doripenem was evaluated in healthy male and female subjects. Doripenem AUC was 13% higher in females compared to males. No dose adjustment is recommended based on gender.

Race
The effect of race on doripenem pharmacokinetics was examined through a population pharmacokinetic analysis. No significant difference in mean doripenem clearance was observed across race groups and therefore, no dose adjustment is recommended for race.

Preclinical safety data

Non-clinical data reveal no special hazard for humans based on conventional studies of safety pharmacology and genotoxicity. However, because of the design of the repeat dose toxicity studies and differences in pharmacokinetics in animals and humans, continuous exposure of animals was not assured in these studies.

No reproductive toxicity was observed in studies performed in rats and rabbits. However, these studies are of limited relevance because studies were performed with single daily dosing resulting in less than one tenth of daily doripenem exposure duration in animals.

6. PHARMACEUTICAL PARTICULARS

List of excipients

None

Incompatibilities

This medicinal product must not be mixed

with other medicinal products except those mentioned in section 6.3.

Shelf life

3 years.

Storage of reconstituted solutions: Upon reconstitution with sterile water for injections or sodium chloride 9mg/ml (0.9%) solution for injection, Doripenam suspension in the vial may be held for up to 1 hour below 30°C prior to transfer and dilution in the infusion bag.

Following dilution in the infusion bag, Doripenam infusions stored at room temperature or under refrigeration should be completed according to the times in the following table:

Time by which reconstitution, dilution and infusion must be completed for Doripenam infusion solutions

Infusion solution	**Solution stored at room temperature**	**Solution stored in a refrigerator (2°C-8°C)**
sodium chloride 9mg/ml (0.9%) solution for injection	12 hours	72 hours*
[+]dextrose 50mg/ml (5%) solution for injection	4 hours	24 hours*

* Once removed from the refrigerator, infusions should be completed within the room temperature stability time, provided the total refrigeration time, time to reach room temperature and infusion time does not exceed refrigeration stability time.

[+] Dextrose 50mg/ml (5%) solution for injection should not be used for infusion durations greater than 1 hour.

Chemical and physical in-use stability has been demonstrated for the times and solutions shown in the above table.

From a microbiological point of view, the product should be used immediately. If not used immediately, in-use storage times and conditions prior to use are the responsibility of the user and would normally not be longer than 24 hours at 2°C-8°C, unless reconstitution/dilution has taken place in controlled and validated aseptic conditions.

Special precautions for storage

This medicinal product does not require any special storage conditions.

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

Nature and contents of container

Clear 20 ml Type I glass vial.

The medicinal product is supplied in cartons containing 10 vials.

Special precautions for disposal and other handling

Each vial is for single use only.

Doripenam is reconstituted and then further diluted prior to infusion.
Preparation of 250mg dose of solution for infusion using the 250mg vial
Add 10 ml of sterile water for injections or sodium chloride 9mg/ml (0.9%) solution for injection to the 250mg vial and shake it to form a suspension.
Inspect the suspension visually for foreign matter. Note: the suspension is not for direct infusion.
Withdraw the suspension using a syringe and needle and add it to an infusion bag containing 50 ml or 100 ml of either sodium chloride 9mg/ml (0.9%) solution for injection or dextrose
50mg/ml (5%) solution for injection and mix to complete dissolution. Infuse all of this solution to administer a 250mg dose of doripenem.

Preparation of 500 mg dose of solution for infusion using the 500 mg vial

1. Add 10 ml of sterile water for injections or sodium chloride 9 mg/ml (0.9%) solution for injection to the 500 mg vial and shake it to form a suspension.
2. Inspect the suspension visually for foreign matter. Note: the suspension is not for direct infusion.
3. Withdraw the suspension using a syringe and needle and add it to an infusion bag containing 100 ml of either sodium chloride 9 mg/ml (0.9%) solution for injection or dextrose 50 mg/ml (5%) solution for injection and mix to complete dissolution. Infuse all of this solution to administer a 500 mg dose of doripenem.

Doripenam solutions for infusion range from clear, colourless solutions to solutions that are clear and slightly yellow. Variations in colour within this range do not affect the potency of the product.

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