SUMMARY OF PRODUCT CHARACTERISTICS

1. NAME OF THE MEDICINAL PRODUCT

TIENAM 500 mg/500 mg powder for solution for infusion

2. QUALITATIVE AND QUANTITATIVE COMPOSITION

Each vial contains imipenem monohydrate equivalent to 500 mg imipenem anhydrate and cilastatin sodium equivalent to 500 mg cilastatin.

Excipient with known effect:
Each vial contains sodium bicarbonate equivalent to approximately 1.6 mEq of sodium (approximately 37.6 mg).

For a full list of excipients, see section 6.1.

3. PHARMACEUTICAL FORM

Powder for solution for infusion.
White to light yellow powder.

4. CLINICAL PARTICULARS

4.1 Therapeutic indications

TIENAM is indicated for the treatment of the following infections in adults and children 1 year of age and above (see sections 4.4 and 5.1):

- complicated intra-abdominal infections
- severe pneumonia including hospital and ventilator-associated pneumonia
- intra- and post-partum infections
- complicated urinary tract infections
- complicated skin and soft-tissue infections

TIENAM may be used in the management of neutropenic patients with fever that is suspected to be due to a bacterial infection.

Treatment of patients with bacteraemia that occurs in association with, or is suspected to be associated with, any of the infections listed above.

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

4.2 Posology and method of administration

Posology
The dose recommendations for TIENAM represent the quantity of imipenem/cilastatin to be administered.

The daily dose of TIENAM should be based on the type of infection and given in equally divided doses based on consideration of degree of susceptibility of the pathogen(s) and the patient's renal function (see also section 4.4 and 5.1).

Adults and adolescents
For patients with normal renal function (creatinine clearance of ≥ 90 ml/min), the recommended dose regimens are:

500 mg/500 mg every 6 hours OR
1000 mg/1000 mg every 8 hours OR every 6 hours

It is recommended that infections suspected or proven to be due to less susceptible bacterial species (such as *Pseudomonas aeruginosa*) and very severe infections (e.g. in neutropenic patients with a fever) should be treated with 1000 mg/1000 mg administered every 6 hours.

A reduction in dose is necessary when creatinine clearance is < 90 ml/min. (see Table 1) The maximum total daily dose should not exceed 4000 mg/4000 mg per day.
Renal impairment
To determine the reduced dose for adults with impaired renal function:

1. The total daily dose (i.e. 2000/2000, 3000/3000 or 4000/4000 mg) that would usually be applicable to patients with normal renal function should be selected.
2. From table 1 the appropriate reduced dose regimen is selected according to the patient's creatinine clearance. For infusion times see Method of administration.

Creatinine clearance (mL/min) is:	If TOTAL DAILY DOSE is: 2000 mg/day	If TOTAL DAILY DOSE is: 3000 mg/day	If TOTAL DAILY DOSE is: 4000 mg/day
≥90 (normal)	500 q6h	1000 q8h	1000 q6h
reduced dosage (mg) for patients with renal impairment:			
<90 - ≥60	400 q6h	500 q6h	750 q8h
<60 - ≥30	300 q6h	500 q8h	500 q6h
<30 - ≥15	200 q6h	500 q12h	500 q12h

Patients with a creatinine clearance of <15 ml/min
These patients should not receive TIENAM unless haemodialysis is instituted within 48 hours.

Patients on haemodialysis
When treating patients with creatinine clearances of <15 ml/min who are undergoing dialysis use the dose recommendation for patients with creatinine clearances of 15 to 29 ml/min (see table 1).

Both imipenem and cilastatin are cleared from the circulation during haemodialysis. The patient should receive TIENAM after haemodialysis and at 12 hour intervals timed from the end of that haemodialysis session. Dialysis patients, especially those with background central nervous system (CNS) disease, should be carefully monitored; for patients on haemodialysis, TIENAM is recommended only when the benefit outweighs the potential risk of seizures (see section 4.4).
Currently there are inadequate data to recommend use of TIENAM for patients on peritoneal dialysis.
Hepatic impairment
No dose adjustment is recommended in patients with impaired hepatic function (see section 5.2).

Elderly population
No dose adjustment is required for the elderly patients with normal renal function (see section 5.2).

Paediatric population ≥1 year of age
For paediatric patients ≥1 year of age, the recommended dose is 15/15 or 25/25 mg/kg/dose administered every 6 hours.

It is recommended that infections suspected or proven to be due to less susceptible bacterial species (such as *Pseudomonas aeruginosa*) and very severe infections (e.g. in neutropenic patients with a fever) should be treated with 25/25 mg/kg administered every 6 hours.

Paediatric population <1 year of age
Clinical data are insufficient to recommend dosing for children less than 1 year of age.

Paediatric population with renal impairment
Clinical data are insufficient to recommend dosing for paediatric patients with renal impairment (serum creatinine > 2 mg/dl). See section 4.4.

Method of administration
TIENAM is to be reconstituted and further diluted (see section 6.2, 6.3 and 6.6) prior to administration. Each dose of ≤500 mg/500 mg should be given by intravenous infusion over 20 to 30 minutes.
Each dose >500 mg/500 mg should be infused over 40 to 60 minutes. In patients who develop nausea during the infusion, the rate of infusion may be slowed.

4.3 Contraindications

- Hypersensitivity to the active substances or to any of the excipients listed in section 6.1
- 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).

4.4 Special warnings and precautions for use

General
The selection of imipenem/cilastatin 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.

Hypersensitivity
Serious and occasionally fatal hypersensitivity (anaphylactic) reactions have been reported in patients receiving therapy with beta-lactams. These reactions are more likely to occur in individuals with a

history of sensitivity to multiple allergens. Before initiating therapy with TIENAM, careful inquiry should be made concerning previous hypersensitivity reactions to carbapenems, penicillins, cephalosporins, other beta-lactams and other allergens (see section 4.3). If an allergic reaction to TIENAM occurs, discontinue the therapy immediately. **Serious anaphylactic reactions require immediate emergency treatment.**

Hepatic
Hepatic function should be closely monitored during treatment with imipenem/cilastatin due to the risk of hepatic toxicity (such as increase in transaminases, hepatic failure and fulminant hepatitis).

Use in patients with liver disease: patients with pre-existing liver disorders should have liver function monitored during treatment with imipenem/cilastatin. There is no dose adjustment necessary (see section 4.2).

Haematology
A positive direct or indirect Coombs test may develop during treatment with imipenem/cilastatin.

Antibacterial spectrum
The antibacterial spectrum of imipenem/cilastatin should be taken into account especially in life- threatening conditions before embarking on any empiric treatment. Furthermore, due to the limited susceptibility of specific pathogens associated with e.g. bacterial skin and soft-tissue infections, to imipenem/cilastatin, caution should be exercised. The use of imipenem/cilastatin is not suitable for treatment of these types of infections unless the pathogen is already documented and known to be susceptible or there is a very high suspicion that the most likely pathogen(s) would be suitable for treatment. Concomitant use of an appropriate anti-MRSA agent may be indicated when MRSA infections are suspected or proven to be involved in the approved indications. 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).

Interaction with valproic acid
The concomitant use of imipenem/cilastatin and valproic acid/sodium valproate is not recommended (see section 4.5).

Clostridium difficile
Antibiotic-associated colitis and pseudomembranous colitis have been reported with imipenem/cilastatin and with nearly all other anti-bacterial agents and may range from mild to life- threatening in severity. It is important to consider this diagnosis in patients who develop diarrhoea during or after the use of imipenem/cilastatin (see section 4.8). Discontinuation of therapy with imipenem/cilastatin and the administration of specific treatment for *Clostridium difficile* should be considered. Medicinal products that inhibit peristalsis should not be given.

Meningitis
TIENAM is not recommended for the therapy of meningitis.

Renal impairment
Imipenem-cilastatin accumulates in patients with reduced kidney function. CNS adverse reactions may occur if the dose is not adjusted to the renal function, see section 4.2 and 4.4 "Central nervous system" in this section.

Central nervous system
CNS adverse reactions such as myoclonic activity, confusional states, or seizures have been reported, especially when recommended doses based on renal function and body weight were exceeded.
These experiences have been reported most commonly in patients with CNS disorders (e.g. brain lesions or

history of seizures) and/or compromised renal function in whom accumulation of the administered entities could occur. Hence close adherence to recommended dose schedules is urged especially in these patients (see section 4.2). Anticonvulsant therapy should be continued in patients with a known seizure disorder.

Special awareness should be made to neurological symptoms or convulsions in children with known risk factors for seizures, or on concomitant treatment with medicinal products lowering the seizures threshold.

If focal tremors, myoclonus, or seizures occur, patients should be evaluated neurologically and placed on anticonvulsant therapy if not already instituted. If CNS symptoms continue, the dose of TIENAM should be decreased or discontinued.

Patients with creatinine clearances of <15 ml/min should not receive TIENAM unless haemodialysis is instituted within 48 hours. For patients on haemodialysis, TIENAM is recommended only when the benefit outweighs the potential risk of seizures (see section 4.2).

Paediatric population
Clinical data are insufficient to recommend the use of TIENAM in children under 1 year of age or paediatric patients with impaired renal function (serum creatinine >2 mg/dl). See also above under Central nervous system.

TIENAM 500 mg/500 mg contains 37.6 mg of sodium (1.6 mEq) which should be taken into consideration by patients on a controlled sodium diet.

4.5 Interaction with other medicinal products and other forms of interaction

Generalized seizures have been reported in patients who received ganciclovir and TIENAM. These medicinal products should not be used concomitantly unless the potential benefit outweighs the risks.

Decreases in valproic acid levels that may fall below the therapeutic range have been reported when valproic acid was co-administered with carbapenem agents. The lowered valproic acid levels can lead to inadequate seizure control; therefore, concomitant use of imipenem and valproic acid/sodium valproate is not recommended and alternative antibacterial or anti-convulsant therapies should be considered (see section 4.4).

Oral anti-coagulants
Simultaneous administration of antibiotics with warfarin may augment its anti-coagulant effects. There have been many reports of increases in the anti-coagulant effects of orally administered anti- coagulant agents, including warfarin in patients who are concomitantly receiving antibacterial agents. The risk may vary with the underlying infection, age and general status of the patient so that the contribution of the antibiotic to the increase in INR (international normalised ratio) is difficult to assess. It is recommended that the INR should be monitored frequently during and shortly after co- administration of antibiotics with an oral anti-coagulant agent.

Concomitant administration of TIENAM and probenecid resulted in minimal increases in the plasma levels and plasma half-life of imipenem. The urinary recovery of active (non-metabolized) imipenem decreased to approximately 60% of the dose when TIENAM was administered with probenecid. Concomitant administration of TIENAM and probenecid doubled the plasma level and half-life of cilastatin, but had no effect on urine recovery of cilastatin.

Paediatric population
Interaction studies have only been performed in adults.

4.6 Fertility, pregnancy and lactation

Pregnancy
There are no adequate and well-controlled studies for the use of imipenem/cilastatin in pregnant women.

Studies in pregnant monkeys have shown reproductive toxicity (see section 5.3). The potential risk for humans is unknown.

TIENAM should be used during pregnancy only if the potential benefit justifies the potential risk to the foetus.

Breast-feeding
Imipenem and cilastatin are excreted into the mother's milk in small quantities. Little absorption of either compound occurs following oral administration. Therefore it is unlikely that the suckling infant will be exposed to significant quantities. If the use of TIENAM is deemed necessary, the benefit of breast feeding for the child should be weighed against the possible risk for the child.

Fertility
There are no data available regarding potential effects of imipenem/cilastatin treatment on male or female fertility.

4.7 Effects on ability to drive and use machines

No studies on the effects on the ability to drive and use machines have been performed. However, there are some side effects (such as hallucination, dizziness, somnolence, and vertigo) associated with this product that may affect some patients' ability to drive or operate machinery (see section 4.8).

4.8 Undesirable effects

In clinical trials including 1,723 patients treated with imipenem/cilastatin intravenous the most frequently reported systemic adverse reactions that were reported at least possibly related to therapy were nausea (2.0%), diarrhoea (1.8%), vomiting (1.5%), rash (0.9%), fever (0.5%), hypotension
(0.4%), seizures (0.4%) (see section 4.4), dizziness (0.3%), pruritus (0.3%), urticaria (0.2%), somnolence (0.2%). Similarly, the most frequently reported local adverse reactions were phlebitis/thrombophlebitis (3.1%), pain at the injection site (0.7%), erythema at the injection site (0.4%) and vein induration (0.2%). Increases in serum transaminases and in alkaline phosphatase are also commonly reported.

The following adverse reactions have been reported in clinical studies or during post-marketing experience.

All adverse reactions are listed under system organ class and frequency: Very common (≥1/10), Common (≥1/100 to <1/10), Uncommon (≥1/1,000 to <1/100), Rare (≥1/10,000 to <1/1,000), Very rare (<1/10,000) and not known (cannot be estimated from the available data).

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

System Organ Class	Frequency	Event
Infections and infestations	Rare	pseudomembranous colitis, candidiasis
	Very rare	gastro-enteritis
Blood and lymphatic system disorders	Common	eosinophilia
	Uncommon	pancytopenia, neutropenia, leucopenia, thrombocytopenia, thrombocytosis
	Rare	agranulocytosis
	Very rare	haemolytic anaemia, bone marrow depression
Immune system disorders	Rare	anaphylactic reactions
Psychiatric disorders	Uncommon	psychic disturbances including hallucinations and confusional states
Nervous system disorders	Uncommon	seizures, myoclonic activity, dizziness, somnolence
	Rare	encephalopathy, paraesthesia, focal tremor, taste perversion
	Very rare	aggravation of myasthenia gravis, headache
	Not known	agitation, dyskinesia
Ear and labyrinth disorders	Rare	hearing loss
	Very rare	vertigo, tinnitus
Cardiac disorders	Very rare	cyanosis, tachycardia, palpitations
Vascular disorders	Common	thrombophlebitis
	Uncommon	hypotension
	Very rare	flushing
Respiratory, thoracic and mediastinal disorders	Very rare	dyspnoea, hyperventilation, pharyngeal pain
Gastrointestinal disorders	Common	diarrhoea, vomiting, nausea Medicinal product-related nausea and/or vomiting appear to occur more frequently in granulocytopenic patients than in non- granulocytopenic patients treated with TIENAM
	Rare	staining of teeth and/or tongue
	Very rare	haemorrhagic colitis, abdominal pain, heartburn, glossitis, tongue papilla hypertrophy, increased salivation
Hepatobiliary disorders	Rare	hepatic failure, hepatitis
	Very Rare	fulminant hepatitis
Skin and subcutaneous tissue disorders	Common	rash (e.g. exanthematous)
	Uncommon	urticaria, pruritus
	Rare	toxic epidermal necrolysis, angioedema, Stevens-Johnson syndrome, erythema multiforme, exfoliative dermatitis
	Very rare	hyperhidrosis, skin texture changes
Musculoskeletal and connective tissue disorders	Very rare	polyarthralgia, thoracic spine pain
Renal and urinary disorders	Rare	acute renal failure, oligurial/anuria, polyuria, urine discoloration (harmless and should not be confused with haematuria) The role of TIENAM in changes in renal function is difficult to assess, since factors predisposing to pre-renal azotemia or to impaired renal function usually have been present.
Reproductive system and breast disorders	Very rare	pruritus vulvae
General disorders and administration site conditions	Uncommon	fever, local pain and induration at the injection site, erythema at the injection site
	Very rare	chest discomfort, asthenia/weakness
Investigations	Common	increases in serum transaminases, increases in serum alkaline phosphatase
	Uncommon	A positive direct Coombs' test, prolonged prothrombin time, decreased haemoglobin, increases in serum bilirubin, elevations in serum creatinine, elevations in blood urea nitrogen

Paediatric population (≥3 months of age*)*
In studies of 178 paediatric patients ≥3 months of age, the reported adverse reactions were consistent with those reported for adults.

Reporting of suspected adverse reactions
Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product.

4.9 Overdose

Symptoms of overdose that can occur are consistent with the adverse reaction profile; these may include seizures, confusion, tremors, nausea, vomiting, hypotension, bradycardia. No specific information is available on treatment of overdose with TIENAM. Imipenem-cilastatin sodium is haemodialyzable. However, usefulness of this procedure in the overdose setting is unknown.

5. PHARMACOLOGICAL PROPERTIES

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Antibacterials for systemic use, carbapenems, ATC code: J01D H51
Mechanism of action
TIENAM consists of two components: imipenem and cilastatin sodium in a 1:1 ratio by weight.

Imipenem, also referred to as N-formimidoyl-thienamycin, is a semi-synthetic derivative of thienamycin, the parent compound produced by the filamentous bacterium *Streptomyces cattleya*.

Imipenem exerts its bactericidal activity by inhibiting bacterial cell wall synthesis in Gram-positive and Gram-negative bacteria through binding to penicillin-binding proteins (PBPs).

Cilastatin sodium is a competitive, reversible and specific inhibitor of dehydropeptidase-I, the renal enzyme which metabolizes and inactivates imipenem. It is devoid of intrinsic antibacterial activity and does not affect the antibacterial activity of imipenem.

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3516
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Gram-negative aerobes:

Citrobacter freundii
Enterobacter aerogenes
Enterobacter cloacae
Escherichia coli
Haemophilus influenzae
Klebsiella oxytoca
Klebsiella pneumoniae
Moraxella catarrhalis
Serratia marcescens

Gram-positive anaerobes:

Clostridium perfringens[**]
Peptostreptococcus spp.[**]

Gram-negative anaerobes:

Bacteroides fragilis
Bacteroides fragilis group
Fusobacterium spp.
Porphyromonas asaccharolytica
Prevotella spp.
Veillonella spp.

Species for which acquired resistance may be a problem:

Gram-negative aerobes:

Acinetobacter baumannii
Pseudomonas aeruginosa

Inherently resistant species:

Gram positive aerobes:

Enterococcus faecium

Gram negative aerobes:

Some strains of *Burkholderia cepacia* (formerly *Pseudomonas cepacia*)
Legionella spp.
Stenotrophomonas maltophilia (formerly *Xanthomonas maltophilia*, formerly *Pseudomonas maltophilia*)

Others:

Chlamydia spp.
Chlamydophila spp.
Mycoplasma spp.
Ureoplasma urealyticum

[*] All methicillin-resistant staphylococci are resistant to imipenem/cilastatin.
[**] EUCAST non-species related breakpoint is used.

5.2 Pharmacokinetic properties

Imipenem

Absorption
In normal volunteers, intravenous infusion of TIENAM over 20 minutes resulted in peak plasma levels of imipenem ranging from 12 to 20 µg/ml for the 250 mg/250 mg dose, from 21 to 58 µg/ml for the 500 mg/500 mg dose, and from 41 to 83 µg/ml for the 1000 mg/1000 mg dose. The mean peak plasma levels of imipenem following the 250 mg/250 mg, 500 mg/500 mg, and 1000 mg /1000 mg doses were 17, 39, and 66 µg/ml, respectively. At these doses, plasma levels of imipenem decline to below 1 µg/ml or less in four to six hours.

Distribution
The binding of imipenem to human serum proteins is approximately 20%.

Biotransformation
When administered alone, imipenem is metabolized in the kidneys by dehydropeptidase-I. Individual urinary recoveries ranged from 5 to 40%, with an average recovery of 15-20% in several studies.

Cilastatin is a specific inhibitor of dehydropeptidase-I enzyme and effectively inhibits metabolism of imipenem so that concomitant administration of imipenem and cilastatin allows therapeutic antibacterial levels of imipenem to be attained in both urine and plasma.

Elimination
The plasma half-life of imipenem was one hour. Approximately 70% of the administered antibiotic was recovered intact in the urine within ten hours, and no further urinary excretion of imipenem was detectable. Urine concentrations of imipenem exceeded 10 µg/ml for up to eight hours after a
500 mg/500 mg dose of TIENAM. The remainder of the administered dose was recovered in the urine
as antibacterially inactive metabolites, and faecal elimination of imipenem was essentially nil.

No accumulation of imipenem in plasma or urine has been observed with regimens of TIENAM, administered as frequently as every six hours, in patients with normal renal function.

Cilastatin

Absorption
Peak plasma levels of cilastatin, following a 20 minute intravenous infusion of TIENAM, ranged from 21 to 26 µg/ml for the 250 mg/250 mg dose, from 21 to 55 µg/ml for the 500 mg/500 mg dose and from 56 to 88 µg/ml for the 1000 mg/1000 mg dose. The mean peak plasma levels of cilastatin following the 250 mg/250 mg, 500 mg/500 mg, and 1000 mg/1000 mg doses were 22, 42, and 72 µg/ml respectively.

Distribution
The binding of cilastatin to human serum proteins is approximately 40%.

Biotransformation and elimination
The plasma half-life of cilastatin is approximately one hour. Approximately 70-80% of the dose of cilastatin was recovered unchanged in the urine as cilastatin within 10 hours of administration of TIENAM. No further cilastatin appeared in the urine thereafter. Approximately 10% was found as the N-acetyl metabolite, which has inhibitory activity against dehydropeptidase comparable to that of cilastatin. Activity of dehydropeptidase-I in the kidney returned to normal levels shortly after the elimination of cilastatin from the blood stream.
Pharmacokinetics in special populations

Renal insufficiency
Following a single 250 mg/250 mg intravenous dose of TIENAM, the area under the curve (AUCs) for imipenem increased 1.1-fold, 1.9-fold, and 2.7-fold in subjects with mild (Creatinine Clearance (CrCL) 50-80 ml/min/1.73 m^2), moderate (CrCL 30-<50 ml/min/1.73 m^2), and severe (CrCL <30 ml/min/1.73 m^2) renal impairment, respectively, compared to subjects with normal renal function (CrCL >80 ml/min/1.73 m^2), and AUCs for cilastatin increased 1.6-fold, 2.0-fold, and 6.2-fold in subjects with mild, moderate, and severe renal impairment, respectively, compared to subjects with normal renal function. Following a single 250 mg/250 mg intravenous dose of TIENAM given 24 hours after haemodialysis, AUCs for imipenem and cilastatin were 3.7-fold and 16.4-fold higher, respectively, as compared to subjects with normal renal function. Urinary recovery, renal clearance and plasma clearance of imipenem and cilastatin decrease with decreasing renal function following intravenous administration of TIENAM. Dose adjustment is necessary for patients with impaired renal function (see section 4.2).

Hepatic insufficiency
The pharmacokinetics of imipenem in patients with hepatic insufficiency have not been established. Due to the limited extent of hepatic metabolism of imipenem, its pharmacokinetics are not expected to be affected by hepatic impairment. Therefore, no dose adjustment is recommended in patients with hepatic impairment (see section 4.2).

Paediatric population
The average clearance (CL) and volume of distribution (Vdss) for imipenem were approximately 45% higher in paediatric patients (3 months to 14 years) as compared to adults. The AUC for imipenem following administration of 15/15 mg/kg per body weight of imipenem/cilastatin to paediatric patients was approximately 30% higher than the exposure in adults receiving a 500 mg/500 mg dose. At the higher dose, the exposure following administration of 25/25 mg/kg imipenem/cilastatin to children was 9% higher as compared to the exposure in adults receiving a 1000 mg/1000 mg dose.

Elderly
In healthy elderly volunteers (65 to 75 years of age with normal renal function for their age), the pharmacokinetics of a single dose of TIENAM 500 mg/500 mg administered intravenously over

20 minutes were consistent with those expected in subjects with slight renal impairment for which no dose alteration is considered necessary. The mean plasma half-lives of imipenem and cilastatin were 91 ± 7.0 minutes and 69 ± 15 minutes, respectively. Multiple dosing has no effect on the pharmacokinetics of either imipenem or cilastatin, and no accumulation of imipenem/cilastatin was observed (see section 4.2).

5.3 Preclinical safety data

Non-clinical data reveal no special hazard for humans based on conventional studies of safety pharmacology, repeated dose toxicity and genotoxicity studies.

Animal studies showed that the toxicity produced by imipenem, as a single entity, was limited to the kidney. Co-administration of cilastatin with imipenem in a 1:1 ratio prevented the nephrotoxic effects of imipenem in rabbits and monkeys. Available evidence suggests that cilastatin prevents the nephrotoxicity by preventing entry of imipenem into the tubular cells.

A teratology study in pregnant cynomolgus monkeys given imipenem-cilastatin sodium at doses of 40/40 mg/kg/day (bolus intravenous injection) resulted in maternal toxicity including emesis, inappetence, body weight loss, diarrhoea, abortion, and death in some cases. When doses of imipenem-cilastatin sodium (approximately 100/100 mg/kg/day or approximately 3 times the usual recommended daily human intravenous dose) were administered to pregnant cynomolgus monkeys at an intravenous infusion rate which mimics human clinical use, there was minimal maternal intolerance (occasional emesis), no maternal deaths, no evidence of teratogenicity, but an increase in embryonic loss relative to control groups (see section 4.6).

Long term studies in animals have not been performed to evaluate carcinogenic potential of imipenem-cilastatin.

Pharmacokinetic/Pharmacodynamic (PK/PD) relationship
Similar to other beta-lactam antibacterial agents, the time that imipenem concentrations exceed the MIC (T>MIC) has been shown to best correlate with efficacy.

Mechanism of resistance
Resistance to imipenem may be due to the following:

- Decreased permeability of the outer membrane of Gram-negative bacteria (due to diminished production of porins)
- Imipenem may be actively removed from the cell with an efflux pump.
- Reduced affinity of PBPs to imipenem
- Imipenem 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 imipenem. There is no target-based cross-resistance between imipenem and agents of the quinolone, aminoglycoside, macrolide and tetracycline classes.

Breakpoints
EUCAST MIC breakpoints for imipenem to separate susceptible (S) pathogens from resistant (R) pathogens are as follows (v 1,1 2010-04-27):

- *Enterobacteriaceae* [1]: S ≤2 mg/l, R >8 mg/l
- *Pseudomonas* spp. [2]: S ≤4 mg/l, R >8 mg/l
- *Acinetobacter* spp.: S ≤2 mg/l, R >8 mg/l
- *Staphylococcus* spp. [3]: Inferred from cefoxitin susceptibility
- *Enterococcus* spp.: S ≤4 mg/l, R >8 mg/l
- *Streptococcus* A, B, C, G: The beta-lactam susceptibility of beta-haemolytic *streptococcus* groups A, B, C and G is inferred from the penicillin susceptibility.
- *Streptococcus pneumoniae* [4]: S ≤2 mg/l, R >2 mg/l
- Other streptococci [4]: S ≤2 mg/l, R >2 mg/l
- *Haemophilus influenzae* [4]: S ≤2 mg/l, R >2 mg/l
- *Moraxalla catarrhalis* [4]: S ≤2 mg/l, R >2 mg/l
- *Neisseria gonorrhoeae*: There is insufficient evidence that *Neisseria gonorrhoeae* is a good target for therapy with imipenem.
- Gram-positive anaerobes: S ≤2 mg/l, R >8 mg/l
- Gram-negative anaerobes: S ≤2 mg/l, R >8 mg/l
- Non-species related breakpoints [5]: S ≤2 mg/l, R >8 mg/l

[1] *Proteus* and *Morganella species* are considered poor targets for imipenem.
[2] The breakpoints for *Pseudomonas* relate to high dose frequent therapy (1g every 6 hours).
[3] Susceptibility of staphylococci to carbapenems is inferred from the cefoxitin susceptibility.
[4] Strains with MIC values above the susceptible breakpoint are very rare or not yet reported. The identification and antimicrobial susceptibility tests on any such isolate must be repeated and if the result is confirmed the isolate must be sent to a reference laboratory. Until there is evidence regarding clinical response for confirmed isolates with MIC above the current resistant breakpoint they should be reported resistant.
[5] Non-species related breakpoint have been determined mainly on the basis of PK/PD data and are independent of MIC distributions of specific species. They are for use only for species not mentioned in the overview of species-related breakpoints or footnotes.

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.

Commonly susceptible species:

Gram-positive aerobes:

Enterococcus faecalis
Staphylococcus aureus (Methicillin-susceptible)[*]
Staphylococcus coagulase negative (Methicillin-susceptible)
Streptococcus agalactiae
Streptococcus pneumoniae
Streptococcus pyogenes
Streptococcus viridans group

6. PHARMACEUTICAL PARTICULARS

6.1 List of excipients

Sodium bicarbonate

6.2 Incompatibilities

This medicinal product is chemically incompatible with lactate and should not be reconstituted in diluents containing lactate. However, it can be administered into an I.V. system through which a lactate solution is being infused.

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

6.3 Shelf life

DO NOT USE AFTER THE EXPIRY DATE MENTIONED ON THE CARTON.

After reconstitution:
Diluted solutions should be used immediately. The time interval between the beginning of reconstitution and the end of intravenous infusion should not exceed two hours.

6.4 Special precautions for storage

Store in a dry place below 25°C.

Do not freeze the reconstituted solution.

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

6.5 Nature and contents of container

20 ml Type I glass vials.

The medicinal product is supplied in packs of 1 vial, 10 vials and 25 vials.
Not all pack sizes may be marketed.

6.6 Special precautions for disposal and other handling

Each vial is for single use only.
Reconstitution:
Contents of each vial must be transferred to 100 ml of an appropriate infusion solution (see section 6.2 and 6.3): 0.9% sodium chloride. In exceptional circumstances where 0.9% sodium chloride cannot be used for clinical reasons 5% glucose may be used instead.

A suggested procedure is to add approximately 10 ml of the appropriate infusion solution to the vial. Shake well and transfer the resulting mixture to the infusion solution container.

CAUTION: THE MIXTURE IS NOT FOR DIRECT INFUSION.

Repeat with an additional 10 ml of infusion solution to ensure complete transfer of vial contents to the infusion solution. The resulting mixture should be agitated until clear.

The concentration of the reconstituted solution following the above procedure is approximately 5 mg/ml for both imipenem and cilastatin.

Variations of colour, from colourless to yellow, do not affect the potency of the product.

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

7. MARKETING AUTHORISATION HOLDER BATCH RELEASER AND MANUFACTURER

MARKET AUTHORISATION HOLDER & BATCH RELEASE SITE

Merck Sharp & Dohme B.V., Waarderweg 39, 2031 BN Haarlem, P.O. Box 581, 2003 PC Haarlem,
The Netherlands.

MANUFACTURER
Merck Sharp & Dohme Corp., 2778 South East Highway, Elkton, Virginia 22827, USA.

8. DATE OF FIRST AUTHORISATION/RENEWAL OF THE AUTHORISATION

Date of first authorisation: 2 May 1986
Date of latest renewal: 4 June 2011

9. DATE OF REVISION OF THE TEXT

13 November 2015

(THIS IS A MEDICAMENT)

-Medicament is a product which affects your health, and its consumption contrary to instructions is dangerous for you.
-Follow strictly the doctor's prescription, the method of use, and the instructions of the pharmacist who sold the medicament.
-The doctor and the pharmacist are experts in medicine, its benefits and risks.
-Do not by yourself interrupt the period of treatment prescribed for you.
-Do not repeat the same prescription without consulting your doctor.

Keep medicament out of reach of children

Council of Arab Health Ministers
Union of Arab Pharmacists

MSD