For the use only of a Registered Medical Practitioners or a Hospital or a Laboratory

Piperacillin/Tazobactam
Revotaz Trio

1. Name of the medicinal product

Piperacillin/Tazobactam powder for solution for infusion (pack of 3 Vials)

2. Qualitative and quantitative composition

Revotaz 1.125g

Each vial contains piperacillin (as sodium salt) USP equivalent to 1000 mg piperacillin and tazobactam as sodium salt equivalent to 125 mg tazobactam.

Revotaz 2.25g

Each vial contains piperacillin (as sodium salt) USP equivalent to 2000 mg piperacillin and tazobactam as sodium salt equivalent to 250 mg tazobactam.

Revotaz 4.5 g

Each vial contains piperacillin (as sodium salt) USP equivalent to 5000 mg piperacillin and tazobactam as sodium salt equivalent to 500 mg tazobactam.

3. Pharmaceutical form

Powder for solution for infusion.

4. Clinical particulars

4.1 Therapeutic indications

Piperacillin/Tazobactam is indicated for the treatment of the following infections in adults and children over 2 years of age:

Adults and adolescents

- Severe pneumonia including hospital-acquired and ventilator-associated pneumonia

- Complicated urinary tract infections (including pyelonephritis)

- Complicated intra-abdominal infections

- Complicated skin and soft tissue infections (including diabetic foot infections)

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

Piperacillin/Tazobactam may be used in the management of neutropenic patients with fever suspected to be due to a bacterial infection.

Children 2 to 12 years of age

- Complicated intra-abdominal infections

Piperacillin/Tazobactam may be used in the management of neutropenic children with fever suspected to be due to a bacterial infection.

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

4.2 Posology and method of administration

Posology

The dose and frequency of Piperacillin/Tazobactam depends on the severity and localisation of the infection and expected pathogens.

Adult and adolescent patients

Infections

The usual dose is 4 g piperacillin / 0.5 g tazobactam given every 8 hours.

For nosocomial pneumonia and bacterial infections in neutropenic patients, the recommended dose is 4 g piperacillin / 0.5 g tazobactam administered every 6 hours. This regimen may also be applicable to treat patients with other indicated infections when particularly severe.

The following table summarises the treatment frequency and the recommended dose for adult and adolescent patients by indication or condition:

Treatment frequency	**Piperacillin/Tazobactam 4 g / 0.5 g**
Every 6 hours	Severe pneumonia
	Neutropenic adults with fever suspected to be due to a bacterial infection.
Every 8 hours	Complicated urinary tract infections (including pyelonephritis)
	Complicated intra-abdominal infections
	Skin and soft tissue infections (including diabetic foot infections)

Renal impairment

The intravenous dose should be adjusted to the degree of actual renal impairment as follows (each patient must be monitored closely for signs of substance toxicity; medicinal product dose and interval should be adjusted accordingly):

Creatinine clearance (ml/min)	**Piperacillin/Tazobactam (recommended dose)**
> 40	No dose adjustment necessary
20-40	Maximum dose suggested: 4 g / 0.5 g every 8 hours
< 20	Maximum dose suggested: 4 g / 0.5 g every 12 hours

For patients on haemodialysis, one additional dose of piperacillin / tazobactam 2 g / 0.25 g should be administered following each dialysis period, because haemodialysis removes 30%-50% of piperacillin in 4 hours.

Hepatic impairment

No dose adjustment is necessary.

Dose in elderly patients

No dose adjustment is required for the elderly with normal renal function or creatinine clearance values above 40 ml/min.

Paediatric population (2-12 years of age)

Infections

The following table summarises the treatment frequency and the dose per body weight for paediatric patients 2-12 years of age by indication or condition:

Dose per weight and treatment frequency	**Indication / condition**
80 mg Piperacillin / 10 mg Tazobactam per kg body weight / every 6 hours	Neutropenic children with fever suspected to be due to bacterial infections*
100 mg Piperacillin / 12.5 mg Tazobactam per kg body weight / every 8 hours	Complicated intra-abdominal infections*

* Not to exceed the maximum 4 g / 0.5 g per dose over 30 minutes.

Renal impairment

The intravenous dose should be adjusted to the degree of actual renal impairment as follows (each patient must be monitored closely for signs of substance toxicity; medicinal product dose and interval should be adjusted accordingly):

Creatinine clearance (ml/min)	**Piperacillin/Tazobactam (recommended dose)**
> 50	No dose adjustment needed.
≤ 50	70 mg piperacillin / 8.75 mg tazobactam / kg every 8 hours.

For children on haemodialysis, one additional dose of 40 mg piperacillin / 5 mg tazobactam / kg should be administered following each dialysis period.

Use in children aged below 2 years

The safety and efficacy of Piperacillin/Tazobactam in children 0- 2 years of age has not been established.

No data from controlled clinical studies are available.

Treatment duration

The usual duration of treatment for most indications is in the range of 5-14 days. However, the duration of treatment should be guided by the severity of the infection, the pathogen(s) and the patient's clinical and bacteriological progress.

Route of administration

Piperacillin/Tazobactam 2 g / 0.25 g is administered by intravenous infusion (over 30 minutes).

Piperacillin/Tazobactam 4 g / 0.5 g is administered by intravenous infusion (over 30 minutes).

For reconstitution instructions, see section 6.6.

4.3 Contraindications

Hypersensitivity to the active substances, any other penicillin-antibacterial agent or to any of the excipients.

History of acute severe allergic reaction to any other beta-lactam active substances (e.g. cephalosporin, monobactam or carbapenem).

4.4 Special warnings and precautions for use

The selection of piperacillin / tazobactam to treat an individual patient should take into account the appropriateness of using a broad-spectrum semi-synthetic penicillin based on factors such as the severity of the infection and the prevalence of resistance to other suitable antibacterial agents.

Before initiating therapy with Piperacillin/Tazobactam, careful inquiry should be made concerning previous hypersensitivity reactions to penicillins, other beta-lactam agents (e.g. cephalosporin, monobactam or carbapenem) and other allergens. Serious and occasionally fatal hypersensitivity (anaphylactic/anaphylactoid [including shock]) reactions have been reported in patients receiving therapy with penicillins, including piperacillin / tazobactam. These reactions are more likely to occur in persons with a history of sensitivity to multiple allergens. Serious hypersensitivity reactions require the discontinuation of the antibiotic, and may require administration of epinephrine and other emergency measures.

Antibiotic-induced pseudomembranous colitis may be manifested by severe, persistent diarrhoea which may be life-threatening. The onset of pseudomembranous colitis symptoms may occur during or after antibacterial treatment. In these cases Piperacillin/Tazobactam, should be discontinued.

Therapy with Piperacillin/Tazobactam may result in the emergence of resistant organisms, which might cause super-infections.

Bleeding manifestations have occurred in some patients receiving β-lactam antibiotics. These reactions have sometimes been associated with abnormalities of coagulation tests such as clotting time, platelet aggregation and prothrombin time, and are more likely to occur in patients with renal failure. If bleeding manifestations occur, the antibiotic should be discontinued and appropriate therapy instituted.

Leukopenia and neutropenia may occur, especially during prolonged therapy; therefore, periodic assessment of haematopoietic function should be performed.

As with treatment with other penicillins, neurological complications in the form of convulsions may occur when high doses are administered, especially in patients with impaired renal function.

This medicinal product contains 4.7 mmol (108 mg) of sodium per vial of powder for solution for infusion. To be taken into consideration by patients on a controlled sodium diet

Hypokalaemia may occur in patients with low potassium reserves or who are receiving concomitant medicinal products that may lower potassium levels; periodic electrolyte determinations may be performed in such patients.

4.5 Interaction with other medicinal products and other forms of interaction

Non-depolarising muscle relaxants

Piperacillin when used concomitantly with vecuronium has been implicated in the prolongation of the neuromuscular blockade of vecuronium. Due to their similar mechanism of action, it is expected that the neuromuscular blockade produced by any of the non-depolarising muscle relaxants could be prolonged in the presence of piperacillin.

Oral anticoagulants

During simultaneous administration of heparin, oral anticoagulants and other substances, which may affect the blood coagulation system including thrombocyte function, appropriate coagulation tests should be performed more frequently and monitored regularly.

Methotrexate:

Piperacillin may reduce the excretion of methotrexate. Serum levels of methotrexate should be monitored in patients to avoid substance toxicity.

Probenecid:

Concurrent administration of probenecid and piperacillin/tazobactam produced a longer half-life and lower renal clearance for both piperacillin and tazobactam. However, peak plasma concentrations of either drug are unaffected.

Aminoglycosides

Piperacillin, either alone or with tazobactam, did not significantly alter the pharmacokinetics of tobramycin in subjects with normal renal function and with mild or moderate renal impairment. The pharmacokinetics of piperacillin, tazobactam, and the M1 metabolite were also not significantly altered by tobramycin administration.

The inactivation of tobramycin and gentamicin by piperacillin has been demonstrated in patients with severe renal impairment

For information related to administration of piperacillin/tazobactam with aminoglycosides please refer to section 6.2 and 6.6

Vancomycin

No pharmacokinetic interactions have been noted between piperacillin / tazobactam and vancomycin

Effects on laboratory tests

Non-enzymatic methods of measuring urinary glucose may lead to false-positive results, as with other penicillins. Therefore, enzymatic urinary glucose measurement is required under Piperacillin/Tazobactam therapy.

A number of chemical urine protein measurement methods may lead to false-positive results. Protein measurement with dip sticks is not affected.

The direct Coombs test may be positive.

Bio-Rad Laboratories *Platelia Aspergillus* EIA tests may lead to false-positive results for patients receiving Piperacillin/Tazobactam. Cross-reactions with non-*Aspergillus* polysaccharides and polyfuranoses with Bio-Rad Laboratories *Platelia Aspergillus* EIA test have been reported.

Positive test results for the assays listed above in patients receiving Piperacillin/Tazobactam should be confirmed by other diagnostic methods.

4.6 Fertility,pregnancy and lactation

Pregnancy

There are no or a limited amount of data from the use of Piperacillin/Tazobactam in pregnant women.

Studies in animals have shown developmental toxicity, but no evidence of teratogenicity, at doses that are maternally toxic.

Piperacillin and tazobactam cross the placenta. Piperacillin / tazobactam should only be used during pregnancy if clearly indicated, i.e. only if the expected benefit outweighs the possible risks to the pregnant woman and foetus.

Breast-feeding

Piperacillin is excreted in low concentrations in breast milk. Tazobactam concentrations in human milk have not been studied. Women who are breast feeding should be treated only if the expected benefit outweighs the possible risks to the woman and child.

Fertility

A fertility study in rats showed no effect on fertility and mating after intraperitoneal administration of tazobactam or the combination piperacillin / tazobactam (see section 5.3).

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.

4.8 Undesirable effects

The most commonly reported adverse reactions (occurring in 1 to 10 patients in 100) are diarrhoea, vomiting, nausea and rash.

In the following table, adverse reactions are listed by system organ class Within each frequency grouping, undesirable effects are presented in order of decreasing seriousness.

System Organ Class	**Common (>1/100, <1/10)**	**Uncommon (>1/1,000, <1/100)**	**Rare (>1/10,000, <1/1,000)**	**Very rare (<1/10,000),**
Infections and infestations:		Candidal superinfection		
Blood and lymphatic system disorders:		leucopenia, neutropenia, thrombocytopenia	anaemia, purpura, epistaxis, bleeding time prolonged) eosinophilia, haemolytic anaemia	agranulocytosis, Coombs direct test positiv, pancytopenia, activated partial thromboplastin time prolonged, , prothrombin time prolonged, thrombocythaemia
Immune system disorders:		hypersensitivity	anaphylactic/ anaphylactoid	

			reaction (including shock)	
Metabolism and nutrition disorders				blood glucose decreased, blood albumin decreased, blood protein total decreased, hypokalaemia
Nervous system disorders		headache, insomnia		
Vascular disorders		hypotension, phlebitis, thrombophlebitis	Flushing	
Gastrointestinal disorders	diarrhoea, nausea, vomiting	constipation, dyspepsia, jaundice, stomatitis	abdominal pain, pseudomembra-nous colitis	
Hepatobiliary disorders		alanine aminotransferase increased, aspartate aminotransferase increased	Blood bilirubin increased, blood alkaline phosphatase increased, gamma-glutamyltransferase increased, hepatitis	
Skin and subcutaneous tissue disorders	Rash including maculopapular rash	pruritus, urticaria	bullous dermatitis, erythema multiforme, exanthema	Stevens-Johnson syndrome, toxic epidermal necrolysis
Musculoskeletal, connective tissue and bone disorders			Arthralgia, myalgia	
Renal and urinary disorders		blood creatinine increased	Tubulointerstitial nephritis, renal failure	blood urea increased
General disorders and administration site conditions		Pyrexia, injection site reaction	chills	

Piperacillin therapy has been associated with an increased incidence of fever and rash in cystic fibrosis patients.

A strong causal relationship between FDC of Piperacillin and Tazobactam and following adverse events has been observed.

- Bronchospasm
- Hypokalaemia

- Abnormal Vision

4.9 Overdose

Symptoms

There have been post-marketing reports of overdose with piperacillin/tazobactam. The majority of those events experienced including nausea, vomiting, and diarrhoea have also been reported with the usual recommended dose. Patients may experience neuromuscular excitability or convulsions if higher than recommended doses are given intravenously (particularly in the presence of renal failure).

Treatment

In the event of an overdose, piperacillin/tazobactam treatment should be discontinued.

No specific antidote is known.

Treatment should be supportive and symptomatic according to the patient's clinical presentation.

Excessive serum concentrations of either piperacillin or tazobactam may be reduced by haemodialysis.

5. Pharmacological properties

5.1 Pharmacodynamic properties

Pharmacotherapeutic group: Antibacterials for systemic use,Combinations of penicillins, including beta-lactamase inhibitors

Mechanism of action:

Piperacillin, a broad-spectrum, semisynthetic penicillin exerts bactericidal activity by inhibition of both septum and cell-wall synthesis.

Tazobactam, a beta-lactam structurally related to penicillins, is an inhibitor of many beta-lactamases, which commonly cause resistance to penicillins and cephalosporinsbut it does not inhibit AmpC enzymes or metallo beta-lactamases. Tazobactum extends the antibiotic spectrum of piperacillin to include many beta-lactamase-producing bacteria that have acquired resistance to piperacillin alone.

PK/PD relationship:

The time above the minimum inhibitory concentration (T>MIC) is considered to be the major pharmacodynamic determinant of efficacy for piperacillin

Mechanism of resistance

The two main mechanisms of resistance to piperacillin / tazobactam are:

• Inactivation of the piperacillin component by those beta-lactamases that are not inhibited by tazobactam: beta-lactamases in the Molecular class B, C and D. In addition, tazobactam does not provide protection against extended-spectrum beta-lactamases (ESBLs) in the Molecular class A and D enzyme groups.

• Alteration of penicillin-binding proteins (PBPs), which results in the reduction of the affinity of piperacillin for the molecular target in bacteria.

Additionally, alterations in bacterial membrane permeability, as well as expression of multi-drug efflux pumps, may cause or contribute to bacterial resistance to piperacillin / tazobactam, especially in Gram-negative bacteria.

Breakpoints

EUCAST clinical MIC breakpoints for Piperacillin / Tazobactam (2009-12-02 v1).

For susceptibility testing purposes, the concentration of tazobactam is fixed at 4 mg/L

Pathogen	**Species-related breakpoints (S</R>)**
Enterobacteriaceae	8/16
Pseudomonas	16/16
Gram-negative and Gram-positive anaerobes	8/16
Non-species related breakpoints	4/16

The susceptibility of streptococci is inferred from the penicillin susceptibility.

The susceptibility of staphylococci is inferred from the oxacillin susceptibility.

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.

Groupings of relevant species according to piperacillin / tazobactam susceptibility
COMMONLY SUSCEPTIBLE SPECIES
Aerobic Gram-positive micro-organisms *Enterococcus faecalis* *Listeria monocytogenes* *Staphylococcus aureus,* methicillin-susceptible[£] *Staphylococcus* species*, coagulase negative*, methicillin-susceptible *Streptococcus pyogenes* *Group B streptococci*
Aerobic Gram-negative micro-organisms *Citrobacter koseri* *Haemophilus influenza* *Moraxella catarrhalis* *Proteus mirabilis*

Anaerobic Gram-positive micro-organisms *Clostridium* species *Eubacterium* species *Peptostreptococcus* species
Anaerobic Gram-negative micro-organisms *Bacteroides fragilis* group *Fusobacterium* species *Porphyromonas* species *Prevotella* species
SPECIES FOR WHICH ACQUIRED RESISTANCE MAY BE A PROBLEM
Aerobic Gram-positive micro-organisms Enterococcus faecium$,+ Streptococcus pneumonia Streptococcus viridans group Aerobic Gram-negative micro-organisms Acinetobacter baumannii$ Burkholderia cepacia Citrobacter freundii Enterobacter species Escherichia coli Klebsiella pneumonia Morganella morganii Proteus vulgaris Providencia ssp. Pseudomonas aeruginosa
Serratia species
INHERENTLY RESISTANT ORGANISMS
Aerobic Gram-positive micro-organisms Corynebacterium jeikeium

Aerobic Gram-negative micro-organisms Legionella species Stenotrophomonas maltophilia+,$
Other microorganisms
Chlamydophilia pneumonia
Mycoplasma pneumonia
$ Species showing natural intermediate susceptibility. + Species for which high-resistance rates (more than 50%) have been observed in one or more areas/countries/regions within the EU. £ All methicillin-resistant staphylococci are resistant to piperacillin / tazobactam.

5.2 Pharmacokinetic properties

Absorption

The peak piperacillin and tazobactam concentrations after 4 g / 0.5 g administered over 30 minutes by intravenous infusion are 298 µg/ml and 34 µg/ml respectively.

Distribution

Both piperacillin and tazobactam are approximately 30% bound to plasma proteins. The protein binding of either piperacillin or tazobactam is unaffected by the presence of the other compound. Protein binding of the tazobactam metabolite is negligible.

Piperacillin and tazobactam are widely distributed in tissue and body fluids including intestinal mucosa, gall bladder, lung, bile and bone. Mean tissue concentrations are generally 50 to 100% of those in plasma. Distribution into cerebrospinal fluid is low in subjects with non-inflamed meninges, as with other penicillins.

Biotransformation

Piperacillin is metabolised to a minor microbiologically active desethyl metabolite. Tazobactam is metabolised to a single metabolite, that has been found to be micro-biologically inactive.

Elimination

Piperacillin and tazobactam are eliminated by the kidney via glomerular filtration and tubular secretion.

Piperacillin is excreted rapidly as unchanged substance with 68% of the administered dose appearing in the urine. Tazobactam and its metabolite are eliminated primarily by renal excretion with 80% of the administered dose appearing as unchanged substance and the remainder as the single metabolite. Piperacillin, tazobactam, and desethyl piperacillin are also secreted into the bile.

Following single or multiple doses of piperacillin / tazobactam to healthy subjects, the plasma half-life of piperacillin and tazobactam ranged from 0.7 to 1.2 hours and was unaffected by dose or duration

of infusion. The elimination half-lives of both piperacillin and tazobactam are increased with decreasing renal clearance.

There are no significant changes in piperacillin pharmacokinetics due to tazobactam. Piperacillin appears to slightly reduce the clearance of tazobactam.

Special populations

The half-life of piperacillin and of tazobactam increases by approximately 25% and 18%, respectively, in patients with hepatic cirrhosis compared to healthy subjects.

The half-life of piperacillin and tazobactam increases with decreasing creatinine clearance. The increase in half-life is two-fold and four-fold for piperacillin and tazobactam, respectively, at creatinine clearance below 20 ml/min compared to patients with normal renal function.

Haemodialysis removes 30% to 50% of piperacillin / tazobactam, with an additional 5% of the tazobactam dose removed as the tazobactam metabolite. Peritoneal dialysis removes approximately 6% and 21% of the piperacillin and tazobactam doses, respectively, with up to 18% of the tazobactam dose removed as the tazobactam metabolite.

Paediatric population

In a population PK analysis, estimated clearance for 9 month-old to 12 year-old patients was comparable to adults, with a population mean (SE) value of 5.64 (0.34) ml/min/kg. The piperacillin clearance estimate is 80% of this value for paediatric patients 2-9 months of age. The population mean (SE) for piperacillin volume of distribution is 0.243 (0.011) l/kg and is independent of age.

Elderly patients

The mean half-life for piperacillin and tazobactam were 32% and 55% longer, respectively, in the elderly compared with younger subjects. This difference may be due to age-related changes in creatinine clearance.

Race

No difference in piperacillin or tazobactam pharmacokinetics was observed between Asian (n=9) and Caucasian (n=9) healthy volunteers who received single 4 g / 0.5 g doses

6. Pharmaceutical particulars

6.1 Incompatibilities

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

Whenever Piperacillin / Tazobactam is used concurrently with another antibiotic (e.g. aminoglycosides), the drugs must be administered separately. The mixing of Piperacillin / Tazobactam with an aminoglycoside *in vitro* can result in substantial inactivation of the aminoglycoside.

Piperacillin / Tazobactam should not be mixed with other drugs in a syringe or infusion bottle since compatibility has not been established.

Piperacillin/Tazobactam should be administered through an infusion set separately from any other drugs unless compatibility is proven.

Due to chemical instability, Piperacillin / Tazobactam should not be used with solutions that contain sodium bicarbonate.

Lactated Ringer's (Hartmann´s) solution is not compatible with piperacillin/tazobactam.

Piperacillin / Tazobactam should not be added to blood products or albumin hydrolysates.

6.2 Shelf life

Vial before opening:

24 months

Vial after first opening/after reconstitution:

After reconstitution (and dilution):

Reconstituted and/or diluted Piperacillin/Tazobactam should be used immediately.

From a microbiological point of view, the product should be used immediately.

Unused solution should be discarded.

6.3 Special precautions for storage

Un opened: Store in the original package in order to protect from light.

Store below 25°C.

6.4 Nature and contents of container

(Pack of 3 vials)

6.5 Special precautions for disposal and other handling

Reconstitution Directions

Sterile diluents for preparation of the reconstituted solution:

• Sterile Water for Injection

• 9 mg/ml (0.9%) Sodium Chloride for Injection

• Dextrose 50 mg/ml (5%) in water

• Dextrose 50 mg/ml (5%) in sodium chloride 9 mg/ml (0.9%) solution

Intravenous Infusion:

Each vial of Piperacillin / Tazobactam 2g/0.25g should be reconstituted with 10ml of one of the above diluents:

Swirl until dissolved.

The reconstituted solution should be further diluted to a total volume of 50 ml to 100 ml with one of the reconstitution diluents, or with dextran 60 mg/ml (6%) in sodium chloride 9 mg/ml (0.9%) solution. Intravenous infusion should be given over 20-30 minutes.

For single use only. Discard any unused solution.

The reconstitution/dilution is to be made under aseptic conditions. The reconstituted solution is to be inspected visually for particulate matter and discoloration prior to administration. The solution should only be used if the solution is clear and free from particles.

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

7. Marketed BY:

ALKEM

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