

Summary of Product Characteristics

1 Name of the Medicinal Product

Aprotinin 10,000 KIU/ml Injection BP

2 Qualitative and Quantitative Composition

Each 50ml vial contains aprotinin solution corresponding to 500,000 Kallikrein Inactivator Units, KIU (= 277.8 European Pharmacopoeia, E.P. units) aprotinin in 0.9% sodium chloride solution.

For a full list of excipients, see section 6.1

3 Pharmaceutical Form

Solution for Injection

4. Clinical Particulars

4.1 Therapeutic indications

Aprotinin is indicated for prophylactic use to reduce blood loss and blood transfusion in adult patients who are at high risk of major blood loss undergoing isolated cardiopulmonary bypass graft surgery (i.e. coronary artery bypass graft surgery that is not combined with other cardiovascular surgery).

Aprotinin should only be used after careful consideration of the benefits and risks, and the consideration that alternative treatments are available (see section 4.4 and 5.1).

4.2 Posology and Method of Administration

An appropriate aprotinin-specific IgG antibody test may be considered before administration of aprotinin (see section 4.3).

Adult:

Owing to the risk of allergic/anaphylactic reactions, a 1 ml (10,000 KIU) test dose should be administered to all patients at least 10 minutes prior to the remainder of the dose. After the uneventful administration of the 1 ml test dose, the therapeutic dose may be given. A H₁-antagonist and a H₂-antagonist may be administered 15 minutes prior to the test dose of aprotinin. In any case

standard emergency treatments for anaphylactic and allergic reactions should be readily available (see section 4.4).

A loading dose of 1 - 2 million KIU is administered as a slow intravenous injection or infusion over 20 - 30 minutes after induction of anaesthesia and prior to sternotomy. A further 1 - 2 million KIU should be added to the pump prime of the heart-lung machine. To avoid physical incompatibility of aprotinin and heparin when adding to the pump prime solution, each agent must be added during recirculation of the pump prime to assure adequate dilution prior to admixture with the other component.

The initial bolus infusion is followed by the administration of a continuous infusion of 250,000 - 500,000 KIU per hour until the end of the operation.

In general, the total amount of aprotinin administered per treatment course should not exceed 7 million KIU.

Paediatric population

The safety and efficacy in children below 18 years of age have not been established.

Renal impairment

Available clinical experience suggests that patients with decreased renal function do not require special dose adjustment.

Hepatic impairment

No data are available on dosage recommendations for patients with hepatic dysfunction.

Elderly

Reported clinical experience has not identified differences in responses in elderly patients.

Method of administration

Aprotinin should be infused using a central venous catheter. The same lumen should not be used for the administration of any other medicinal product. When using a multi-lumen central catheter, a separate catheter is not required.

Aprotinin must be given only to patients in the supine position and must be given slowly (maximum 5 - 10 ml/min) as an intravenous injection or a short infusion.

4.3 Contra-indications

Hypersensitivity to the active substance or any of the excipients listed in section 6.1.

Patients with a positive aprotinin-specific IgG antibody test are at an increased risk of anaphylactic reaction when treated with aprotinin. Therefore, administration of aprotinin is contraindicated in these patients.

In case no aprotinin specific IgG antibody test is possible prior to treatment, administration of aprotinin to patients with a suspected previous exposure including in fibrin sealant products during the last 12 months is contraindicated.

4.4 Special Warnings and Precautions for Use

Aprotinin should not be used when CABG surgery is combined with another cardiovascular surgery because the benefit risk balance of aprotinin in other cardiovascular procedures has not been established.

Laboratory monitoring of anticoagulation during cardiopulmonary bypass

Aprotinin is not a heparin-sparing agent and it is important that adequate anticoagulation with heparin be maintained during aprotinin-therapy. Elevations in the partial thromboplastin time (PTT) and celite Activated Clotting Time (Celite ACT) are expected in aprotinin-treated patients during surgery, and in the hours after surgery. **Therefore, the partial thromboplastin time (PTT) should not be used to maintain adequate anticoagulation with heparin. In patients undergoing cardiopulmonary bypass with aprotinin therapy, one of three methods is recommended to maintain adequate anticoagulation: Activated Clotting Time (ACT), Fixed Heparin Dosing, or Heparin Titration (see below). If activated clotting time (ACT) is used to maintain adequate anticoagulation, a minimal celeite-ACT of 750 seconds or kaolin-ACT of 480 seconds, independent of the effects of haemodilution and hypothermia, is recommended in the presence of aprotinin.**

Additional note on use with extracorporeal circulation

In patients undergoing cardiopulmonary bypass with aprotinin therapy, one of the following methods is recommended to maintain adequate anticoagulation:

- Activated Clotting Time (ACT)

An ACT is not a standardized coagulation test, and different formulations of the assay are affected differently by the presence of aprotinin. The test is further influenced by variable dilution effects and the temperature experienced during cardiopulmonary bypass. It has been observed that kaolin-based ACTs are not increased to the same degree by aprotinin as are diatomaceous earth-based (celite) ACTs. While protocols vary, a minimal celeite ACT of 750 seconds or kaolin ACT of 480 seconds, independent of the effects of haemodilution and hypothermia, is recommended in the presence of aprotinin. Consult the manufacturer of the ACT test regarding the interpretation of the assay in the presence of aprotinin.

- Fixed Heparin Dosing
A standard loading dose of heparin, administered prior to cannulation of the heart, plus the quantity of heparin added to the prime volume of the cardiopulmonary bypass circuit, should total at least 350 IU/kg. Additional heparin should be administered in a fixed-dose regimen based on patient weight and duration of cardiopulmonary bypass.
- Determination of Heparin Levels
Protamine titration, a method that is not affected by aprotinin, can be used to measure heparin levels. A heparin dose response, assessed by protamine titration, should be performed prior to administration of aprotinin to determine the heparin loading dose. Additional heparin should be administered on the basis of heparin levels measured by protamine titration. Heparin levels during bypass should not be allowed to drop below 2.7 U/ml (2.0 mg/kg) or below the level indicated by heparin dose-response testing performed prior to administration of aprotinin.

In aprotinin treated patients the neutralisation of heparin by protamine after discontinuation of cardiopulmonary bypass should either be based on a fixed ratio to the amount of heparin applied or be controlled by a protamine titration method.

Important: aprotinin is not a heparin-sparing agent.

Graft Conservation

Blood drawn from the aprotinin central infusion line should not be used for graft preservation.

Re-exposure to aprotinin

Administration of aprotinin, especially to patients who have received aprotinin (including aprotinin containing fibrin sealants) in the past requires a careful risk/benefit assessment because an allergic reaction may occur (see sections 4.3 and 4.8). Although the majority of cases of anaphylaxis occur upon re-exposure within the first 12 months, there are also single case reports of anaphylaxis occurring upon re-exposure after more than 12 months. Standard emergency treatment for allergic/anaphylactic reactions should be readily available during treatment with aprotinin.

Assessment of potential for allergic reactions

All patients treated with aprotinin should first receive a test dose to assess the potential for allergic reactions (see section 4.2). The test dose of aprotinin should only be administered when facilities and equipment for handling acute anaphylactic reactions are available on-site.

Renal impairment

Results from recent observational studies indicate that renal dysfunction could be triggered by aprotinin, particularly in patients with pre-existing renal dysfunction. An analysis of all pooled placebo-controlled studies in patients

undergoing coronary artery bypass graft (CABG) has found elevations of serum creatinine values >0.5 mg/dL above baseline in patients with aprotinin therapy (see section 5.1). Careful consideration of the balance of risks and benefits is therefore advised before administration of aprotinin to patients with pre-existing impaired renal function or those with risk factors (such as concomitant treatment with aminoglycosides).

An increase in renal failure and mortality compared to age-matched historical controls has been reported for aprotinin-treated patients undergoing cardiopulmonary bypass with deep hypothermic circulatory arrest during operation of the thoracic aorta. Adequate anticoagulation with heparin must be assured (see also above).

Mortality

Information on mortality from randomized clinical trials is provided in section 5.1.

An association between aprotinin use and increased mortality has been reported in some non-randomized observational studies (eg, Mangano 2007, Schneeweiss 2008, Olenchock 2008, Shaw 2008) while other non-randomized studies have not reported such an association (eg, Karkouti 2006, Mangano 2006, Coleman 2007, Pagano 2008, Ngaage 2008, Karkouti, 2009). In these studies, aprotinin was usually administered to patients who had more risk factors for increased mortality before surgery than patients in the other treatment groups.

Most of the studies did not adequately account for these baseline differences in risk factors and the influence of these risk factors on the results is not known. Therefore interpretation of these observational studies is limited and an association between aprotinin use and increased mortality can neither be established nor refuted. Thus, aprotinin should only be used as authorized in isolated CABG surgery, after careful consideration of the potential risks and benefits.

A publication by Fergusson et al 2008 analyzed data from a randomized controlled trial, Blood Conservation Using Antifibrinolytics in a Randomized Trial (BART), and reported a higher mortality rate in aprotinin-treated patients compared to those treated with tranexamic acid or aminocaproic acid. However, due to several methodological deficiencies no firm conclusion on cardiovascular risks can be made on the BART study results.

4.5 Interactions with other Medicaments and other forms of Interaction

Aprotinin has a dose-dependent inhibitory effect on the action of thrombolytic agents, e.g. streptokinase, urokinase, alteplase (r-tPA).

Renal dysfunction could be triggered by aprotinin, particularly in patients with pre-existing renal dysfunction. Aminoglycosides are a risk factor for renal dysfunction.

4.6 Fertility, Pregnancy and Lactation

Pregnancy

There are no adequate and well-controlled studies in pregnant women. Animal studies did not provide any evidence of teratogenic or other embryotoxic effects of aprotinin.

Aprotinin should be used throughout pregnancy only if the potential benefit justifies the potential risk. In case of severe adverse drug reactions (like anaphylactic reaction, heart arrest, etc.) and their consecutive therapeutic measures, damage to the foetus has to be taken into account for a risk/benefit evaluation.

Breastfeeding

It is unknown whether aprotinin is excreted in human milk. However, since aprotinin is not bioavailable after oral administration, any drug contained in the milk is not expected to have a systemic effect on the breast-feed child.

Fertility

There are no adequate and well-controlled studies addressing fertility in men or women.

4.7 Effects on Ability to Drive and Use Machines

Not relevant.

4.8 Undesirable Effects

Summary of the safety profile

The safety of aprotinin has been evaluated in more than forty five phase II and phase III studies including more than 3800 patients exposed to aprotinin. In total, about 11% of aprotinin-treated patients experienced adverse reactions. The most serious adverse reaction was myocardial infarction. The adverse reactions should be interpreted within the surgical setting.

Tabulated summary of adverse reactions

Adverse drug reactions (ADRs) based on all placebo-controlled clinical studies with aprotinin sorted by CIOMS III categories of frequency (aprotinin n=3817 and placebo n=2682; status: April 2005) are listed in the table below:

Frequencies are defined as:

Common: $\geq 1/100$ to $< 1/10$

Uncommon: $\geq 1/1,000$ to $< 1/100$

Rare: $\geq 1/10,000$ to $< 1/1,000$

Very rare: $< 1/10,000$

Not known: cannot be estimated from the available data

MedDRA Standard System organ class	Common	Uncommon	Rare	Very Rare
Immune system disorders			Allergic reaction Anaphylactic / anaphylactoid reaction	<i>Anaphylactic shock (potentially life threatening)</i>
Blood and lymphatic system disorders				<i>Disseminated intravascular coagulation Coagulopathy</i>
Cardiac disorders		Myocardial ischaemia Coronary occlusion/ thrombosis Myocardial infarction Pericardial effusion		
Vascular disorders		Thrombosis	Arterial thrombosis (and its organ specific manifestations that might occur in vital organs such as kidney, lung or brain)	<i>Pulmonary embolism</i>
Renal and urinary disorders		Oliguria, acute renal failure, renal tubular necrosis		
General disorders or administration site conditions				Injection and infusion site reactions Infusion site (thrombo-) phlebitis

- ADRs derived from post-marketing reports are printed in ***bold italic***

Description of selected adverse reactions

Allergic/anaphylactic reactions are rare in patients with no prior exposure to aprotinin. In case of re-exposure the incidence of allergic/anaphylactic reactions may reach the five percent level. A retrospective review showed that the incidence of an allergic/anaphylactic reaction following re-exposure is

increased when the re-exposure occurs within 6 months of the initial administration (5.0 % for re-exposure within 6 months and 0.9 % for re-exposures greater than 6 months). A retrospective review suggests that the incidence of severe anaphylactic reactions to aprotinin may further increase when patients are re-exposed more than twice within 6 months. Even when a second exposure to aprotinin has been tolerated without symptoms, a subsequent administration may result in severe allergic reactions or anaphylactic shock with, in very rare cases, fatal outcome.

The symptoms of allergic/anaphylactic reactions may include:

Respiratory system: asthma (bronchospasm)

Cardiovascular system: hypotension

Skin and appendages: pruritus, rash, urticaria

Digestive system: nausea

If allergic reactions occur during injection or infusion, administration should be stopped immediately. Standard emergency treatment may be required, i.e. adrenaline/epinephrine, volume substitution and corticosteroids.

Cardiovascular system

In the pooled analysis of all placebo-controlled clinical studies, the incidence of investigator-reported myocardial infarction (MI) in aprotinin treated patients was 5.8 % compared to 4.8 % in placebo treated patients, with difference of 0.98 % between the groups (aprotinin n=3817 and placebo n=2682; status: April 2005).

A trend of increased incidence of MI in association with aprotinin was observed in some studies, while other studies showed a lower incidence compared to placebo.

Mortality

For the risk of mortality associated with the use of aprotinin see section 4.4.

Reporting of suspected adverse reactions

Reporting suspected adverse reactions after authorisation of the medicinal product is important. It allows continued monitoring of the benefit/risk balance of the medicinal product. Healthcare professionals are asked to report any suspected adverse reactions via Yellow Card Scheme in UK Website: www.mhra.gov.uk/yellowcard or search for MHRA Yellow Card in the Google Play or Apple App Store.

4.9 Overdose

There is no specific antidote.

5. Pharmacological Properties

5.1 Pharmacodynamic Properties

Pharmacotherapeutic group: Antihemorrhagics, proteinase inhibitors, ATC code: B02AB01

Aprotinin is a broad-spectrum protease inhibitor which has antifibrinolytic properties. By forming reversible stoichiometric enzyme-inhibitor complexes, aprotinin acts as an inhibitor of human trypsin, plasmin, plasma kallikrein and tissue kallikrein, thus inhibiting fibrinolysis.

It also inhibits the contact phase activation of coagulation which both initiates coagulation and promotes fibrinolysis.

Data from a global pool of placebo-controlled studies in patients undergoing coronary artery bypass graft (CABG) surgery showed that the incidence of serum creatinine elevations >0.5 mg/dL above pre-treatment levels was statistically higher at 9.0 % (185/2047) in the full-dose aprotinin group compared with 6.6 % (129/1957) in the placebo group, with an odds ratio of 1.41 (1.12 - 1.79). In the majority of instances, post-operative renal dysfunction was not severe and reversible. The incidence of serum creatinine elevations >2.0 mg/dL above baseline was similar (1.1 % vs 0.8 %) in both the full-dose aprotinin and placebo group, with an odds ratio of 1.16 (0.73 - 1.85) (see section 4.4).

The in-hospital mortality in a pool of randomized, clinical trials is summarized in the table below:

In-hospital Mortality in a pool of Randomized Clinical Trials (Population: All Global CABG Patients Valid for Safety)					
Population	Full-Dose Aprotinin		Placebo		Odds Ratio (95% CI)
	n/N	%	n/N	%	
All CABG	65/2249	2.9	55/2164	2.5	1.09 (0.78, 1.52)
Primary CABG	36/1819	2.0	39/1785	2.2	0.92 (0.62, 1.38)
Repeat CABG	22/276	8.0	13/255	5.1	1.47 (0.75, 2.87)

5.2 Pharmacokinetic Properties

After intravenous injection, rapid distribution of aprotinin occurs into the total extracellular space, leading to an initial decrease in plasma aprotinin concentration with a half-life of 0.3 - 0.7 h. At later time points, (i.e. beyond 5 hours post-dose) there is a terminal elimination phase with a half-life of about 5 - 10 hours.

The placenta is probably not absolutely impermeable to aprotinin, but permeation appears to take a very slow course.

Metabolism, elimination and excretion

The aprotinin molecule is metabolised to shorter peptides or amino acids by lysosomal activity in the kidney. In man, urinary excretion of active aprotinin accounts for less than 5 % of the dose. After receiving injections of ^{131}I -aprotinin healthy volunteers excreted within 48 hours 25 - 40 % of the labelled substance as metabolites in the urine. These metabolites lacked enzyme-inhibitory activity.

No pharmacokinetic studies are available in patients with terminal renal insufficiency. Studies in patients with renal impairment revealed no clinically significant pharmacokinetic alterations or obvious side effects. A special dose adjustment is not warranted.

5.3 Preclinical Safety Data

Acute toxicity

In rats, guinea-pigs, rabbits and dogs, high doses ($> 150,000 \text{ KIU/kg}$) injected quickly caused a blood pressure reduction of varying magnitude, which rapidly subsided.

Reproduction toxicity

In rat intravenous studies, daily doses of up to 80,000 KIU/kg produced no maternal toxicity, embryotoxicity, or foetotoxicity. Daily doses of up to 100,000 KIU/kg did not interfere with the growth and development of the young and doses of 200,000 KIU/kg/day were not teratogenic. In rabbits, daily intravenous doses of 100,000 KIU/kg produced no evidence of maternal toxicity, embryotoxicity, foetotoxicity or teratogenicity.

Mutagenic potential

Aprotinin gave a negative mutagenic response in the salmonella/microsome and *B.subtilis* DNA damage system.

6 Pharmaceutical Particulars

6.1 List of Excipients

Sodium chloride, water for injections.

6.2 Incompatibilities

Aprotinin is incompatible with antibiotics such as tetracyclines which react with proteins, corticosteroids, heparin and nutrient solutions containing amino acids or fat emulsions. The addition of aprotinin to mixed infusions

(particularly with beta-lactam antibiotics) should be avoided. Electrolyte and sugar solutions are compatible with aprotinin.

6.3 Shelf Life

3 years

6.4 Special Precautions for Storage

Store at room temperature (not more than 25°C); protect from light.

6.5 Nature and Contents of Container

Clear glass vials of 50ml.

6.6 Special precautions for disposal and other handling

Parenteral drug products should be inspected visually for particulate matter and colour change prior to administration. Any residual solution should not be kept for later use.

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

7 Marketing Authorisation Holder

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