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Guideline on clinical investigation of recombinant and human plasma-derived factor IX products

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30 Churchill Place ● Canary Wharf ● London E14 5EU ● United Kingdom
Telephone +44 (0)20 3660 6000 **Facsimile** +44 (0)20 3660 5555
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GLOSSARY

AUC – Area under the Curve

BU - Bethesda Unit

CI – Confidence Interval

E - Efficacy

ED - Exposure Day

HAART - Highly active anti-retroviral therapy

ITI – Immune Tolerance Induction

IU – International Units

MA – Marketing Authorisation

MAA – Marketing Authorisation Application

p-d - plasma-derived

PhVWP - Pharmacovigilance Working Party

PK – Pharmacokinetics

PMI – Post Marketing Investigation

PTP - Previously Treated Patient (defined as >150 EDs)

PUP - Previously Untreated Patient

RMP - Risk Management Plan

S - Safety

SAE – Serious Adverse Event

TSE – Transmissible spongiform encephalopathy

SmPC – Summary of Product Characteristics

y - years

Executive summary

This guideline describes the information to be documented when an application for a marketing authorisation for recombinant or human plasma-derived factor IX products is made for use in treatment and prevention of bleeding in patients with haemophilia B. The guideline covers clinical investigations to be conducted pre- and post-marketing authorisation. Guidance is also provided for authorised products where a significant change in the manufacturing process has been made.

Timeline history of guideline: The original Note for Guidance on Clinical Investigation of Human Plasma Derived FVIII and FIX Products (CPMP/BPWG/198/95) came into operation on 14 February 1996. The first revision (CPMP/BPWG/198/95 Rev. 1) came into operation in April 2001. The original Note for Guidance on Clinical Investigation on Recombinant FVIII and FIX Products (CPMP/BPWG/1561/99) came into operation in April 2001. Draft revisions of CPMP/BPWG/1561/99 and CPMP/BPWG/198/95 were released for public consultation in July 2007. Following this consultation, it was decided to reorganise the guidance to have separate documents: The Guideline on clinical investigation of recombinant and plasma derived factor VIII products (EMA/CHMP/BPWP/144533/2009) and the Guideline on clinical investigation of recombinant and plasma derived factor IX products (EMA/CHMP/BPWP/144552/2009). EMA/CHMP/BPWP/144552/2009 came into effect on 1 February 2012. Revision 1 is a rapid revision following the 2013 EMA/EDQM workshop on potency assays. The opportunity is taken to make other minor updates.

1. Introduction (background)

The purpose of this guideline is to provide applicants and regulators with harmonised requirements for applications for marketing authorisation for recombinant or plasma-derived factor IX products.

A comparison of pharmacokinetic parameters of recombinant factor IX and plasma-derived factor IX indicated that the elimination half-lives were nearly identical whereas the *in vivo* recoveries were statistically different. Differences in sulphation and lack of phosphorylation in recombinant factor IX may account for the lower recovery of recombinant factor IX as compared to plasma-derived factor IX.

Clinical trial data, addressing efficacy and safety with respect to immunogenicity and other adverse events in all age groups, are required in an application for a marketing authorisation. Depending on the type of factor IX product (see chapter 6.6) studies in previously untreated patients (PUPs) should be performed to investigate efficacy and safety in this specific patient population. In addition, the potential for thrombogenicity should be investigated in the case of factor IX products.

This guideline describes the clinical trials required for authorisation with respect to human plasma-derived and recombinant factor IX products.

These data are required for:

- products for which an application for a marketing authorisation is to be submitted, referred to as ‘new products’ in the text; and
- authorised products where a significant change in the manufacturing process has been made (e.g. additional viral inactivation/removal steps or new purification procedures).

The clinical trials described in this guideline should be performed according to the ICH E6 Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95).

If a specific benefit of a certain product should be claimed e.g. a prolonged half-life which might lead to modifications of the clinical trial, it is recommended that advice on the design of clinical studies is sought via an EMA scientific advice procedure.

This guidance introduces general principles on efficacy and safety in chapters 4 and 5. Information on the clinical development concept is included in subsequent chapters regarding “new products” and significant changes of the manufacturing process. Detailed “at a glance” requirements for clinical trials for factor IX products are found in Annexes I to III.

2. Scope

The guideline covers clinical investigations to be conducted pre- and post-marketing authorisation. In general, quality aspects are outside the scope of this guideline.

3. Legal basis

This guideline has to be read in conjunction with the introduction and general principles (4) and Annex I to Directive 2001/83/EC as amended, as well as the Paediatric Regulation (EC) 1901/2006 as amended.

4. Efficacy: General aspects

Efficacy needs to be demonstrated in clinical trials to be conducted before marketing authorisation combined with the commitment to perform (a) post-authorisation investigation(s) to collect additional clinical data and to bridge in the long-term between the outcome from clinical trials and from routine use. When clinically evaluating human plasma-derived or recombinant coagulation factors for the treatment of haemophilia B patients, the initial trial typically examines the pharmacokinetics of the principal active factor. Appropriate pharmacokinetic data (incremental recovery, half-life, area under the curve (AUC), and clearance) are the most important surrogate endpoints for efficacy of a new factor IX product. Furthermore, clinical efficacy of factor IX treatment (e.g. prophylaxis, on demand) should be assessed during a period of a minimum of 50 exposure days by the patients themselves and treating physicians.

5. Safety: General aspects

Safety aspects of factor IX products include viral safety, immunogenicity and other adverse events. For recombinant products the use of non-human cell-lines raises the possibility of different contaminants and altered immunogenic potential. Thrombogenicity should also be considered a potential safety issue.

5.1. Adverse events

Safety, including vital signs, should be assessed in all patients receiving the factor IX product during clinical trials. All adverse events in clinical studies must be recorded and analysed with regard to causality, seriousness and expectedness.

All adverse events occurring in relationship with any use of the product should be recorded and reported to competent authority in accordance with normal regulatory procedures.

Depending on the type of product the development of hypersensitivity reactions to heterologous proteins (e.g. murine, bovine or hamster origin) may occur with related adverse events which should

be recorded and reported. All study protocols should include a hypersensitivity questionnaire/reporting form to collect all relevant data in this regard.

5.2. Safety with respect to viruses and other transmissible agents

Recombinant products

The safety of recombinant products with regard to viral contamination can only be reasonably assured by the application of virus testing within the manufacturing process and implementation of virus inactivation and removal steps during the manufacturing process, according to the relevant guidelines (e.g. ICH Q5A 'Note for Guidance on quality of biotechnological products: viral safety evaluation of biotechnology products derived from cell lines of human or animal origin' (CPMP/ICH/295/95)).

Plasma-derived products

Manufacturers of plasma-derived products, including factor IX products, are obliged to optimise viral safety by selection of donors, screening of individual donations and plasma pools for specific markers of infection and the inclusion of effective steps for the inactivation/removal of viruses in manufacturing processes. Similar principles to those outlined for viral safety should apply for all transmissible agents including TSE and other emerging pathogens. Manufacturers should follow the respective guidance documents and position statements. Information can be found in the Biologicals guidelines on the EMA website in the section "Guidelines on Plasma-derived Medicinal Products".

The above-mentioned procedures are now considered to be highly effective and demonstrative of the viral safety of the product with respect to enveloped viruses. Therefore it is no longer considered appropriate to use clinical trials to investigate viral safety with regard to enveloped viruses.

These procedures may be of limited value against non-enveloped viruses, such as hepatitis A virus and parvovirus B19. The safety of the products with respect to non-enveloped viruses cannot currently be adequately evaluated in clinical studies.

The applicant is nevertheless required to provide all available data gathered on patients treated with the product in clinical trials. Investigators should continue with their normal clinical practice of monitoring patients. The applicant should demonstrate that there are systems in place to collect information on patients treated with the product and to respond rapidly to any reports of infection with a full investigation.

5.3. Immunogenicity

In general, immunogenicity should be investigated prior to marketing authorisation and substantiated with post-marketing studies.

Haemophilia B is around 4 times less common than haemophilia A. The incidence of inhibitors in these patients following administration of factor IX is less common compared to the incidence found in haemophilia A patients. Inhibitors to factor IX have been demonstrated in approximately 4% of patients with severe haemophilia B. It has been observed that the occurrence of inhibitors is commonly associated with the total deletion of the factor IX gene. However, with regard to investigation of development of antibodies, the basic principles as outlined for haemophilia A patients in chapter 5.3 of the Guideline on the clinical investigation of recombinant and human plasma-derived factor VIII products (EMEA/CHMP/BPWP/144533/2009) should be taken into account where applicable. Unlike those with haemophilia A, patients with haemophilia B more often experience anaphylactic reactions to factor IX products in association with the development of inhibitors. Literature also reports on the occurrence of anaphylactic type reactions as well as the development of a nephrotic syndrome

following immune tolerance therapy. These problems have been observed for plasma-derived as well as for recombinant factor IX products.

In patients developing anaphylaxis and/or inhibitors to factor IX, data on relevant antibodies, e.g. IgE, IgG, against factor IX (using appropriate methods) should be submitted.

5.4. Thrombogenicity

Treatment with plasma-derived factor IX products that contain factors II, VII and X has been associated with thrombosis. Factor IX products with higher purity have displayed less risk of thrombogenicity. For new factor IX products, appropriate tests for markers of activation of coagulation (prothrombin fragment 1+2, thrombin-antithrombin (TAT) and D-dimer) should be carried out in pre- and post-infusion samples obtained in the non-bleeding state. This should be determined in the patients participating in the pharmacokinetic trial. Clinical evaluation of thrombosis should be undertaken by safe, objective means in a minimum of 5 patients undergoing at least 10 surgical procedures.

6. Application for marketing authorisation: “new products”

This chapter is about either recombinant or plasma-derived factor IX products for which a marketing authorisation is applied for.

6.1. General aspects on clinical trials

In view of the limited availability of patients suffering from haemophilia B, data from pre-licensing studies only are considered insufficient to estimate all aspects of therapy with factor IX products, especially with respect to immunogenicity. Therefore, to collect additional clinical data and to ensure consistency in the long-term between the outcome from pre-authorisation clinical studies and from routine use, a post-marketing investigation should be performed. The number of patients typically needed to be enrolled into the pre-authorisation clinical trials is 40. This number has been selected by balancing the clinical data package needed to demonstrate efficacy and safety against the availability of patients suffering from a rare disease. The number of patients is expected to be adequate to provide relevant information on general safety aspects and to demonstrate efficacy of a factor IX product in terms of its ability to restore factor IX levels and reach haemostasis, to stop as well as to prevent bleeding. In view of the limited number of patients in the pre-authorisation trials, further information mainly focussing on safety aspects is needed through post-marketing investigations.

The clinical development for factor IX products should follow a stepwise approach in order to have some experience in adults and older children before investigating younger children. Therefore, the initial age cohort to be investigated is previously treated patients (PTPs) ≥12 years of age. Subsequently, when PK and efficacy/safety in 10 PTPs ≥12 years for at least 50 EDs are available, the clinical trial(s) in children 0 - <12 years can be initiated. The clinical study in children of 0 - <12 years should be started with PK followed by investigation of efficacy and safety for at least 50 EDs each in 20 children. These data have to be provided within the initial application for marketing authorisation. The clinical investigation in children needs to be supported by an approved paediatric investigation plan.

A PUP study needs to be conducted for all novel recombinant factor IX products, such as novel genetic constructs or modification of the factor IX molecule in order to alter its *in vivo* properties, e.g. pharmacokinetics, and for factor IX products manufactured with novel production methods, e.g. a new cell line where there is limited experience. The lack of data in PUPs should be indicated through a statement in 4.2 Posology and method of administration (see core SmPC) until data from 20 PUPs

investigated for efficacy and safety for at least 50 EDs each are available. In the case of plasma-derived factor IX products (e.g. manufactured with novel methods) the need for PUP studies will be considered on a case by case basis. Applicants will receive feedback on this issue when submitting the paediatric investigation plan or waiver application and may also seek scientific advice from the EMA to clarify this issue.

Please refer to Annex I 'Overview on Clinical Trial Concept' and Annex II 'Clinical Trials for Factor IX Products "New Products"'.

6.1.1 Potency measurement

A number of different assays for factor IX potency measurement are available and for some products significantly different product potencies can be obtained with the different methods/assays, reagents and reference standards that are available. These method-related potency discrepancies can impact both the finished product potency labelling and also the clinical monitoring post-infusion. A working group of the ISTH has published "Recommendations on the potency labelling of factor VIII and factor IX concentrates".[†] These recommendations include advice for the characterization of products with respect to potency assays, calibration of manufacturers' product reference, pharmacokinetic studies and testing of post-infusion samples. A joint EMA/EDQM workshop on this topic was held in 2013 (see reference list).

Thorough characterization of new factor IX products, taking into account ISTH recommendations, in a variety of potency assays against the WHO IS (concentrate and plasma) is important. In the case that significant potency discrepancies are observed depending on the method/assay variables used, it should be demonstrated that the particular assay design chosen for potency labelling supports comparability (with the unitage applied) to an appropriate, non-modified licensed product based on comparisons of *in vitro* and *in vivo* functionality. Consequences for laboratory monitoring of product plasma levels should be addressed in the risk management plan and appropriate information should be given to users of the product.

6.2. Efficacy in PTPs ≥12 years

Pharmacokinetics

A pharmacokinetic trial, should be performed in at least 12 PTPs (>150 exposure days (EDs)) suffering from haemophilia B (factor IX ≤2%) and who are immunocompetent (HIV patients should have CD4> 200/µL) The study should record incremental recovery, *in vivo* half-life, area under the curve (AUC), and clearance in patients without inhibitors who are not actively bleeding. Patients should be at least 12 years of age and should not have received an infusion of any factor IX product for at least 4 days. In order to allow for evaluation of a patient's individual response, existing pharmacokinetic information with the patient's previous factor IX product (historical or recent recovery and half-life) should be available prior to first administration of the new factor IX product. Samples should be taken before injection of 50-75 IU/kg of the factor IX product (baseline), 10-15 minutes (times refer to the interval after the completion of the infusion) and at 30 minutes, and 1 hour. Additional time points to include 3, 6, 9, 24, 48, and 50 hours post-infusion; a 72 hour sample is optional provided the patient was given at least 75 IU/kg. Depending on the type of factor IX product (e.g. prolonged half-life) sampling time points may be adjusted to cover the main parts of the activity time profile. At least 3 different lots should be employed in the trial. Incremental recovery is determined as the peak factor level recorded

[†] Recommendations on the potency labelling of factor VIII and factor IX concentrates (Hubbard AR, Dodt J, Lee T, Mertens K, Seitz R, Srivastava A, Weinstein M, on behalf of the Factor VIII and Factor IX Subcommittee of the Scientific and Standardisation Committee of the International Society on Thrombosis and Haemostasis. J Thromb Haemost. 2013: 11:988-9. doi: 10.1111/jth.12167).

in the first hour after infusion and is reported as [IU/ml]/[IU/kg]. As several assay methods are possible, the assay used should be described. Preferably the same assay should be used for analysis of the product and the patient's plasma (see also 6.1.1).

It is very important to record the exact time interval post-infusion at which the samples were actually collected and to use these precise values in the analysis.

An additional description of the pharmacokinetic data according to body weight (normal range, overweight and underweight) should be provided.

Patients taking part in the pharmacokinetic trial should continue treatment with the product, and should be re-tested for the same pharmacokinetic parameters after 3-6 months using the same dose as in the first investigation. Inhibitor testing should also be performed (see Annex III for further details)

If a factor IX product should be marketed in different strengths leading to a broad range of factor IX concentrations after reconstitution, the pharmacokinetics of the lowest and highest concentration should be investigated unless otherwise justified.

Efficacy including surgery

Clinical efficacy of factor IX should be evaluated in at least 20 PTPs (≥12 years, >150 EDs), suffering from haemophilia B (factor IX ⩽ 2%) and who are immunocompetent (HIV patients should have CD4 > 200/µL). During an observation period of a minimum of 50 exposure days, clinical response should be assessed by the patients. Response should be assessed as "none", "moderate", "good" or "excellent" by the physician for those patients who were treated in hospital with the product for major bleeds. In addition, response should be determined by the physician in a minimum of 5 patients undergoing at least 10 surgical procedures (comprising major surgeries), including efficacy of haemostasis, loss of blood, and requirements for transfusion. For the assessment of clinical efficacy of factor IX in long-term prophylaxis, patients should be treated for 6 months and assessed for bleeding episodes, bleeding intervals and number of treatments.

Clinical efficacy should be assessed by calculating the consumption of factor IX, expressed as number of infusions and IU/kg per month and per year, as well as IU/kg per event (prophylaxis, on-demand, and surgery).

Continuous infusion

If continuous infusion therapy is claimed, the study should be carried out in at least 10 severe haemophilia B patients (FIX ≤2%) undergoing elective major surgical procedures.

Prior to surgery, a pharmacokinetic analysis in each individual should be performed to obtain, in particular, an estimate of clearance. The initial infusion rate could be based on the clearance as follows:

Clearance x desired steady state level = infusion rate (IU/kg/hr)

(if necessary plus a corresponding safety margin)

After the initial 24 hours of continuous infusion, the clearance should be calculated again every day using the steady state equation with the measured level and the known rate of infusion.

Efficacy and safety data during surgery and for at least 6 days thereafter should be submitted, including PK parameters with the description of the assay used, daily dosage of factor IX with the description of the administration method used, administration rate, consumption, haemostatic response and blood loss, transfusion requirements and local and systemic adverse events.

Pharmaceutical data on reconstitution and stability of the product should be provided in the Quality section of the dossier.

6.3. Clinical investigation in PTPs ≥12 years

Choice of patients

Previously treated patients (PTPs) with at least 150 treatment EDs to previous products are considered as low risk patients and should be evaluated for product related immunogenicity. These PTPs should be ≥12 years of age, with a factor IX level ≤2% and immunocompetent (HIV positive patients should have CD4 lymphocytes >200/µl). The viral status of patients should be documented. The patients should be HIV negative or have a viral load < 200 particles/µl or <400000 copies/ml. Due to the lower incidence of haemophilia B as compared to haemophilia A, at least 20 frequently treated patients should be followed and documented for a minimum of 50 exposure days. These data should be provided with the application.

Immunogenicity testing

The factor IX inhibitor titre should be determined by following the schedule set out in Annex III. In the clinical studies, it is proposed to perform sampling for inhibitor measurements not less than 3 days after the previous administration, if possible. Product specific properties e.g. extended half-life should be taken into account to avoid interference from residual factor IX product. For all patients who develop inhibitors a full clinical report should be provided including clinical relevance, the cumulative incidence and the number of exposure days. The titre of the inhibitor should be reported in Bethesda Units (BU) using the Bethesda assay or the Nijmegen modification of the Bethesda assay. Plasma samples from patients who are suspected of inhibitors or who have developed inhibitors should be stored until evaluation of the clinical study by the competent authority is completed in order to permit additional inhibitor analysis if needed. For further details please refer to chapter 5.3.

Viral safety

Compliance with CHMP recommendations with regard to viral safety (see chapter 5.2) is necessary for all plasma-derived products and is verified by information supplied in Module 3 of the dossier.

A pre-treatment serum sample from each patient included in the clinical trials should be stored at -70°C for possible future testing.

6.4. Clinical investigation in children <12 years

Since children may respond differently compared to adults, a multicentre trial in children should be conducted. Due to the lower incidence of haemophilia B as compared to haemophilia A, the number of children to be enrolled should be at least 20, allocated to 2 age cohorts. A minimum of 10 patients should be PTPs at the age of 6 - <12 years and at least 10 patients should be <6 years who have undergone >50 EDs with previous factor IX products. The clinical trial in children <12 years should not start before safety is proven for 50 EDs each of 10 patients who are included in the PTP trial ≥12 years.

The clinical trial in children should begin with the investigation of pharmacokinetics (incremental recovery, *in vivo* half-life, AUC and clearance) in 10 patients of each age cohort. In order to allow for evaluation of a patient's individual response, existing pharmacokinetic information with patient's previous factor IX product (historical or recent recovery and half-life) should be available prior to first administration of the new factor IX product. With regard to patient compliance, PK sampling time points can be reduced to measurements prior to infusion (baseline) and 1 hour, 10 hours, 24 hours

and 48 hours after infusion. Depending on the type of factor IX product (e.g. prolonged half-life) further sampling time points could be necessary. It is anticipated that some deviation from the recommendation may occur in clinical practice; therefore, it is very important to record the exact time post-infusion at which the actual samples were collected and to use these precise values in the analysis. Preferably, the testing should be conducted in a central laboratory to decrease variability in test results.

Factor IX consumption (dose/kg for prophylaxis and therapy (on demand)) should be monitored as well as development of inhibitors in all the children participating in the study. Inhibitor testing should be performed following the same testing schedule as set out in Annex III and if there is any suspicion of inhibitor (see also chapter 5.3). In accordance with the requirements for the ≥12 years pre-authorisation PTP trial, the study in children should continue until the patients have received a minimum of 50 EDs to the investigational product. For all patients who develop inhibitors, a full clinical report should be provided including clinical relevance, the cumulative incidence and the number of EDs in relation to development of inhibitors. The titre of the inhibitor should be reported in Bethesda Units using the modified Nijmegen assay. Plasma samples from patients who are suspected or confirmed to have inhibitors should be stored for possible future testing.

Within the application for marketing authorisation, pharmacokinetic data (incremental recovery, *in vivo* half-life, AUC and clearance) as well as the completed efficacy and safety trial in 20 children (0 to <12y) followed for 50 EDs should be submitted.

For the post-marketing investigation, PTPs (>150 EDs) regardless of their age can be included provided that the pre-authorisation study in children <12 years is finished.

6.5. Clinical investigation in PUPs

Previously untreated patients (PUPs) are defined as those patients who have never been treated with clotting factor products (except previous exposure to blood components). Clinical trials in PUPs are required depending on the type of factor IX product (e.g. novel modified proteins to extend half-life). For plasma-derived factor IX products the need to perform PUP studies will be considered if novel manufacturing methods are used, on a case by case basis. For novel products requiring a PUP study, the lack of data in PUPs should be indicated through a statement in 4.2 Posology and method of administration (see core SmPC), until data from 20 PUPs investigated for efficacy and safety are available. The approval of the indication in PUPs will be based on a pre-authorisation clinical trial in a minimum of 20 PUPs evaluated for efficacy and safety during at least 50 ED connected with a post-approval commitment to follow-up at least 20-40 PUPs (20 from efficacy/safety trial and 20 new) for a minimum of 100 ED.

The clinical trial in PUPs should be started when data are available from 10 patients participating in the children trial <12 years with 50 ED each, including a minimum of 5 patients <6 years, and when pharmacokinetic investigations in children <12 years are completed.

6.6. Post-marketing investigation

In order to collect additional clinical data and to ensure consistency in the long-term between the outcome from pre-authorisation clinical studies and from routine use, a post-marketing investigation should be performed. The clinical study protocol should be submitted with the application for marketing authorisation as part of the risk management plan (see Volume 9A of The Rules Governing Medicinal Products in the European Union). The results of the pre-authorisation studies should be taken into account for the design of the post-marketing study. Besides aspects like the general product safety

and clinical efficacy, there has to be a focus on immunogenicity, particularly on inhibitor development, anaphylactic reactions and thrombogenic effects.

In general, the study should reflect the population in the countries where the product is intended to be marketed. A detailed patient documentation (diary, logbook etc.) covering the last 50 exposure days or the last 2 years per patient to confirm treatment modality (i.e. prophylaxis, on demand or recent surgery) is needed as a prerequisite for patient enrolment and should be available upon request. Patients with severe haemophilia after successful Immune Tolerance Induction (ITI) can be included, in order to obtain valuable information in this patient cohort. The proportion of these ITI patients should not be more than 25% of the whole cohort.

The number of patients typically needed in a post-marketing study with a factor IX product to cover especially immunogenicity aspects (besides general efficacy and safety) is 50. In case of plasma-derived factor IX products (e.g. manufactured by known methods, for national approval only) a smaller number of patients could be enrolled but justification should be provided. Study participants should be PTPs (>150EDs), and could be recruited regardless of their age, however, aiming for a balanced age distribution. In general, all patients from pre-authorisation clinical trials could be enrolled in post-marketing investigations.

The post-marketing investigation protocol will be approved at marketing authorisation as part of the risk management plan. A separate progress study report should be provided to the relevant Competent Authority(ies) 2 years after marketing authorisation to allow for evaluation of recruitment status, progress and the adherence to timelines. The post-marketing investigation should be completed within 4 years.

For detailed requirements of study design please refer to Annex III.

7. Change in the manufacturing process

Changes in the manufacturing process may lead to significant changes in the product and may thereby alter the structure of the coagulation factor and its activity. The effects of changes in the manufacturing process (e.g. viral inactivation steps or purification procedures) on the biological characteristics and activity of the product should be investigated. If significant impact on the activity of the coagulation factor cannot be excluded, data on pharmacokinetics, efficacy and safety should also be provided with the application. These data should be generated by following the comparability exercise (see ICH Q5E Note for Guidance on Biotechnological/Biological Products Subject to Changes in their Manufacturing Process (CPMP/ICH/5721/03) and Guideline on comparability of biotechnology-derived medicinal products after a change in the manufacturing process non-clinical and clinical issues (EMEA/CHMP/BMWP/101695/2006).

7.1. General aspects on clinical trials

When a change is introduced to the manufacturing process of a given product, the marketing authorisation holder will have to demonstrate that the “post-change” and the “pre-change” product are comparable in terms of quality, safety and efficacy (see Guidelines on Comparability). This might be a sequential process, beginning with investigations of quality and supported, as necessary, by non-clinical and/or clinical studies.

The extent of clinical data to be provided has to be judged on a case by case basis depending on the anticipated impact of the changes and could vary from pharmacokinetic investigations comparing “pre-change” versus “post-change” product up to the full clinical data set as outlined for a new product (see chapter 6).

Of special interest will be whether the immunogenicity profile of the “post-change” product remains the same when compared to the “pre-change” product. Depending on the anticipated risk, a study monitoring the switch between “pre-change” and “post-change” product could be required.

As a consequence, applications should be accompanied by assessment of the potential impact of a change on efficacy and safety of a given product and the rationale behind the clinical development plan should be outlined and justified.

7.2. Efficacy

Evidence should be provided to demonstrate that the change in the manufacturing process has not affected the pharmacokinetics of the product. Guidance is provided in the Guideline on comparability of biotechnology-derived medicinal products after a change in the manufacturing process non-clinical and clinical issues (EMEA/CHMP/BMWP/101695/2006), Guideline on the clinical investigation of the pharmacokinetics of therapeutic proteins (CHMP/EWP/89249/2004) and Note for Guidance on the Investigation of Bioavailability and Bioequivalence (EMEA/EWP/QWP/1401/98).

A comparative pharmacokinetic trial with the “pre-change” product versus the “post-change” product should be performed in at least 12 PTPs suffering from haemophilia B (factor IX ≤2%). The study should record incremental recovery, *in-vivo* half-life, area under the curve (AUC), and clearance in patients without inhibitors who are not actively bleeding. Patients should be at least 12 years of age and should not have received an infusion of any factor IX product for at least 4 days. Samples should be taken before injection of 50-75 IU/kg of the factor IX product (baseline), 10-15 minutes (times refer to the interval after the completion of the infusion) and at 30 minutes, and 1 hour. Additional time points to include 3, 6, 9, 24, 48, and 50 hours post-infusion; a 72 hour sample is optional provided the patient was given at least 75IU/kg. Depending on the type of factor IX product (e.g. prolonged half-life) further sampling time points could be necessary. A minimum of 3 different lots of the “post-change” product should be employed in the trial. Incremental recovery is determined as the peak level recorded 30 minutes after infusion and reported as [IU/ml]/[IU/kg].

It is very important to record the exact time post-infusion at which the actual samples were collected and to use these precise values in the analysis.

Patients in the pharmacokinetic trial should continue treatment with the “post-change” product for 6 months, and should be re-tested for the same pharmacokinetic parameters after 3-6 months using the same dose as in the first investigation.

Should any of the patients participating in the clinical trials undergo surgical procedures, response will be determined by the physician, including efficacy of haemostasis, loss of blood, requirement for transfusion and occurrence of thromboembolic episodes.

8. Risk management plan

This chapter provides specific guidance on topics to be addressed in a Risk management plan for factor IX products. The RMP should be tailored appropriately for the specific product based on the accumulated data from the development programme up to the application for marketing authorisation, taking into account the general guidance on RMPs. This section indicates aspects that would be appropriate to include in the RMP but should not be interpreted as exhaustive. The following points should be considered in the relevant sections of the Risk Management Plan (RMP) for new factor IX products as well as for factor IX products with a significant change in the manufacturing process.

Risk Management Plans should be compiled in compliance with the provisions of the Volume 9A of The Rules Governing Medicinal Products in the European Union. The protocol of the post-marketing investigation should be included in the respective annex of the RMP.

Inhibitor formation

The most serious complication in haemophilia is the development of inhibitors in PUPs and PTPs although inhibitor occurrence in haemophilia B is less common than in haemophilia A. A comprehensive analysis of reported *de novo* and recurrent inhibitors should be provided as a cumulative report in RMP Annex VII, including:

- Source of inhibitor reports (e.g. clinical trial/post-authorisation investigation/spontaneous reports)
- Low and high titre, intermittent inhibitor.
  (Every positive laboratory test should be retested in a central laboratory with a second separately drawn sample from the same patient before a diagnosis of an inhibitor can be made. Samples should be stored for possible future testing.)
- Type 1 and 2 inhibitors

Classification of risk to develop factor IX inhibitor:

  - Haemophilia severity
  - Status of treatment (i.e. PUP/PTP)
  - Cumulative exposure to factor IX products (total ED and ED on product)
  - Type of gene mutation
  - Ethnicity
  - Age at first treatment
  - Intensity of treatment
- Inhibitor incidence should be expressed as point estimate and 95 % CI.
- Special populations:
  - Patients who underwent surgery and subsequently develop inhibitors
  - Any specific risk (e.g. inhibitor development, lack of effect) induced in switching to the product from another factor IX product should be discussed separately. This is in particular relevant for products with a significant change in the manufacturing process. The switch from pre-change to post-change product should be investigated carefully.

Lack of drug effect

Lack of drug effect and breakthrough bleeding may point to inhibitor development. A pre-defined case definition is essential. Careful follow-up including inhibitor evaluation (consumption, recovery, half-life, inhibitor testing) needs to be reported.

Hypersensitivity/anaphylactic reactions

Hypersensitivity / anaphylactic reactions including against host cell proteins, excipients and residues used in the manufacturing process may occur. These reactions should be classified according to local and systemic hypersensitivity reactions. Patients developing anaphylaxis should be carefully investigated and followed-up for inhibitor development. An appropriate questionnaire/reporting form

should be used with information collected on status of treatment (e.g. PUP/PTP). Data on relevant antibodies against factor IX (using appropriate methods), e.g. IgE, IgG, should be submitted.

Thrombogenicity

Thrombotic events need to be monitored and reported.

Measurement of plasma factor IX levels significantly affected by the assay used for clinical monitoring

Where there can be discrepant assay results depending on the assay used for clinical monitoring (see 6.1.1), some information will be included in the product information but other approaches may also be needed including educational material for training of clinical laboratories. The Risk Management Plan is an appropriate place to address the risk of discrepant monitoring of plasma levels and the measures to avoid this.

References

Report of Expert Meeting on Factor VIII Products and Inhibitor Development, 28 February 2006 – 02 March 2006 ((EMEA/CHMP/BPWP/123835/2006), http://www.ema.europa.eu/docs/en_GB/document_library/Report/2009/11/WC500015512.pdf).

Neugebauer B., Drai C., Haase M., Hilger A., Keller-Stanislawski B., Laitinen-Parkkonen P., Mentzer D., Rasmussen C., Ratignier C. and Seitz R. (2008), Factor VIII products and inhibitor development: concepts for revision of European regulatory guidelines. Haemophilia, 14: 142–144. doi: 10.1111/j.1365-2516.2007.01604.x

Core SmPC for Human Plasma Derived and Recombinant Coagulation Factor IX Products

Workshop report: Characterisation of new clotting factor concentrates (FVIII, FIX) with respect to potency assays used for labelling and testing of post infusion samples, 28-29 November 2013 (EMA/135928/2014)
http://www.ema.europa.eu/docs/en_GB/document_library/Report/2014/07/WC500169760.pdf

https://www.edqm.eu/en/Workshop-on-characterisation-of-new-clotting-factor-concentrates-new-report-available-1582.html?mbID=216

Dodt, J., Hubbard, A. R., Wicks, S. J., Gray, E., Neugebauer, B., Charton, E. and Silvester, G. (2015), Potency determination of factor VIII and factor IX for new product labelling and postinfusion testing: challenges for caregivers and regulators. Haemophilia. doi: 10.1111/hae.12634

Applicants should also refer to other relevant European and ICH guidelines (in their current version) including those on:

ICH E6 Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95)

ICH E8 Note for Guidance on General Considerations for Clinical Trials (CPMP/ICH/291/95)

Guideline on strategies to identify and mitigate risks for first-in human clinical trials with investigational medicinal products (EMEA/CHMP/SWP/28367/07)

Guideline on clinical trials in small populations (CHMP/EWP/83561/2005)

ICH Q5E Note for Guidance on Biotechnological/Biological Products Subject to Changes in their Manufacturing Process (CPMP/ICH/5721/03)

Guideline on comparability of biotechnology-derived medicinal products after a change in the manufacturing process - non-clinical and clinical issues (EMEA/CHMP/BMWP/101695/2006)

Guideline on the clinical investigation of the pharmacokinetics of therapeutic proteins (CHMP/EWP/89249/2004)

Note for Guidance on the Investigation of Bioavailability and Bioequivalence (CPMP/EWP/QWP/1401/98)

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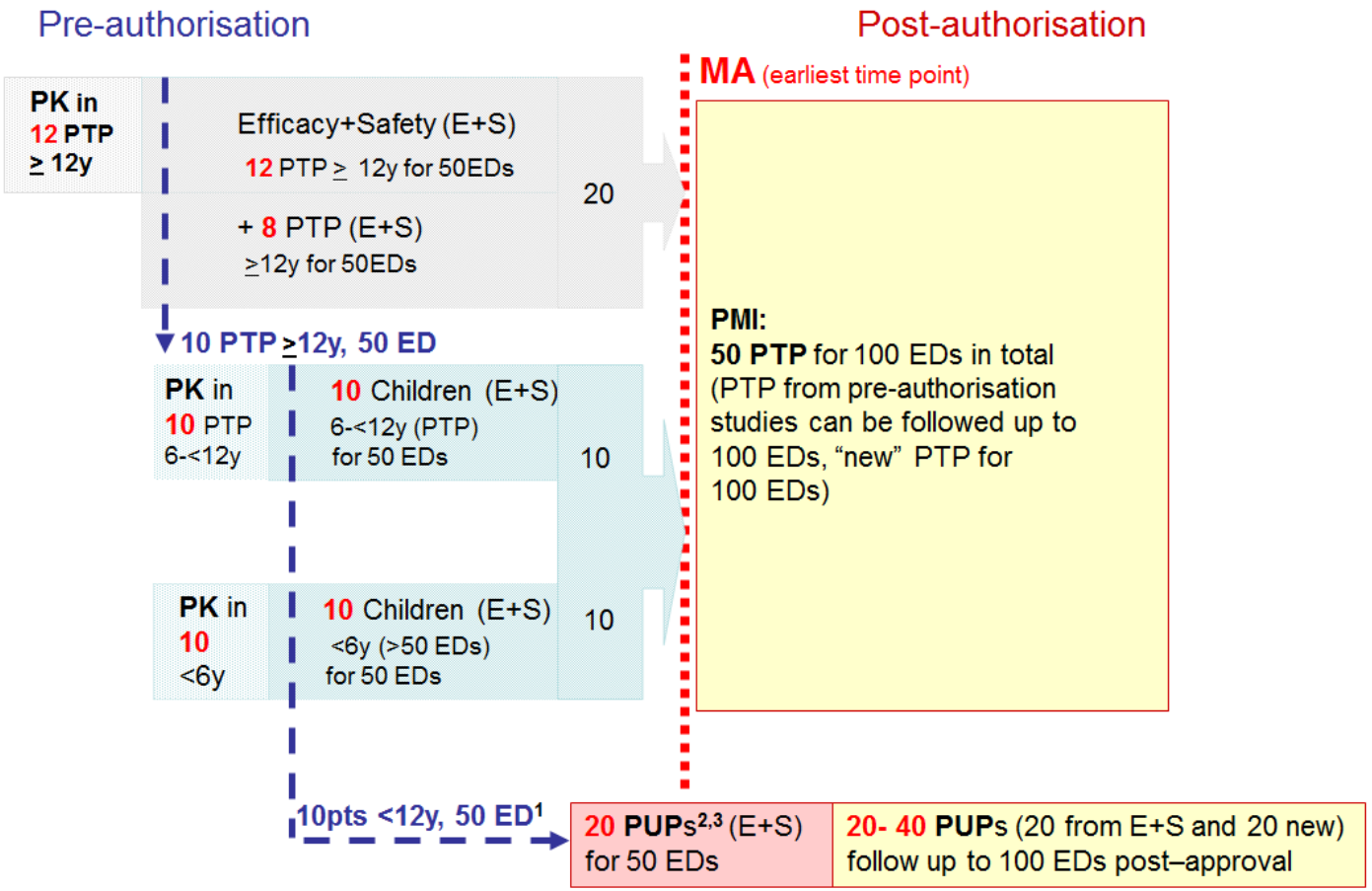
Annex I – Overview on clinical trial concept



[1] min. 5 patients <6y and pk in children 0-<12y completed
[2] plasma-derived factor IX products = case by case
[3] completion of clinical study in 20 PUPs not required for initial MAA, however for approval of indication in PUPs for novel products

SmPC of novel products: Indication is restricted as in 4.2 of core SmPC until data from 20 PUPs (E+S) are available

Annex II – Clinical trials with factor IX products: new products

Trial, subject	Investigation	Parameters
PTP ≥12y study – pre-authorisation		
12 haemophilia B patients (PTP ≥12 years; factor IX ≤2%) without inhibitors and not actively bleeding	Pharmacokinetics[3]	Incremental recovery, half-life, AUC, clearance. Patients should be re-tested after 3-6 months (including factor IX inhibitor assay).
	Safety	Blood pressure, heart rate, temperature, respiratory rate and adverse events. Thrombogenicity.
5 haemophilia B patients (PTP ≥12 years; factor IX ≤2%) undergoing at least 10 surgical procedures	Clinical efficacy	Efficacy of haemostasis, loss of blood and requirement for transfusion. Factor IX consumption.
	Safety	Adverse events. Thrombogenicity.
Efficacy and safety in 20 PTPs (≥12 years; factor IX ≤2% and CD4>200/µl)	Clinical efficacy	Factor IX consumption, physician's assessment of response in treatment of major bleeds.
	Immunogenicity	Inhibitor titre in Bethesda Units immediately before first exposure, ED10-15, ED50-75 and if there is any suspicion of inhibitor development, continue for a minimum of 50 exposure days.
	Safety	Adverse events. Thrombogenicity.
Children < 12y study – pre-authorisation (to be started after results of 50 ED in 10 PTPs (≥12 years) have become available.)		
10 haemophilia B patients (PTPs, **6 - <12y**; factor IX ≤2%) without inhibitors and not actively bleeding 10 haemophilia B patients (>50 EDs, <**6y**; factor IX ≤2%) without inhibitors and not actively bleeding	Pharmacokinetics	Incremental recovery, half-life, AUC, clearance.
	Safety	Blood pressure, heart rate, temperature, respiratory rate and adverse events. Thrombogenicity.
Multicentre trial in 20 children with haemophilia B allocated to 2 cohorts of 10 PTPs (6 - <12 y) and 10 children (<6y, >50EDs)	Clinical efficacy	Factor IX consumption, physician's assessment of response in treatment of major bleeds.
	Immunogenicity	Inhibitor testing immediately before first exposure, ED10-15, ED50-75 and if there is any suspicion of inhibitor development. Continue until a minimum of 50 exposure days.

[3] In order to allow for evaluation of a patient's individual response, pharmacokinetic information e.g. existing PK data with the patient's previous factor IX product (at least historical or recent recovery and half-life) should be available prior to first administration of the new factor IX product.

Trial, subject	Investigation	Parameters
	Safety	Adverse events. Thrombogenicity.
Post-marketing investigation		
50 PTPs for 100 EDs in total (PTPs from pre-authorisation studies can be followed up to 100 EDs, "new" PTPs for 100 EDs)	Clinical efficacy Immunogenicity Safety	Protocol should be provided according to Annex III.
PUP study (novel products) (to be started after results of 50 ED in 10 children (0 - <12y, at least 5 of them <6y) are available and PK in children 0 - <12y completed.)		
20 PUPs for at least 50 EDs	Clinical efficacy	Factor IX consumption, physician's assessment of response in treatment of major bleeds.
	Immunogenicity	Inhibitor testing immediately before first exposure, ED10-15, ED50 and if there is any suspicion of inhibitor development. Continue until a minimum of 50 exposure days.
	Safety	Adverse events, blood pressure, heart rate, temperature. Thrombogenicity.
Post-approval commitment of PUP indication At least 20-40 PUPs should be followed up to 100 EDs (20 PUPs from pre-approval PUP indication).		

Annex III – Post-marketing investigation

Inclusion criteria

- Diagnosis: haemophilia B
- Factor IX activity: ≤2% factor IX:C
- Number of exposure days before inclusion: >150 ED
- PTPs of every age group could be included, provided that trial in children is completed (PK and efficacy and safety) and report is submitted and evaluated by the relevant Competent Authority(ies).
- Immunocompetent with CD4 lymphocytes >200/µl, HIV negative or having a viral load <200 particles/µl ~ 400000 copies/ml

Documentation of Patient's characteristics

- Gene defect
- Ethnicity
- Family history of haemophilia
- History of inhibitors
- The viral status of patients should be documented. The patients should be HIV negative or have a viral load <200 particles/µl ~ 400000 copies/ml.
- Co-morbidity or co-medication which would significantly impact blood coagulation or immunoreaction (any information concerning this issue should be included)

Patient enrolment

- At least 50 patients per post-marketing investigation
- Follow-up of each patient must be at least 100 ED
- Progress on recruitment has to be reported on a regular basis (will be set out before approval of procedure)
- A separate progress study report should be provided to the relevant Competent Authority(ies) 2 years after marketing authorisation to allow for evaluation of recruitment status, progress and the adherence to timelines.
- The post-marketing investigation should be completed within 4 years.

Study procedures

- Before patient inclusion there should not be a clinical suspicion of inhibitors, and a recovery and inhibitor test in a central laboratory should confirm that the patient is inhibitor negative at study entry. An inhibitor test which is not negative should be confirmed by testing a second separately drawn sample in a central laboratory.
- Testing schedule (ED = Exposure Day)

	Previous product [#]	Test product ED1	Test product ED10-15	Test product ED50-75	Test product ED~100
Inhibitor[*]	x	x[†]	x	x	x
Recovery	x	x	x	x	x

[*]after washout period (see Explanatory Note); storage of back up blood sample is recommended

[#]new patients = not recruited for pre-authorisation studies

[†]baseline inhibitor testing prior to first infusion of test product

Testing should also be carried out if there is any suspicion of an inhibitor.

- Patients' diaries should be evaluated on total number of exposures per year and mean dose per kg per patient/year (consumption).
- Intended treatment regimen for every patient at study entry and reason for each ED should be documented
- In case of bleeding: documentation of particulars; judgement of severity and treatment outcome by clinician and patient (consumption)
- In case of surgery different data are to be collected (surgical protocol) (e.g. type of surgery (planned or emergency); documentation of complications; mode of administration, consumption)
- Monitoring of all adverse events.

Explanatory Note

Inhibitor tests should be performed when the plasma factor IX level has reached a pre-substitution nadir (documentation for the last infusion should be provided). Inhibitor questionnaires/report forms should be used. In the case that patients are treated on demand, an inhibitor can be missed when the patients did not receive treatment for > 2 weeks. According to the t1/2 of immunoglobulins, the inhibitor will drop gradually when treatment has been stopped. In case of a positive inhibitor test, also PK / recovery tests are necessary to confirm inhibitory activity.

Co-medication: At the present time, all patients are accepted in studies (provided they are immunocompetent CD4 lymphocytes >200/µl, HIV negative or having a viral load <200 particles/µl ~ 400000 copies/ml). Patients with HIV infection receive intensive co-medication, and it is unknown whether this, e.g. HAART therapy, can influence inhibitor formation or efficacy of treatment. Similar problems can be expected for HCV positive patients, some receive therapy and others have lower platelets, decreased liver function and altered coagulation. These patients can be included in order to provide additional data on efficacy in this group, but more parameters on co-morbidity should be collected.