



NDA 20-634  
NDA 20-635  
NDA 21-721

Ortho-McNeil Pharmaceutical, Inc.  
c/o Johnson & Johnson Pharmaceutical Research & Development, L.L.C.  
Attention: Ms. Cynthia Chianese  
Director, Regulatory Affairs  
920 U.S. Highway 202  
P.O. Box 300  
Raritan, NJ 08869

Dear Ms. Chianese:

Please refer to your correspondence, dated April 21, 2006 and received on April 22, 2006, requesting changes to FDA's December 19, 2005 Written Request for pediatric studies for levofloxacin.

We have reviewed your proposed changes and are amending the Written Request. This Written Request supercedes the Written Request dated December 19, 2005.

To obtain needed pediatric information about levofloxacin, the Food and Drug Administration (FDA) is hereby making a formal Written Request, pursuant to Section 505A of the Federal Food, Drug, and Cosmetic Act (the Act), that you submit information from the studies described below.

In the design of these studies, consideration is given to the fact that systemic use of levofloxacin has been associated with arthropathy in juvenile animals and developing a quality safety database to better understand the safety profile of this drug in the pediatric population is needed. Obtaining information on the true incidence of rare, serious adverse events in this population, including persistent and disabling arthropathy, as well as gaining additional safety data in pediatric patients with community acquired pneumonia (CAP) including pneumonia due to penicillin-resistant *S. pneumoniae* is needed. In particular, determining if pediatric use of levofloxacin will predispose to musculoskeletal abnormalities following exposure is needed.

***Type of Studies:***

**Study 1:** A prospective, randomized, multicenter, comparative, study in the pediatric population 6 months of age to 16 years of age with CAP. The study will compare levofloxacin (orally, intravenously or sequentially) with an established active non-fluoroquinolone antimicrobial control.

**Study 2:** A study to evaluate the safety, tolerability, and pharmacokinetics of levofloxacin following intravenous administration of single doses to pediatric patients ages 6 months to 12 years.

**Study 3:** A study to evaluate the safety, tolerability, and pharmacokinetics of levofloxacin following intravenous and oral tablet administration of single doses to older pediatric patients ages 8 to 16 years.

**Study 4:** A study to evaluate the safety, tolerability, and pharmacokinetics of levofloxacin following administration of single doses of levofloxacin oral suspension to pediatric patients ages 6 months to 16 years.

**Study 5:** A prospective, multicenter, comparative, active-controlled pediatric study to evaluate long-term musculoskeletal adverse events occurring during the first year following levofloxacin or non-quinolone antimicrobial control drug exposure in pediatric patients. This study may include some patients that were initially treated in Study 1.

***Indication to be Studied (Objective):***

**Study 1:** A prospective, randomized, multicenter, comparative, study in the pediatric population 6 months of age to 16 years of age with CAP. The study will compare levofloxacin (orally, intravenously, or sequentially) with an established active non-quinolone antimicrobial control.

The study will address several safety and efficacy concerns of particular importance in children. These include the efficacy in patients with pneumonia and concurrent bacteremia, as well as in pneumonia complicated by empyema. As part of the evaluation of the efficacy of levofloxacin treated pediatric patients with CAP complicated by empyema, the concentration of levofloxacin should be determined in the pleural fluid obtained from the empyema. The concentration of levofloxacin in plasma should also be determined at the same time that the pleural fluid sample was obtained in these patients. An evaluation of the penetration of levofloxacin into pleural fluid relative to plasma should be determined.

Additionally, the pharmacokinetics of levofloxacin at steady state will be determined in a subset of levofloxacin-treated pediatric patients with CAP over the entire range of ages from 6 months to 16 years using a population pharmacokinetic approach with sparse sampling (e.g., approximately 1 to 2 samples per patient at recorded times).

Safety concerns include musculoskeletal adverse events including potential bone and joint toxicity, which should be addressed in the study. Approximately 50% of patients will be less than 5 years of age.

**Studies 2, 3, and 4:** The primary objective for these studies will be to characterize the plasma pharmacokinetics, safety, and tolerability of single intravenous and oral doses of levofloxacin in pediatric patients.

**Study 5:** The primary objective of this study will be to evaluate the overall incidence of musculoskeletal adverse events occurring in children after their exposure to either levofloxacin or non-quinolone antimicrobial therapy for an acute bacterial infection in a minimum of 1000 pediatric patients treated with levofloxacin and 700 pediatric patients treated with a non-quinolone antimicrobial and followed up for 1 year. A minimum of 20% of patients will be less than 5 years of age.

The dose, dosage form (IV solution, oral suspension, or oral tablet), route of administration, and time of switch (from IV to oral therapy) should be selected based on the clinical judgment of the treating physician. Follow up of all patients will be for at least one year. Those patients identified with musculoskeletal adverse events including tendon or joint disorders during this period that are

considered to be possibly, probably, or likely related to exposure to levofloxacin or comparator will be asked to undergo evaluation until resolution or yearly for five years if resolution does not occur before.

***Age Groups in which Study will be Performed:***

**Study 1:** The following age groups will be studied:  $\geq 6$  months to  $< 5$  years and  $\geq 5$  years to  $< 17$  years. Approximately 50% of the study population will consist of patients  $\leq 5$  years of age.

**Study 2:** The following age groups of male and female pediatric patients should be studied: 6 months to  $\leq 2$  years,  $> 2$  years to  $\leq 5$  years, and  $> 5$  years to 12 years. Patients should be approximately evenly distributed across the age range within each of the age groups.

**Study 3:** The following age groups of male and female pediatric patients should be studied: 8 to  $< 12$  years and  $\geq 12$  to 16 years. Patients should be approximately evenly distributed across the age range within each of the age groups.

**Study 4:** The following age groups of male and female pediatric patients should be studied: 6 months to  $< 2$  years,  $\geq 2$  years to  $< 5$  years,  $\geq 5$  years to  $< 10$  years,  $\geq 10$  years to  $< 12$  years, and  $\geq 12$  years to 16 years. Patients should be approximately evenly distributed across the age range within each of the age groups.

**Study 5:** The following age groups of male and female pediatric patients should be studied:  $\geq 2$  months but  $< 24$  months,  $\geq 2$  years through  $< 6$  years,  $\geq 6$  years through  $< 12$  years, and  $\geq 12$  years through  $< 17$  years. A minimum of 20% of the study population will consist of patients  $\leq 5$  years of age.

***Number of Patients to Be Studied or Power of Study to be Achieved:***

**Study 1:** To determine efficacy of levofloxacin for pediatric patients with CAP, the study will include approximately 480 patients randomized to receive levofloxacin and approximately 160 control patients. Additionally, plasma samples for pharmacokinetic analysis will be obtained from a minimum of 100 levofloxacin treated pediatric patients from Study 1. Pleural fluid and corresponding plasma samples should also be obtained for levofloxacin-treated pediatric patients with CAP complicated by empyema.

**Studies 2, 3, and 4:** The number of patients enrolled into these studies should be sufficient to allow for adequate characterization of the pharmacokinetics of levofloxacin in pediatric patients in each of the age groups described above. The minimum number of evaluable pediatric patients in each of the age groups (age strata) specified in each study specified is 6, corresponding to a minimum of 18 patients in Study 2, a minimum of 12 patients in Study 3, and a minimum of 30 patients in Study 4.

**Study 5:** For the purpose of completing the entire study, approximately 1000 levofloxacin-treated patients and approximately 700 non-quinolone antimicrobial-treated patients will be enrolled and complete 1 year of follow-up.

***Study Endpoints and Timing of Assessments:***

**Study 1:** This study will evaluate the safety and efficacy of levofloxacin and a non-quinolone control drug in the treatment of pediatric patients with CAP. Patients will be assessed for the development of any adverse event, including any serious adverse event, with particular attention to musculoskeletal events that occur during treatment (day 1-7) and at 10-35 days following levofloxacin or non-quinolone control drug exposure. Clinical evaluations of the musculoskeletal system (including gait/joint examination) should be performed at least once during treatment (day 1-7), at 10-35 days and at 1 year following levofloxacin or non-quinolone control drug exposure; patients may be enrolled into Study 5 to complete the 1 year follow up. Special emphasis should be placed on the evaluation of musculoskeletal adverse event rates using all applicable WHOART “Musculoskeletal and Connective Tissue Disorders” body systems. Gait/joint examinations should be performed by rheumatologists, trained physical therapists experienced in musculoskeletal examinations or clinicians who are trained to perform developmentally appropriate and thorough examination of the musculoskeletal system. Pediatric rheumatologic follow-up should be obtained if any signs or symptoms suggestive of musculoskeletal adverse events develop. Patients who develop joint effusions should have joint fluid evaluations. Patients who develop arthropathy, defined as joint disease diagnosed by a physician experienced in evaluating the musculoskeletal system, should be evaluated with the goal of establishing the cause and extent of the disease.

Efficacy evaluations including clinical and microbiological assessments of children with CAP should also be performed at approximately 1-7 days and 10-35 days following levofloxacin or control drug exposure.

**Studies 1, 2, 3, and 4:** These studies will determine the relevant pharmacokinetic parameters so that appropriate dosing recommendations for the intravenous and oral administration of levofloxacin for the treatment of target infections (e.g., CAP, complicated urinary tract infections, and pyelonephritis) in the pediatric population, including those patients with varying degrees of renal function (i.e., normal to impaired), may be made. In each of these studies, pharmacokinetic characterization of levofloxacin in pediatric patients may be determined using a traditional (or dense) pharmacokinetic sampling scheme, or alternatively, a population pharmacokinetic approach using a sparse sampling scheme. With the latter population pharmacokinetic approach, approximately 2 to 3 samples per patient staggered at various times throughout the dosing interval should be obtained.<sup>1</sup>

**Study 5:** The objective of the study is to assess all adverse events, including serious adverse events that occur at 1-7 days and 10-35 days following levofloxacin or non-quinolone control drug exposure and to also assess the development of any musculoskeletal adverse events that occur within 1 year following levofloxacin or non-quinolone control drug exposure. The reversibility of all adverse events should be identified and the severity of adverse events should be characterized. Patients should receive two structured assessments for general, neurological, and musculoskeletal safety, i.e., evaluations of the joints (especially all weight-bearing joints) and gait. These should be conducted 1-7 days after the initiation of therapy and at approximately 10-35 days following exposure. At the end of the first year, a trained interviewer should perform an assessment. All patients that report musculoskeletal adverse events, in WHOART “Musculoskeletal and Connective Tissue” body systems, will be asked to undergo evaluation until resolution or yearly for 5 years if resolution does not occur before.

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<sup>1</sup> In Study 1, approximately 1 to 2 samples per patient will be obtained, as written under “*Indication to be Studied (Objective):*” Study 1 on page 2 of this document.

Definitions pertaining to musculoskeletal adverse events and causality attributions should be developed. Such case definitions should be applied to individual adverse events by an independent Data Safety Monitoring Committee that will be blinded to treatment group. Pediatric rheumatologic evaluation should be obtained if any signs or symptoms suggestive of arthropathy develop. Patients who develop joint effusions should have joint fluid evaluations. Patients who develop arthropathy, regardless of the degree of severity, should undergo MRI (or other appropriate imaging technique) of the affected joint.

***Study Evaluations:***

**Studies 1, 2, 3, and 4:** The pharmacokinetic parameters of levofloxacin will be determined (e.g., C<sub>max</sub>, T<sub>max</sub>, AUC, clearance, and half-life). Sparse plasma samples obtained after dosing to steady state will be used to determine the pharmacokinetics of levofloxacin in the pediatric population with CAP (**Study 1**). Covariates such as age, body weight, and renal function, which may affect the pharmacokinetics of levofloxacin in the pediatric patient population, will also be evaluated across these four studies.

**Study 5:** Evaluation of pediatric patients will be made at baseline, approximately 10-35 days and 1 year following treatment. All patients that report having a musculoskeletal adverse event will be asked to undergo evaluation until resolution or yearly for 5 years if resolution does not occur before. Attempts should be made by the investigator to obtain the reason for the loss to follow-up if a patient does not undergo the yearly evaluation.

***Drug Information:***

**Study 1:**

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|--------------------------|--|
| Dosage Forms:            | I.V. solution, oral tablet, or oral suspension   |
| Regimen:                 | The levofloxacin dosage regimen should be determined by pharmacokinetic studies; comparator dosage regimens are those currently approved for pediatric patients. |
| Route of Administration: | Intravenous or Oral  |

**Study 2:**

- |                          |   |
|--------------------------|---|
| Dosage Form:             | I.V. solution                                   |
| Regimen:                 | 7 mg/kg single dose to a maximum dose of 500 mg |
| Route of Administration: | Intravenous                                     |

**Study 3:**

Dosage Forms: I.V. solution and oral tablet  
Regimen: 7 mg/kg single dose to a maximum dose of 500 mg  
Route of administration: Intravenous and Oral

**Study 4:**

Dosage Form: Oral suspension  
Regimen: 7 mg/kg single dose to a maximum dose of 500 mg  
Route of Administration: Oral

**Study 5:**

Dosage Forms: I.V. solution, oral tablet, or oral suspension  
Regimen: The levofloxacin dosage regimen should be determined by pharmacokinetic studies  
Route of Administration: Intravenous or Oral

***Drug-Specific Safety Concerns:***

**Studies 1, 2, 3, 4, and 5:** The development of arthropathy, arthritis, or neurologic events is the major safety concern.

**Studies 1 and 5:** In addition to the above, any reported adverse events under the WHOART “Musculoskeletal and Connective Tissue Disorders” body systems.

***Statistical Information and Power of the Study:***

**Study 1:** The study will enroll approximately 480 levofloxacin-treated patients and 160 comparator-treated patients. This sample size is based on the confidence interval approach for establishing non-inferiority and the following assumptions: a 3:1 randomization, a 90% cure rate for both treatment arms, 78% clinical evaluability rate, a 95% confidence interval, and a 10% non-inferiority margin.

**Studies 2, 3, and 4:** For pharmacokinetic analyses, see the section *Number of Patients to be Studied*.

**Study 5:** The study will enroll approximately 1000 levofloxacin-treated patients and approximately 700 non-quinolone antimicrobial-treated patients who complete follow-up through 1 year. This sample size is based on providing 95% confidence that the serious adverse event rate is no greater than 1 in 333 (0.3%) in patients if no serious adverse event is observed among 1000 levofloxacin-exposed patients.

***Statistical Analyses of Data to be Performed:***

**Study 1:** Adverse event rates for both treatment arms will be calculated for all adverse events. Comparative statistical analyses will be used for clinical and bacteriological assessments.

**Studies 2, 3 and 4:** Pharmacokinetic analyses will be performed to determine pharmacokinetic parameters in the pediatric population that will allow for adequate pediatric dosing recommendations. Descriptive statistics of the pharmacokinetic parameters of levofloxacin will be provided. Additionally, age should be treated as a continuous variable and as a categorical variable in these pharmacokinetic analyses.

**Study 5:** Adverse events rates will be calculated for all events. Ninety-five percent confidence intervals should be calculated for the rates of all musculoskeletal adverse events and serious adverse events occurring through the evaluations at approximately 10-35 days following levofloxacin or non-quinolone control drug exposure. Ninety-five percent confidence intervals should be calculated for the rates of all musculoskeletal adverse events occurring after the visit at approximately 10-35 days through the one year follow-up visit. Rates and confidence intervals will be generated separately for levofloxacin-treated and non-quinolone antimicrobial-treated pediatric patients. Lifetime tables should be provided to present cumulative incidence rates for events occurring at these time points in the levofloxacin and non-quinolone comparator groups, for all patients as well as stratified by pubescence stage (where prepubescence is defined as girls < 9 years, boys < 11 years, pubescence is defined as girls 9-14 years, boys 11-15 years, and postpubescence is defined as girls > 14 years and boys > 15 years).

***Labeling that may Result from the Studies:*** These studies will provide safety information including the incidence of musculoskeletal adverse events for levofloxacin in pediatric patients. Information regarding the proper dose for safe and efficacious use in pediatric patients with serious infections will also be provided.

***Format of Reports to be Submitted to the Agency:*** Full study reports of requested Studies 1, 2, 3, 4, and 5 including full analysis, assessment, and interpretation, will be submitted in the usual format. As an alternative, you may submit an abbreviated study report along with all data in electronic form, with a case report form annotated with the names of the SAS variables used for each blank on the form.

***Timeframe for Submitting Reports of the Studies:*** Reports of each of the studies must be submitted to the Agency on or before August 1, 2010. Please keep in mind that pediatric exclusivity attaches only to existing patent protection or exclusivity that has not expired at the time you submit your report of the study in response to this Written Request.

### **Animal Study: Post-Dosing Arthrototoxicity Susceptibility Study**

An animal study designed to evaluate the potential for levofloxacin to cause latent arthrototoxicity in the juvenile dog model should be performed. Juvenile dogs should be dosed for a period of 7 to 14 days at three discrete dose levels (high, middle, and low) of levofloxacin. A no-treatment control group should be included. The study design should include the sacrifice of 3 dogs from both sexes per dose level at 24 hours following the final dose and at 6 to 9 months of age. Gross pathology, histopathology, and electron microscopic analysis of chondrocytes should evaluate all weight-bearing joints and growth plates (where present) from each dog.

A full study report of the requested animal study, including full analysis, assessment, and interpretation, will be submitted in the usual format. Reports of the study must be submitted to the Agency on or before August 1, 2010. Please keep in mind that pediatric exclusivity attaches only to existing patent protection or exclusivity that has not expired at the time you submit your report of the study in response to this Written Request.

Reports of the studies that meet the terms of the Written Request dated December 20, 2001, as amended April 1, 2004, and by this letter must be submitted to the Agency on or before August 1, 2010, in order to possibly qualify for pediatric exclusivity extension under Section 505A of the Act.

Submit protocols for the above studies to an investigational new drug application (IND) and clearly mark your submission, **“PEDIATRIC PROTOCOL SUBMITTED FOR PEDIATRIC EXCLUSIVITY STUDY”** in large font, bolded type at the beginning of the cover letter of the submission. Notify us as soon as possible if you wish to enter into a written agreement by submitting a proposed written agreement. Please clearly mark your submission, **“PROPOSED WRITTEN AGREEMENT FOR PEDIATRIC STUDIES”** in large font, bolded type at the beginning of the cover letter of the submission.

Submit reports of the studies as supplements to approved NDAs [or as an administrative new drug application (NDA) if you wish to supplement an unapproved NDA] with the proposed labeling changes you believe are warranted based on the data derived from these studies. When submitting the reports, clearly mark your submission **“SUBMISSION OF PEDIATRIC STUDY REPORTS – PEDIATRIC EXCLUSIVITY DETERMINATION REQUESTED”** in large font, bolded type at the beginning of the cover letter of the submission and include a copy of this letter. In addition, send a copy of the cover letter of your submission, by fax (301-594-0183) or messenger to the Director, Office of Generic Drugs, HFD-600, Metro Park North II, 7500 Standish Place, Rockville, MD 20855-2773.

If you wish to discuss any amendments to this Written Request, submit proposed changes and the reasons for the proposed changes to your application. Clearly mark submissions of proposed changes to this request **“PROPOSED CHANGES IN WRITTEN REQUEST FOR PEDIATRIC STUDIES”** in large font, bolded type at the beginning of the cover letter of the submission. We will notify you in writing if we agree to any changes to this Written Request.

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We hope you will fulfill this pediatric study request. We look forward to working with you on this matter in order to develop additional pediatric information that may produce health benefits to the pediatric population.

If you have any questions, call Rebecca D. Saville, Pharm.D., Regulatory Project Manager, at 301-796-1600.

Sincerely,

*{See appended electronic signature page}*

Mark J. Goldberger, M.D., M.P.H.  
Director  
Office of Antimicrobial Products  
Center for Drug Evaluation and Research

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**This is a representation of an electronic record that was signed electronically and  
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/s/

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Edward Cox  
5/16/2006 03:56:04 PM  
for Mark J. Goldberger, MD MPH