View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Elsevier - Publisher Connector

Current Therapeutic Research 77 (2015) 99–104

Contents lists available at ScienceDirect

Current Therapeutic Research

journal homepage: www.elsevier.com/locate/cuthre

# Chemical Stability of Telavancin in Elastomeric Pumps

Patrick Sand, MSc[1], Traci Aladeen, BA[2], Paul Kirkegaard, BS[3], Dennis LaChance, BS[3], Christine Slover, PharmD[4,*]

[1] Astellas Pharma, Inc, Chuo-ku, Tokyo, Japan
[2] Astellas US Technologies, Inc, Northbrook, Illinois
[3] Covance Laboratories, Inc, Madison, Wisconsin
[4] Theravance Biopharma US, Inc, South San Francisco, California

ARTICLE INFO

*Article history:*
Accepted 6 October 2015

*Key words:*
antibiotic
elastomeric
outpatient
parenteral
stability
telavancin

ABSTRACT

*Background:* VIBATIV is a once-daily, injectable lipoglycopeptide antibiotic approved in the U.S. for the treatment of hospital-acquired and ventilator-associated bacterial pneumonia (HABP/VABP) caused by susceptible isolates of Staphylococcus aureus when alternative treatments are not suitable. In addition, VIBATIV is approved in the U.S. for the treatment of adult patients with complicated skin & skin structure infections (cSSSI) caused by susceptible isolates of Gram-positive bacteria, including Staphylococcus aureus, both methicillin-susceptible (MSSA) and methicillin-resistant (MRSA) strains.
*Objective:* To evaluate the chemical stability of telavancin (Vibativ; Theravance Biopharma US, Inc, Northbrook, Illinois), a lipoglycopeptide antibiotic with activity against methicillin-resistant *Staphylococcus aureus*, in 2 types of elastomeric pumps, the Intermate Infusion System (Baxter International Inc) and the Homepump Eclipse (I-Flow Corporation).
*Methods:* Different sizes of the Baxter (Ontario, Canada) (105 mL and 275 mL) and I-Flow (Stoughton, Massachusetts) (100 mL and 250 mL) pumps were compared with glass controls. The telavancin drug product was reconstituted and diluted to concentrations of 0.6 mg/mL and 8.0 mg/mL using either 0.9% saline, 5% dextrose in water, or sterilized water for injection (0.6 mg/mL telavancin) or saline (8.0 mg/mL telavancin) followed by Ringer's Lactate solution. Pumps were filled and stored at 2°C to 8°C, protected from light. Aliquots from both pump types and for all telavancin reconstitution/dilution schemes and concentrations were taken over a period of 8 days and analyzed for appearance, pH, telavancin concentration and purity, and degradation products.
*Results:* The pH of all pump solutions remained consistent throughout the 8-day analysis period, within a range of 4.6 to 5.7 for the 0.6 mg/mL and 4.4 to 4.9 for the 8.0 mg/mL telavancin solutions. There was no significant change in the chromatographic purity for any of the pump solutions examined. All decreases in telavancin concentration were $\leq$2.7%. Comparison of each test sample solution to the corresponding glass control indicated no loss of active drug due to absorption by the elastomeric material of the pumps. The greatest increase in the amount of total degradants observed over the 8-day period was ~0.7 w/w%.
*Conclusions:* The results of this study indicate that telavancin remains chemically stable when diluted in the Intermate Infusion System and the Homepump Eclipse elastomeric pumps and stored at 2°C to 8°C for up to 8 days protected from light at the concentration range and dilution schemes evaluated.
© 2015. The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Study Registry Identification Number:

## Introduction

Telavancin (Vibativ; Theravance Biopharma Antibiotics, Inc, South San Francisco, California) is a lipoglycopeptide antibiotic approved in the United States and Canada. This novel anti-infective agent treats patients with complicated skin and skin structure infections due to susceptible gram-positive pathogens. Additionally, in the United States and Europe, telavancin is approved for treating hospital-acquired bacterial pneumonia, including ventilator-associated bacterial pneumonia due to susceptible isolates of *Staphylococcus aureus* (methicillin-resistant *S aureus* strains only in Europe), when alternative medicines are unsuitable. The recommended dosing of both indications for telavancin is 10 mg/kg administered over a 60-minute period in patients aged 18 years and older by intravenous infusion once every 24 hours for 7 to 21 days.[1]

This study was presented, in part, at the Annual Meeting and Exposition of the American Association of Pharmaceutical Scientists, October 23–27, 2011; Washington, DC.

* Address correspondence to: Christine Slover, PharmD, Medical Information Services, Theravance Biopharma, 901 Gateway Blvd, South San Francisco, CA 94080.
*E-mail address:* cslover@theravance.com (C. Slover).

http://dx.doi.org/10.1016/j.curtheres.2015.10.002
0011-393X/© 2015. The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

**Table I**
Elastomeric pump part information.

| Pump | Size (mL) | Flow rate (mL/h) |
|---|---|---|
| Baxter Intermate* Infusion System | 275 | 100† |
| | 105 | 100 |
| I-Flow Homepump Eclipse‡ | 250 | 175† |
| | 100 | 100 |

* Ontario, Canada
† Delivery time is >60 minutes
‡ Stoughton, Massachusetts

Studies have shown that the reconstituted solution in the vial should be used within 7 days under refrigeration at 2°C to 8°C (36°F–46°F). The final solution in the infusion bag should also be used within 7 days when stored under refrigeration at 2°C to 8°C (36°F–46°F). However, the total time in the vial plus the time in the infusion bag should not exceed 7 days under refrigeration at 2°C to 8°C (36°F–46°F). The final solution in the infusion bag can also be stored at −30°C to −10°C (−22°F to 14°F) for up to 32 days.[1]

The 24-hour dosing interval is also compatible with outpatient parenteral antimicrobial therapy (OPAT).[2] Disposable infusion pumps, known as elastomeric devices, are attractive providers Of OPAT due to their portability, simplicity, and ease of disposal; patients have preferred elastomeric devices over electronically controlled pumps due to the aforementioned reasons.[3,4] The Intermate Infusion System (Baxter International Inc, Ontario, Canada) and the Homepump Eclipse (I-Flow Corporation, Stoughton, Massachusetts) are 2 commonly used elastomeric infusion pumps. Stability is an essential consideration when using elastomeric pumps. Two other antibiotics, doripenem and meropenem, have been shown to be stable in elastomeric containers for at least 7 days when stored between 4ºC and 5ºC (39°F–41°F).[5,6]

## Objective

This study investigated the chemical stability of telavancin when reconstituted and stored over an extended period in Intermate Infusion System and Homepump Eclipse pumps. Microbiologic testing was not carried out during this study.

## Methods

Telavancin for injection vials (750 mg/vial) were reconstituted and pooled in a glass volumetric flask before being diluted to concentrations of 0.6 mg/mL and 8.0 mg/mL using 1 of 3 reconstitution/dilution solutions: normal saline (0.9%) as reconstitution solution and diluent, dextrose in water (5%) as reconstitution solution and diluent, or sterile water for injection (0.6 mg/mL telavancin) or saline (8.0 mg/mL telavancin) followed by Ringer's Lactate solution as diluent. The reconstituted telavancin solution and the diluent were not prefiltered and were added in different volumetric sizes of either the Intermate Infusion System (105 mL and 275 mL) or Homepump Eclipse (100 mL and 250 mL) pumps (**Table I**).

Pumps were filled by adding the appropriate amount of the pooled reconstituted solution and diluent using sterile syringes of various sizes (1–60 mL) fitted with 18-gauge needles. The glass control solutions were dilutions of the pooled telavancin stock solution prepared to concentrations of 0.6 mg/mL and 8.0 mg/mL in glass volumetric flasks (**Table II**). Once the reconstituted telavancin solutions were mixed with their respective diluents, the filled pumps and glass controls were stored at 2°C to 8°C and protected from light to mimic expected storage and handling.

Samples from both pump types, for all telavancin reconstitution/dilution schemes and concentrations, were removed via the pump tubing at the initial ($T_0$,15–30 minutes after preparation), 24-, 48-, 72-, 96-, 120-, 144-, 168-, and 192-hour ($T_{192}$) time points and were immediately compared with glass controls assessed at $T_0$. At each sample pull time point, the pumps were removed to ambient conditions under low-actinic (yellow) lighting briefly to remove the testing aliquot, then returned to darkened storage. The pH of each sample was measured only at $T_0$ and $T_{192}$. The appearance of each sample was examined at all sample pull time points.

Sample aliquots were diluted to 0.2 mg/L with the appropriate diluent and assayed for telavancin concentration, purity, and degradation products by reverse phase high-performance liquid chromatography (HPLC). The HPLC method was validated in accordance with the International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use guideline Q2(R1). The HPLC system (Agilent 1100; Agilent Technologies, Inc, Santa Clara, California) was equipped with a binary pump, a single wavelength ultraviolet detector, a refrigerated autosampler, a C18 analytical column (Waters SunFire; Waters Corporation, Milford, Massachusetts), and was controlled using Empower acquisition software (Waters Corporation, Milford, MA). Mobile Phase A consisted of 2% acetonitrile: 98% water: and 0.05% formic acid. Mobile Phase B consisted of 60% acetonitrile: 40% water: and: 0.05% formic acid. The HPLC gradient was set as follows for Mobile Phase A: 0 minutes at 90%: 20 minutes at 85%, 30 minutes at 80%, 50 minutes at 60%, and 50.5 minutes at 0% followed by a washout and equilibration period. The flow rate was 1.0 mL/min and the injection volume was 80 μL. Quantitation was performed by integration of the peaks at a detection wavelength of 230 nm.

## Results

The visual appearance of all pump solutions remained clear and essentially free from visible particulate matter at all time points examined. There were no significant changes in pH in any of the pump solutions from $T_0$ to $T_{192}$, with maximum ranges in pH throughout the analysis period of 4.6–5.7 and 4.4–4.9 for the 0.6 mg/mL and 8.0 mg/mL telavancin solutions, respectively (**Table III**).

Comparison of $T_0$ to $T_{192}$ concentration assay data for each pump solution demonstrated that there were no significant changes in telavancin concentrations (**Table III**). Although the assays were not done in triplicate, the stability results in other storage containers (ie, frozen nonpolyvinyl chloride [PVC] bags and

**Table II**
Preparation of test articles and glass control solutions from vials of telavancin for injection (750 mg/vial).

| Test articles and solutions | Telavancin test solution | | | | Glass controls | |
|---|---|---|---|---|---|---|
| Final concentration in pump, mg/mL | 0.6 | | 8.0 | | 0.6 | 8.0 |
| Total solution volume in pump, mL | 100.0 | 250.0 | 100.0 | 250.0 | 100.0 | 100.0 |
| Volume of pooled reconstituted vial solution, mL | 4.0 | 10.0 | 53.3 | 133.3 | 4.0 | 53.3 |
| Diluent volume, mL | 96.0 | 240.0 | 46.7 | 116.7 | 96.0 | 46.7 |

**Table III**
Elastomeric pump stability of telavancin in the Intermate Infusion System (Baxter, Ontario, Canada) and Homepump Eclipse (I–Flow Corp, Stoughton, Massachusetts) pumps.

| Fill volume, mL* | Target concentration, mg/mL | Reconstitution/ dilution solutions | Assay, mg/mL | | Assay change | | HPLC purity, % | | pH | | Degradant A, w/w% | | Degradant B, w/w% | | Total degradants, w/w% | | Recovery vs glass control, % | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $T_0$ | $T_{192}$ | Overall, mg/mL | Percentage, %† | $T_0$ | $T_{192}$ | $T_0$ | $T_{192}$ | $T_0$ | $T_{192}$ | $T_0$ | $T_{192}$ | $T_0$ | $T_{192}$ | $T_0$ | $T_{192}$ | Change |
| **Intermate Infusion System** | | | | | | | | | | | | | | | | | | | |
| 100 | 0.6 | NaCl/NaCl | 0.541 | 0.542 | 0.001 | 0.2 | 92.3 | 91.7 | 5.2 | 5.0 | 0.16 | 0.15 | 1.50 | 1.85 | 1.7 | 2.0 | 96.3 | 96.4 | 0.2 |
| 250 | 0.6 | NaCl/NaCl | 0.554 | 0.555 | 0.001 | 0.2 | 92.4 | 91.6 | 5.3 | 5.0 | 0.16 | 0.14 | 1.50 | 1.87 | 1.7 | 2.0 | 98.7 | 98.8 | 0.1 |
| 100 | 0.6 | D5W/D5W | 0.617 | 0.609 | −0.008 | −1.3 | 91.8 | 90.6 | 4.8 | 4.6 | 0.16 | 0.12 | 1.67 | 2.33 | 1.8 | 2.5 | 100.4 | 99.1 | −1.3 |
| 250 | 0.6 | D5W/D5W | 0.618 | 0.612 | −0.006 | −1.0 | 91.8 | 90.8 | 4.7 | 4.7 | 0.13 | 0.11 | 1.52 | 2.14 | 1.6 | 2.3 | 100.8 | 99.9 | −1.0 |
| 100 | 0.6 | SWFI/LR | 0.603 | 0.591 | −0.012 | −2.0 | 91.9 | 90.9 | 5.6 | 5.6 | 0.14 | 0.12 | 1.60 | 1.95 | 1.7 | 2.1 | 99.5 | 97.6 | −1.9 |
| 250 | 0.6 | SWFI/LR | 0.605 | 0.589 | −0.016 | −2.7 | 91.9 | 91.0 | 5.7 | 5.5 | 0.15 | 0.12 | 1.58 | 1.97 | 1.7 | 2.1 | 99.8 | 97.2 | −2.7 |
| 100 | 8.0 | NaCl/NaCl | 8.040 | 8.050 | 0.010 | 0.1 | 91.5 | 91.7 | 4.8 | 4.8 | 0.14 | 0.18 | 1.38 | 1.69 | 1.5 | 1.9 | 100.5 | 100.7 | 0.1 |
| 250 | 8.0 | NaCl/NaCl | 8.030 | 7.980 | −0.050 | −0.6 | 91.4 | 91.9 | 4.8 | 4.8 | 0.17 | 0.18 | 1.39 | 1.71 | 1.6 | 1.9 | 100.4 | 99.8 | −0.6 |
| 100 | 8.0 | D5W/D5W | 8.080 | 8.030 | −0.050 | −0.6 | 91.8 | 90.9 | 4.5 | 4.5 | 0.12 | 0.11 | 1.48 | 1.92 | 1.6 | 2.0 | 100.0 | 99.3 | −0.6 |
| 250 | 8.0 | D5W/D5W | 8.050 | 8.000 | −0.050 | −0.6 | 92.1 | 91.0 | 4.4 | 4.5 | 0.10 | 0.13 | 1.47 | 1.94 | 1.6 | 2.1 | 99.7 | 99.0 | −0.7 |
| 100 | 8.0 | NaCl/LR | 8.280 | 8.170 | −0.110 | −1.3 | 92.3 | 91.4 | 4.8 | 4.7 | 0.13 | 0.14 | 1.54 | 1.91 | 1.7 | 2.1 | 100.4 | 99.1 | −1.3 |
| 250 | 8.0 | NaCl/LR | 8.180 | 8.100 | −0.080 | −1.0 | 92.1 | 91.4 | 4.8 | 4.8 | 0.13 | 0.12 | 1.54 | 1.91 | 1.7 | 2.0 | 99.2 | 98.2 | −1.0 |
| **Homepump Eclipse** | | | | | | | | | | | | | | | | | | | |
| 100 | 0.6 | NaCl/NaCl | 0.549 | 0.545 | −0.004 | −0.7 | 92.0 | 91.4 | 5.1 | 5.3 | 0.16 | 0.14 | 1.51 | 1.90 | 1.7 | 2.0 | 97.7 | 97.0 | −0.7 |
| 250 | 0.6 | NaCl/NaCl | 0.547 | 0.544 | −0.003 | −0.6 | 92.2 | 91.7 | 5.1 | 5.2 | 0.15 | 0.13 | 1.47 | 1.90 | 1.6 | 2.0 | 97.4 | 96.8 | −0.6 |
| 100 | 0.6 | D5W/D5W | 0.617 | 0.615 | −0.002 | −0.3 | 91.8 | 90.4 | 4.8 | 4.9 | 0.13 | 0.10 | 1.52 | 2.17 | 1.6 | 2.3 | 100.7 | 100.3 | −0.3 |
| 250 | 0.6 | D5W/D5W | 0.614 | 0.615 | 0.001 | 0.2 | 91.5 | 90.7 | 4.8 | 4.9 | 0.12 | 0.10 | 1.52 | 2.20 | 1.6 | 2.3 | 100.1 | 100.4 | 0.2 |
| 100 | 0.6 | SWFI/LR | 0.599 | 0.586 | −0.013 | −2.2 | 91.9 | 91.0 | 5.7 | 5.6 | 0.13 | 0.11 | 1.59 | 1.95 | 1.7 | 2.1 | 99.0 | 96.8 | −2.2 |
| 250 | 0.6 | SWFI/LR | 0.608 | 0.594 | −0.014 | −2.3 | 92.1 | 91.4 | 5.6 | 5.7 | 0.14 | 0.12 | 1.60 | 1.96 | 1.7 | 2.1 | 100.4 | 98.1 | −2.3 |
| 100 | 8.0 | NaCl/NaCl | 8.000 | 7.990 | −0.010 | −0.1 | 91.4 | 91.9 | 4.8 | 4.9 | 0.17 | 0.17 | 1.40 | 1.71 | 1.6 | 1.9 | 100.1 | 100.0 | −0.1 |
| 250 | 8.0 | NaCl/NaCl | 8.020 | 8.050 | 0.030 | 0.4 | 91.5 | 91.7 | 4.8 | 4.8 | 0.16 | 0.18 | 1.43 | 1.69 | 1.6 | 1.9 | 100.4 | 100.7 | 0.3 |
| 100 | 8.0 | D5W/D5W | 8.060 | 8.060 | 0.000 | 0.0 | 91.9 | 91.0 | 4.4 | 4.5 | 0.11 | 0.11 | 1.50 | 1.91 | 1.6 | 2.0 | 99.7 | 99.8 | 0.1 |
| 250 | 8.0 | D5W/D5W | 8.010 | 7.980 | −0.030 | −0.4 | 92.1 | 91.0 | 4.6 | 4.5 | 0.11 | 0.09 | 1.50 | 1.93 | 1.6 | 2.0 | 99.2 | 98.8 | −0.4 |
| 100 | 8.0 | NaCl/LR | 8.240 | 8.140 | −0.100 | −1.2 | 92.2 | 91.1 | 4.8 | 4.8 | 0.13 | 0.13 | 1.55 | 1.92 | 1.7 | 2.1 | 99.9 | 98.7 | −1.2 |
| 250 | 8.0 | NaCl/LR | 8.230 | 8.140 | −0.090 | −1.1 | 92.1 | 91.4 | 4.8 | 4.7 | 0.14 | 0.12 | 1.56 | 1.91 | 1.7 | 2.0 | 99.8 | 98.8 | −1.0 |

D5W = 5% dextrose; HPLC = high-performance liquid chromatography; LR = Ringer's Lactate; NaCl = normal saline (0.9% sodium chloride); SWFI = sterile water for injection.

* Fill volumes of 100 mL and 250 mL were used for the 105 mL and 275 mL pumps, respectively.

† Due to mathematical computation and rounding, the exact values may not be accurate.

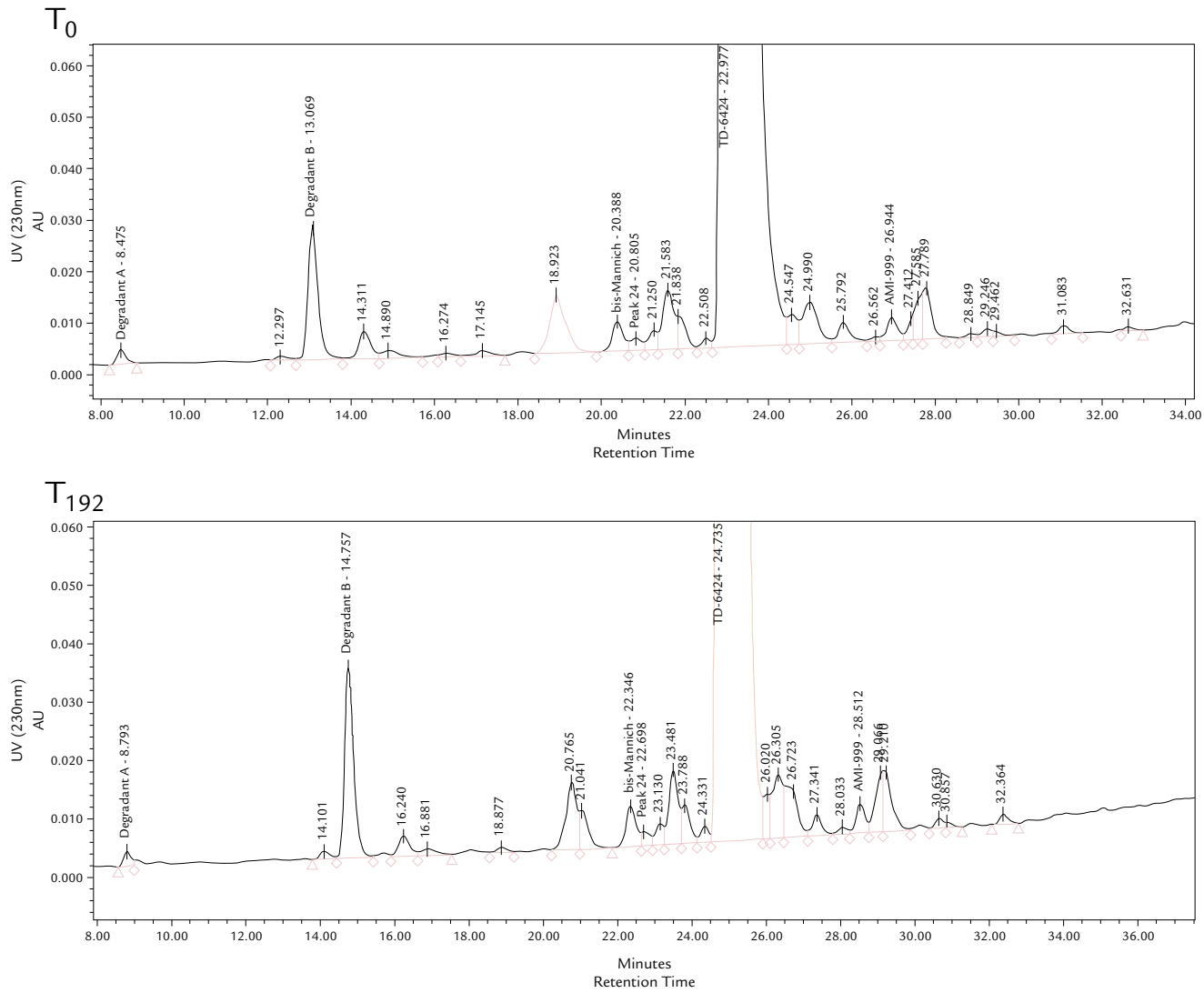


**Figure 1.** Chromatographic purity in the Intermate Infusion System pump (Baxter International Inc, Ontario, Canada). A fill volume of 250 mL and a target concentration of 0.6 mg/mL were used, reconstituted in sterile water for injection, and diluted in Ringer's Lactate solution.

frozen PVC bags) are similar to those in elastomeric devices.[7] Based on the storage environment, multiple concentrations, reconstitution solutions, and diluents, the greatest change in assay results over the 192-hour study period were noted in 100 mL of the 8 mg/mL concentration of telavancin with normal saline as the reconstituting solution and Ringer's Lactate being the diluent; the changes observed were −0.11 mg/mL and −0.10 mg/mL in the Intermate Infusion System and Homepump Eclipse, respectively.

Comparison of each test sample to a corresponding glass control indicated no loss of active drug due to absorption by the elastomeric material of either type of pump (**Table III**). The initial mean overall recovery assays in the Intermate Infusion System in sterile water/lactated Ringer's solution at $T_0$ and $T_{192}$ were 0.605 mg/mL and 0.589 mg/mL, respectively, with an overall 2.7% decrease in telavancin concentration when compared with glass control. The greatest decrease for both pump types was seen in the 0.6 mg/mL sterile water/Ringer's Lactate solution, 250 mL pump size configuration (**Table III**). There was no corresponding change in the amount of Degradant B in these solutions, because Degradant B was regarded as the primary degradation product of telavancin.[7]

There was no significant change in chromatographic purity for any of the pump solutions examined during this study (**Table III**), as depicted in representative chromatograms for each pump at the target concentration of 0.6 mg/mL and pump size configuration of 250 mL (Figures 1 and 2). Additionally, the largest increase in total degradants observed was ~0.7 w/w% over the 8-day period, seen in both sizes of both pumps at the 0.6 mg/mL telavancin concentration (**Table III**). This amount of increase was consistent with telavancin stability testing and the total degradant values at $T_{192}$ as well as the first appearance of degradants A and B at approximately 8.5 and 14.7 minutes after elution (Figures 1 and 2) fall within the acceptable range from previous studies.[7]

## Discussion

We have demonstrated that telavancin remains chemically stable when reconstituted, diluted, and stored (protected from light at 2°C–8°C) for up to 8 days in the Intermate Infusion System and the Homepump Eclipse elastomeric pumps, for the reconstitution/dilution schemes evaluated in this study. Further, HPLC comparison of telavancin concentrations in the pump solutions with glass controls indicate that active drug is not absorbed by the container components of either pump assessed during this study to any appreciable extent. There was no apparent influence on

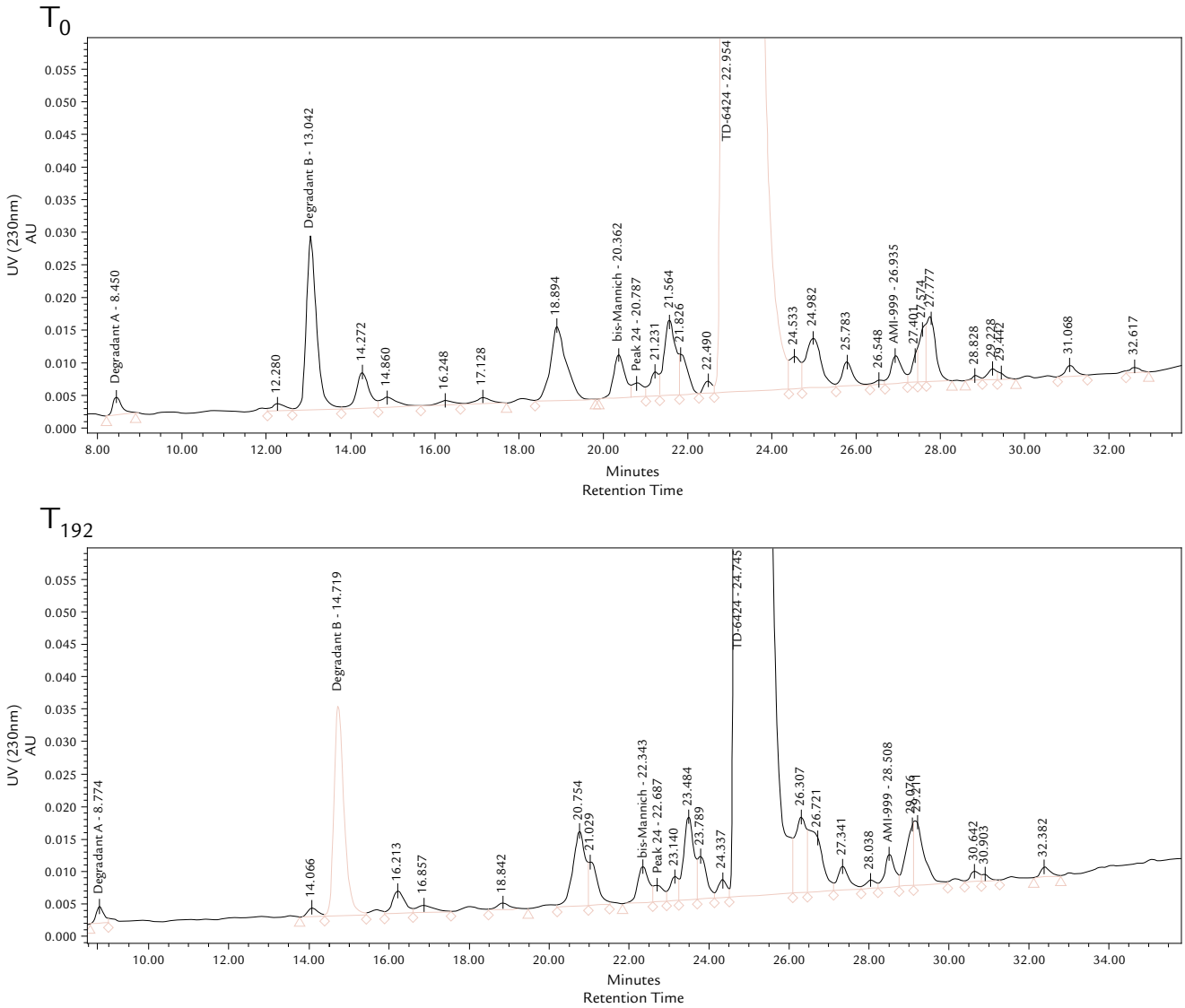


**Figure 2.** Chromatographic purity in the Homepump Eclipse pump (I-Flow Corp, Stoughton, Massachusetts). A fill volume of 250 mL and a target concentration of 0.6 mg/mL were used, reconstituted in sterile water for injection, and diluted in Ringer's Lactate solution.

chromatographic purity due to contact with the pump surfaces, further evidenced by negligible increases in the amount of degradants.

Use of antimicrobial agents compatible with OPAT—from a stability, dosing interval, and safety perspective—along with the identification of patients appropriate for OPAT, is key to ensuring favorable outcomes.[2,8] In addition to being often preferable for patients in terms of comfort and convenience, the hospital cost savings from using OPAT can be significant due to shorter hospital stays and lower incidence of costly nosocomial infections.[8,9] Additional research into the safety of telavancin in the outpatient setting, together with evidence to aid identification of the patients most appropriate for telavancin OPAT, is needed.

There are limitations to this study. Different models of elastomeric pumps are available and, as such, the findings of this study could not be extrapolated to other pumps that differ from the Intermate Infusion System and Homepump Eclipse with alternative designs, composed of different elastomeric materials (eg, polyurethane or PVC), or the use of other diluents; consequently, telavancin stability or degradation in other elastomeric devices could not be verified at present and additional investigation is warranted.

## Conclusions

The results of this study indicate that reconstituted telavancin diluted in the Baxter Intermate Infusion System and I-Flow Homepump Eclipse elastomeric pumps retain purity and chemical stability for up to 8 days when stored between 2ºC and 8ºC and protected from light. Reconstituted telavancin diluted in elastomeric pumps may be a viable drug delivery option for patients requiring OPAT with telavancin for the approved indications; additional evidence regarding the appropriate use of telavancin in this setting is required.

## Acknowledgments

The authors thank Melanie Schneider and Rebecca Koeper (Covance Laboratories, Inc).

Medical writing support was provided by Brian Catton and Paul Hale (AlphaBioCom), who were paid by Theravance Biopharma Antibiotics, Inc.

These data were presented, in part, at the Annual Meeting and Exposition of the American Association of Pharmaceutical Scientists; October 23–27, 2011; Washington, DC, USA.

P.Sand was responsible for design, analysis, interperation of data, T.Aladeen was responsible for analysis, interperation of data, P.Kirkegaard and D.LaChance were responsible for the conducted study, analysis, interperatation of data and C. Slover was responsible for design, analysis, interperation of data.

## Conflicts of Interest

Patrick Sand is an employee of Astellas. Christine M. Slover and Traci Aladeen were employees of Astellas at the time of the study. Christine M. Slover is an employee of Theravance Biopharma US, Inc; Paul Kirkegaard and Dennis LaChance's institution (Covance) received funding from Theravance Biopharma Antibiotics, Inc.: and Astellas for this study. The study and publication process were supported jointly by Theravance Biophama Antibiotics, Inc.; and Astellas US Technologies, Inc. The authors have indicated that they have no other conflicts of interest regarding the content of this article.

## References

1. VIBATIV® (telavancin) for injection package insert. Available at: http://www.vibativ.com/docs/VIBATIV_PI_Final.pdf. South San Francisco, CA: Theravance, Inc. 2014.
2. Tice AD, Rehm SJ, Dalovisio JR, et al. Practice guidelines for outpatient parenteral antimicrobial therapy. IDSA guidelines. *Clin Infect Dis.* 2004;38(12):1651–1672.
3. Skryabina EA, Dunn TS. Disposable infusion pumps. *Am J Health Syst Pharm.* 2006;63(13):1260–1268.
4. Zahnd D, Aebi S, Rusterholz S, et al. A randomized crossover trial assessing patient preference for two different types of portable infusion-pump devices. *Ann Oncol.* 1999;10(6):727–729.
5. Smith DL, Bauer SM, Nicolau DP. Stability of meropenem in polyvinyl chloride bags and an elastomeric infusion device. *Am J Health Syst Pharm.* 2004;61(16):1682–1685.
6. Crandon JL, Sutherland C, Nicolau DP. Stability of doripenem in polyvinyl chloride bags and elastomeric pumps. *Am J Health Syst Pharm.* 2010;67(18):1539–1544.
7. Gu Z, Wong A, Raquinio E, Nguyen A. Stability of reconstituted telavancin drug product in frozen intravenous bags. *Hospital Pharmacy*. 2015;50(7):609–614.
8. Paladino JA, Poretz D. Outpatient parenteral antimicrobial therapy today. *Clin Infect Dis.* 2010;51(Suppl 2):S198–S208.
9. Heintz BH, Halilovic J, Christensen CL. Impact of a multidisciplinary team review of potential outpatient parenteral antimicrobial therapy prior to discharge from an academic medical center. *Ann Pharmacother.* 2011;45(11):1329–1337.