

## Home Infusion of Anti-Infective Therapy

Anti-infective therapy, which includes antibiotics, antivirals and antifungals, continues to represent the largest segment of the home infusion market, servicing approximately 400,000 patients each year. This number will grow as changes in healthcare continue and providers increasingly work to ensure appropriate use of hospital days and to avoid unnecessary initial and rehospitalizations, while recognizing the value of alternate site-of-care options.

For many patients, the benefits of anti-infective administration in the home have been clearly established. Notable benefits include:

- Cost savings through hospital avoidance and decreased length of stay
- Decreased exposure to often-resistant nosocomial infections, with associated clinical and economic impact
- Increased patient satisfaction (patients prefer to receive care in the home environment)
- Continued productivity for many infusion patients (work, school)

### Determining Appropriate Home Infusion Candidates

Comprehensive patient assessment is one of the most important services that an infusion provider

can offer, beginning at the time of referral and continuing throughout the patient's time on service. The patient assessment centers significantly on the patient's unique situation. Questions must be asked that address the type of therapy and the patient's ability to meet the administration responsibilities. Does the patient:

- Have the ability to physically manage the equipment?
- Have the ability to comprehend care requirements?
- Have the willingness and capability to meet the home infusion requirements?
- Have a willing and capable caregiver?
- Reside in an environment that supports cleanliness, safety, and access to emergency services?
- Have an appropriate access and understand how to maintain it?
- Have insurance coverage for home infusion that covers drugs, supplies, and clinical services?

### Considerations for Determining Appropriate Therapy and Delivery Method

Once a patient's candidacy for home infusion is established, numerous factors must be considered in order to ensure the safety and effectiveness of the

patient's home infusion therapy. Determining the most appropriate therapy and delivery options for a given patient is dependent on factors such as:

- The patient's characteristics and home infusion needs
- Requests and preferences of payers or physicians

Additionally, one must consider the prescribed anti-infective itself:

- What is the infecting organism and what is the most effective drug choice to treat that specific pathogen?
- What is the most cost-effective choice of anti-infective?
- What delivery method is used to administer the drug?
- Is the drug compatible with concomitant infusion therapies?
- Is the drug a vesicant or an irritant (thus requiring a certain type of venous access)?
- What is the drug's stability and half-life?
- How complicated is the drug mixing (if that is required in the home)?
- What is the anticipated length of therapy?
- What are the potential side effects of the drug?

Similarly, the selection of appropriate delivery systems must be carefully reviewed, including such factors as:

- The patient's specific needs and abilities, such as functional/ self-care abilities
- Type of vascular access device
- Complexity of therapy
- The potential risks associated with the therapy, such as venous irritation or phlebitis, or systemic toxicities
- The stability and other characteristics of the medication
- Dosing frequency
- Physician preference
- Cost-effectiveness

## Vascular Access Devices

The available access devices for home infusion are peripheral lines, midlines, peripherally inserted central catheters (PICCs), non-tunneled and tunneled catheters, and implanted ports.

Each type of device has advantages and disadvantages, as well as critical factors to take into account when deciding which catheter is best for the patient. Questions to consider may include:

- What is the drug's pH and osmolarity?
- Is the prescribed drug considered an irritant?
- What is the infusion volume that will be flowing through the veins?
- How often does the catheter need to be interrupted for therapy infusion?
- What is the anticipated duration of therapy?

**Peripheral intravenous lines** are easily inserted and can be used for shorter-term therapies (less than 5 days), and with drugs that are not considered irritants. Because these catheters are easily dislodged, they are not acceptable for therapies such as parenteral nutrition or inotropic medications. They are also not appropriate for high-volume infusions. However, if a patient

is otherwise ready for discharge, peripheral lines are often placed until a longer-term access can be inserted, which helps to avoid unnecessary hospital days.

**Midline catheters** are another type of peripherally inserted catheter. Typically five to nine inches in length, midlines are inserted at the antecubital fossa and threaded up through the cephalic or basilic veins. Because the midline catheter tip does not lie beyond the axillary notch, an x-ray is not indicated (as for a PICC, below), thus making insertion in the home less complicated. Midlines are generally indicated for therapies that will last from 5 days to 6 weeks. They can stay in place for a longer period of time if there are no signs of infection or other complications.

**A PICC (Peripherally Inserted Central Catheter) line** is inserted in the antecubital fossa, generally through the same veins as the midline. The PICC is longer than the midline, however, and the catheter tip is located centrally, usually in the lower one-third of the superior vena cava, just outside the right atrium of the heart. To ensure that the catheter has correct placement, the length of the PICC is custom measured and cut for each patient. Before the PICC line is used, a post-insertion chest x-ray or ultrasound confirmation is necessary to ensure that the tip is in the correct location. PICCs are generally inserted at a physician's office, clinic or hospital to ensure access to x-ray equipment. Depending on the capabilities of the home infusion nurse, some PICCs can be inserted in the home, as long as an x-ray can be obtained before any drug is administered.

Because a PICC is a central catheter in a large, flowing vein, it is ideal for medications with a pH that is below 5 or above 9, and with osmolality greater than 600 mOsm/L. Barring any complications

### Common Disease States Appropriate for Home Anti-infective Infusion Therapy

- Cellulitis
- Endocarditis
- Hepatitis
- Infections in immunosuppressed patients, such as those impacted by:
  - Cancer
  - Solid organ transplant
  - Blood cell transplant
  - HIV
  - Immunodeficiencies
- Lyme disease
- Osteomyelitis
- Pancreatitis
- Pneumonia

and with appropriate care, PICCs can remain in place for a year or longer.

**Non-tunneled catheters** (such as subclavians) are placed by a physician at the bedside or in interventional radiology under strict sterile conditions. These catheters are intended for short-term therapy administration (usually 6 weeks or less), and are therefore not the first choice for home infusion patients.

**Tunneled catheters**, such as a Hickman, Broviac or Groshong, are inserted under local anesthesia and are tunneled beneath the skin, where they enter the superior vena cava. Ten to 12 days after insertion, adhesions form on a Dacron® cuff on the catheter that not only stabilize the catheter, but can also seal it. This helps to prevent infection of the exit site from migrating into the vein. For this reason, these catheters are considered for patients who will receive long-term therapy. These catheters can have single, double, or triple lumens, depending on what the patient needs.

## Safety Systems for Home Anti-infective Therapy

- Needleless devices, which enable connection, flushing, and disconnection of syringes and IV tubing without the risk of needle sticks
- Protected needle systems
- Anti free-flow devices, which protect patients from inadvertent medication boluses during IV pump use
- Back check valves, which prevent back flow of solutions and blood during medication administration

## Drug Selection

Antibiotics work by affecting the reproduction of bacteria (bacteriostatic antibiotics) or by directly destroying them (bacteriocidal antibiotics). Rapid identification of organisms and antibiotic/antifungal sensitivity has allowed physicians to more quickly select the most appropriate drug at the outset of therapy. Emphasis on pharmacodynamics and pharmacokinetics for selection and dosing of anti-infectives has enabled healthcare providers to select the most appropriate and effective drug, dosage, and administration regimens.

Especially in this era of antibiotic resistance, intense focus is being placed on anti-infective stewardship — determining when an anti-infective is needed and prescribing the most appropriate drug at the most appropriate dose for the most appropriate length of time. Improved techniques in identifying organisms and more succinct determination of sensitivity has led to a more focused drug selection process, which has decreased both the

time to effective treatment and the risk of resistance. Emphasis upon pharmacodynamics (PD) and pharmacokinetics (PK) essentially individualizes the effects of the drug on the body, as well as the body's effects of absorption, distribution, metabolization, and excretion of the drug, and thus enables anti-infective selection and dosing of the most appropriate and effective drug, dosage, and administration regimen from the outset of therapy. PD/PK essentially describe the analysis of factors such as how a drug works, in what time frame, and at what concentration, in order to promote the most effective drug choice for a particular organism.

PD/PK correlates the concentration of the drug with its pharmacological or clinical effects. For an antibiotic, this correlation refers to the ability of the drug to kill or inhibit the growth of microorganisms, depending on the time or concentration of the pathogen's exposure to the medication. To understand PD/PK, it is helpful to understand the foundation of how antibiotics work and how resistance develops.

For an antibiotic to impact an organism, three major events must occur:

- *First*, the antibiotic needs to bind to its target site(s) within the bacterium itself, an often challenging endeavor. The antibiotic must penetrate the organism's outer membrane, avoid being pumped out of the membrane, and remain intact. By binding to these sites, the antibiotic interferes with the bacterial cell and causes its death.
- *Second*, the drug must attach to an adequate number of binding sites, which is related to its concentration within the microorganism.

## Resistance

Each class of antibiotics works to inhibit or kill bacteria in a unique way. Resistance develops uniquely to that antibiotic class when the organism blocks the activity of the antibiotic. For example:

- If the antibiotic destroys the bacteria by penetrating their cell walls, the organisms will strengthen their walls and no longer be susceptible to that antibiotic.
- If an antibiotic kills by inhibiting bacteria's ability to develop protective walls around themselves (so that when the cell divides, its weakened cell wall ruptures), resistance occurs as the bacteria's walls become stronger.
- If the antibiotic blocks the formation of folic acid (essential for bacterial cell life), resistance occurs as the pathogen develops mechanisms to form folic acid even in the presence of the antibiotic.

- *Third*, the antibiotic must remain bound for a sufficient period of time in order for the metabolic processes of the bacteria to be sufficiently inhibited.

Anti-infectives can also be described as being time-dependent or concentration-dependent for bacterial killing. Time-dependent killing refers to medications that depend upon optimizing exposure of the organism to the drug. The goal of time-dependent killing is to maximize the time or duration of exposure of the drug to the organism. It requires the serum concentration of the antibiotic to

exceed the minimum inhibitory concentration (MIC) over an adequate period of time.

For concentration-dependent drugs, the rate of microorganism eradication rises with increasing concentration, up to a specific level. After this specific concentration is achieved, increasing the concentration further does not increase the magnitude of organism killing. If the concentration is high enough, most bacteria die within a short time. In these conditions, the effect of the duration of drug exposure is minimal.

These concepts are illustrated in Figure 1. The gray area illustrates where the drug is most effective.

## Delivery Systems for Anti-infective Home Infusion Therapy

The appropriate selection of an infusion system depends on a number of factors that include:

- A careful and thorough assessment of the patient
- Assurance of the availability of a capable and willing caregiver
- Consideration of the risks of various infusion administration techniques for a particular anti-infective drug
- Preferences of payers and physicians
- Consideration of the cost-effectiveness of various administration systems

**Syringes** can be used to administer small volumes of diluted medications by direct intravenous push through a peripheral IV or central venous device. This IV push method is easiest for most patients, but is only an option for medication antibiotics that can be dissolved in a small volume (10 to 20 mL) and given rapidly (over 2 to 10 minutes). IV push is not suitable

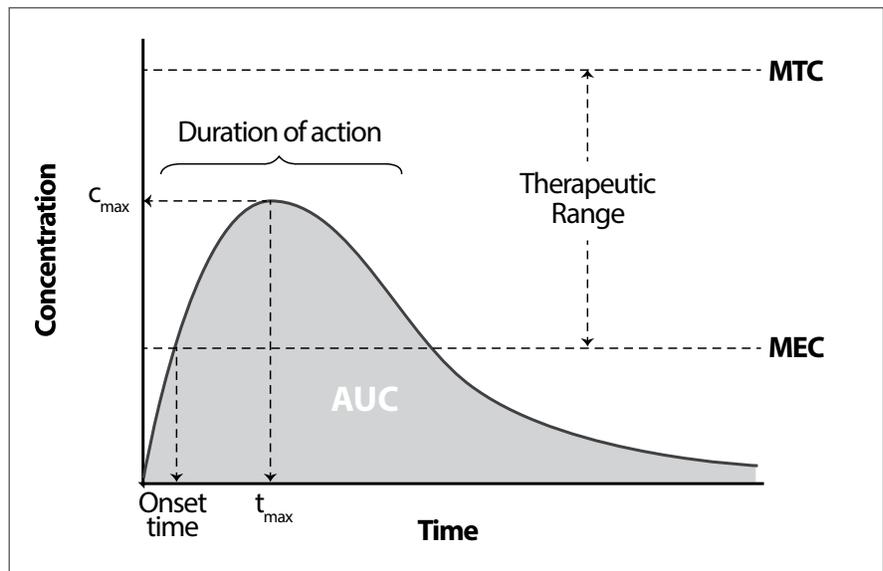


Figure 1

for patients who are unable to safely manipulate a syringe.

**Gravity infusion** employs a pole, a mini-bag of solution containing the medication (50 to 250 mL), and tubing. A rate control device may be added or the patient/caregiver may simply learn to count drops to control the rate of infusion. Gravity infusion systems are a cost-effective option when the patient has been prescribed a therapy that requires an intermittent dosing regimen, such as every eight hours over 30 to 60 minutes. Since the dose is given over a range of time, it does not require an exact administration rate.

Certain IV anti-infectives have a limited stability of less than 24 to 72 hours after being mixed into solution. These antibiotics cannot be pre-mixed in the home infusion pharmacy and then delivered to the patient. A drug reconstitution system that allows the medication vial to be attached to the mini-bag in the pharmacy enables quick and easy mixing by the patient just prior to infusion. When the dose is due to be administered, the connection between the powdered drug and the solution is broken, allowing the solution to enter the

vial of powder. After the powder is dissolved in the fluid, the drug is released back into the bag by holding the vial upside down and squeezing the bag. The dose is then ready for administration. This system is most commonly used for gravity administration, but can be administered by pump.

**Syringe driver systems** are usually battery-operated devices that, when activated, slowly push the plunger of a syringe (5- to 60-mL syringe) filled with diluted antibiotic solution. The syringes are prepared in the pharmacy and delivered to the patient ready to be loaded into the syringe driver. Candidates for this type of infusion include those who require one to three infusions per day of antibiotics that can be diluted in small volumes.

**Rate-restricted systems** are often non-electronic and work by mechanical action. Elastomeric devices fall into this category. Rate-restricted infusion systems use resistance to administer the dose of medication over time. Rate-restricted systems are:

- Used for intermittent intravenous anti-infective medications (that are given two or more times per day)

- Small and lightweight and can be worn or carried by the patient while infusing

Some rate-restricted systems require filling under pressure and are more difficult for the pharmacy technician to prepare.

**Electronic pumps** are the most complicated administration devices but also provide the most accurate, controlled rate. Electronic pumps are required when the rate of administration must be tightly controlled. Both stationary pumps and ambulatory pumps are considered electronic pumps.

- *Ambulatory infusion pumps* are ideal for anti-infectives requiring more frequent administration, such as every four or six hours. Depending on drug stability, the pharmacist can admix multiple doses of anti-infective in a single container. Ambulatory infusion systems are lightweight, compact, and portable. The system consists of a pump approximately the size of a portable electronic device; a medication cassette or solution chamber; and tubing. The system is carried in a backpack or small pouch. Ambulatory systems typically have a digital screen and must be programmed. Patients are taught to review the program and select certain functions to start, stop, and reset the pump. Ambulatory systems are most suitable for patients who:
  - Are mobile
  - Require an extended therapy time and/or larger volumes of infusion (and thus take longer to infuse)
  - Are unable to use a gravity system because the drug must be more accurately controlled

- Require frequent administration of their medication (every four to six hours)

- *Stationary infusion systems* are suitable for most intermittent infusions when the patient can self-administer or a caregiver is available. A stationary system consists of an electronic pump and a rolling or stationary IV pole. This administration system is most appropriate for patients who do not need to be ambulatory while infusing. Stationary systems are useful for infusions that require a controlled infusion rate over a short period of time (30 to 120 minutes). They are also used for patients who have limited or restricted mobility. These systems are less expensive and less complicated to program than ambulatory systems.

## Patient and Caregiver Education

Successful outcomes obviously depend in large part on the patient's ability to comply. Patients and caregivers are often apprehensive about self-administration, at least initially.

Comprehensive teaching with return demonstration is essential to best ensure successful home treatment. Patient and family/caregiver education incorporates written and pictorial education materials, hands-on learning, and return demonstration. Education must address:

- Administration of medications
- Maintenance of the vascular access/site
- Equipment use/troubleshooting/maintenance
- Logistics for drug delivery and storage
- Infection control measures

- Therapy-specific information such as potential adverse effects

Each nursing or pharmacy interaction provides the opportunity to assess both application of and compliance with this patient education.

## Clinical Management and Monitoring

Comprehensive nursing and pharmacy management of the anti-infective home infusion patient is significantly patient-specific, depending on, for example:

- The patient's disease state
- Comorbidities
- Physician orders/plan of treatment

Patient assessment may address:

- Vital signs
- Weight (especially for weight-based dosing)
- Status of vascular access device/site
- Patient competency/compliance, such as with:
  - Medication
  - Use of equipment
  - Vascular access device (VAD) dressing changes
  - Areas requiring educational reinforcement
- Response to therapy
- Clinical effectiveness
- Medication adverse effects
- Patient nutritional status
- Laboratory tests, such as:
  - Chemistry panels, CBC
  - Blood cultures
  - Drug troughs
- Psychosocial factors that may impact outcomes

## First-Dosing in the Home

Increasingly, administering the first dose of a prescribed anti-infective therapy in the home is both accepted and prescribed. Advantages related to hospital avoidance (such as reduction of both hospital days and risk of nosocomial infection) are significant. However, it is also essential to ensure safety measures via established policies and procedures addressing factors including:

- Response to a hypersensitivity or anaphylactic reaction
- Patient history of hypersensitivity or anaphylactic reactions to anti-infective agents
- Patient history of other allergic reactions, such as to bee stings or food
- Environmental criteria, such as having access to EMS and having a working telephone and electricity in the home
- Nursing competency with first dosing, including CPR certification
- Available acute infusion reaction medications and physician order to use in case of allergic or adverse reaction
- Clinician presence for at least 60 minutes post-infusion
- Patient and caregiver education specific to signs and symptoms of and responses to an allergic reaction
- Nursing/pharmacy follow-up

## Catheter-related Infections

Certainly the presence of an intravenous line creates a risk for catheter-related infection (CRI), and home infusion providers are accountable for the care and outcomes of IV catheters. Infection prevention is key.

Signs and symptoms of CRIs may be localized—at or around the insertion site or the track of a tunneled line—or systemic, even to the point of bacteremia or sepsis.

Factors affecting the therapy decisions for a CRI or catheter-related bloodstream infection (CRBSI) include:

- The type of catheter, severity of symptoms, any underlying disease or comorbidities
- The actual or potential pathogens involved
- The patient's history of and response to antibiotic usage.

In some cases, it becomes necessary to remove the intravenous line. Catheter removal is certainly the most reliable means of eradicating the infection, but there are risks and benefits to that treatment option. Considerations such as how to manage the patient without a central line, and whether to replace the line and with which type of catheter, impact treatment decisions. Line removal is typically indicated with severe sepsis, the presence of septic emboli or thrombosis, infections secondary to virulent organisms, or persistent fever and/or bacteremia despite anti-infective therapy.

## Summary

Intravenous anti-infective therapy is frequently prescribed for home use. Positive clinical and economic outcomes are promoted with appropriate, patient and therapy-specific medication options, vascular access, and delivery systems. Application of the principles of pharmacodynamics and pharmacokinetics helps improve drug selection and dosing. Patient and family education and clinical monitoring and management, combined with innovative therapy options, remain key to successful anti-infective infusion in the home setting. ♦

---

*Do not use the information in this article to diagnose or treat a health problem or disease without consulting a qualified physician. Patients should consult their physician before starting any course of treatment or supplementation, particularly if they are currently under medical care, and should never disregard medical advice or delay in seeking it because of something set forth in this publication.*

This activity has been approved for 2.0 CEU contact hours. Please contact your state licensing authority to determine their requirements for receiving continuing education credits.

## Self-Assessment Quiz: Home Infusion of Anti-Infective Therapy

### LEARNING GOAL

To understand the complexities of and responsibilities for home infusion of anti-infective therapies.

### LEARNING OBJECTIVES

At the end of this program, the reader will be able to:

1. Identify three reasons for the ongoing growth in numbers of patients appropriate for home infusion of anti-infective therapies.
2. Differentiate the different types of venous access devices and the different indications for their use.
3. Differentiate the delivery system options and the influencing factors for deciding which to use.
4. Describe the importance of choosing the most effective anti-infective.

### SELF-ASSESSMENT QUESTIONS

**In the Quiz Answers section on the next page, fill in the correct answer for each question. To obtain two (2.0) contact hours toward CE credit, the passing score is 100%.** Return your Self-Assessment Quiz to Coram via email or fax. See the next page for details on how to return your quiz. Please allow approximately seven days to process your test and receive your certificate upon achieving a passing score.

1. **Factors influencing anti-infective therapy use today include all of the following EXCEPT:**
  - a. Increasing focus being placed on antibiotic resistance
  - b. New delivery devices making home infusion easier and safer
  - c. Improved dosing regimens determined using pharmacodynamics and pharmacokinetics
  - d. Fewer patients determined to be appropriate candidates for home infusion
2. **Skillful and comprehensive patient assessment is one of the most important services that an infusion provider can offer, beginning at the time of referral and continuing throughout the patient's time on service:**
  - a. True
  - b. False
3. **Determining the most appropriate therapy and delivery options for a given patient is dependent on:**
  - a. The patient's unique situation
  - b. The potential risks associated with the therapy
  - c. Characteristics of the prescribed medication
  - d. A and B
  - e. A, B and C
4. **The most common type of vascular access device used for anti-infective therapy in the home setting is a peripheral line.**
  - a. True
  - b. False
5. **Midline catheters are indicated for therapies that are anticipated to last:**
  - a. <3 days
  - b. From about 1 to 6 weeks
  - c. >3 months
6. **ONLY the first 1 or 2 anti-infective doses can be administered through a PICC line before a chest x-ray must be obtained.**
  - a. True
  - b. False
7. **A drug-reconstituted system requires a patient / caregiver to:**
  - a. Break the connection between the powdered drugs and the solution
  - b. Add fluid from the IV bag to the powdered dose of antibiotics in a small vial and allow powder to dissolve in the solution
  - c. Drain the fluid back into the same IV bag and administer
  - d. All of the above
8. **Ambulatory administration systems allow patients to be as mobile as possible.**
  - a. True
  - b. False
9. **It is necessary to know how a specific drug works in order to support the most effective anti-infective drug choice for a particular pathogen.**
  - a. True
  - b. False
10. **Exposure to an antibiotic to which an organism is not sensitive will not significantly impact the ability of that organism to develop resistance against that antibiotic.**
  - a. True
  - b. False

## Home Infusion of Anti-Infective Therapy

### QUIZ ANSWERS

Fill in the key below with the correct answers to receive 2.0 Continuing Education credits.\*\*

1. (a) (b) (c) (d)
2. (a) (b)
3. (a) (b) (c) (d) (e)
4. (a) (b)
5. (a) (b) (c)
6. (a) (b)
7. (a) (b) (c) (d)
8. (a) (b)
9. (a) (b)
10. (a) (b)

#### \*\*Accreditation Information

- Provider approved by the California Board of Registered Nursing, Provider Number 15200 for 2.0 contact hours.
- Coram CVS Specialty<sup>®</sup> Infusion Services is approved by the Delaware Board of Nursing, Provider Number DE-14-010517.
- Coram CVS Specialty Infusion Services is approved by The Commission for Case Manager Certification to provide continuing education credit to CCM<sup>®</sup> board certified case managers.
- Coram CVS Specialty Infusion Services is a Continuing Professional Education (CPE) accredited provider with the Commission on Dietetic Registration (CDR). Registered Dietitians (RDs) and Dietetic Technicians Registered (DTRs) will receive 2.0 continuing professional education units (CPEU) for completion of this program/material. CDR Provider CO100.
- Provider approved by the National Association of Social Workers (Approval Number 886613245).
- Coram CVS Specialty Infusion Services is an approved provider for the American Board for Transplant Certification (ABTC). Coram CVS Specialty Infusion Services will grant one Continuing Education Point for Transplant Certification (CEPTC) for this offering. Provider Number 147.
- Coram CVS Specialty Infusion Services is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education.

To obtain Continuing Education credits, please complete this information in full. Please print clearly.

Name: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_

License Number (required to receive CEs): \_\_\_\_\_

RN  LPN  Certified Case Manager  Social Worker

Employer: \_\_\_\_\_

Work Phone: \_\_\_\_\_

Coram Representative: \_\_\_\_\_ Date: \_\_\_\_\_

#### Was this material:

Useful in your practice?  Yes  No

Comprehensive enough?  Yes  No

Well organized?  Yes  No

#### Certificate delivery:

I would like my certificate mailed to the address provided above.

I would like my certificate emailed to me at: \_\_\_\_\_  
(ex: john.smith@coramhc.com)

Fax this page to Coram at 949-462-8990, or

**SUBMIT FORM VIA EMAIL: [CEDept@coramhc.com](mailto:CEDept@coramhc.com)**

\*Coram CVS Specialty Infusion Services  
©2017 Coram CVS Specialty Infusion Services. All rights reserved.  
COR16045-0414