Meeting the Challenge of Hospitalized PAH Patients Receiving IV Prostacyclins

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In this PHPN column, we invited members from around the country to share their experiences and tips on several aspects of dealing with PAH patients in the hospital setting, particularly related to infusion pumps. Former section editor Martha Kingman, DNP, FNP-C, University of Texas Southwestern Medical Center at Dallas, provides valuable insight as an introduction to the topic.

Pulmonary arterial hypertension (PAH) patients receiving intravenous (IV) prostacyclin therapies pose significant challenges for nurses in the hospital setting. Even at large pulmonary hypertension (PH)-treating hospitals, the number of PAH patients receiving IV prostacyclin in the hospital at any given time will be small. Therefore, many nurses, and some doctors, may have limited or no knowledge of the complex dosing and safety profile of these medications. Intravenous prostacyclins are dosed in nanograms per kilogram per minute, and have a very patient-specific and narrow therapeutic range. Sudden increases or decreases in dose can lead to significant adverse events, including death. Further complicating the safety of this therapy in the hospital setting involves the infusion pumps. There are safety concerns when nurses are not familiar with ambulatory pump operation, and maintaining competence can be challenging. There are also concerns when patients are transitioned to hospital pumps, which require a change in pump rate or medication concentration, thus introducing opportunity for errors.

Regardless of hospital policies on the use of home infusion pumps or hospital pumps, extensive ongoing education is required for nurses caring for hospitalized PAH patients. At a minimum, nurses should understand the disease process and be able to identify the difference between prostacyclin side effects and PH symptoms. If patients are sustained on their home infusion pumps in the hospital, nurses must be proficient in pump operation. This instruction can be accomplished in a collaborative way between the PH staff and the specialty pharmacy nurses. Additional educational topics should include direction on how to prime the central lines and avoid common errors such as flushing the central line. In our survey of 97 PH programs, flushing the line was the most common error mentioned. Other common errors reported by 20 or more respondents include: wrong dose due to miscalculation (N=29), use of a prostacyclin cassette or bag intended for another patient (N=25), incorrect rate programmed into the infusion pump (N=24), and pump inadvertently turned off for a period of time (N=24).[1]

In this issue, our distinguished panel of nurses and nurse practitioners with extensive hospital experience caring for PAH patients discuss how best to address some of these important topics. Additional information regarding prostacyclin safety practices can be found within Online University on the Pulmonary Hypertension Association's Web site.

What are the most common errors you are aware of related to hospitalized infusion patients, and what are some tools you use in an attempt to prevent these errors?
Jacqueline Brewer, BSN, RN
Beaumont Health System

We have instituted numerous effective policies and practices at our institution to prevent the occurrence of errors with prostacyclin medications—including but not limited to incorrect dose, weight, patient, and drug. Upon entering the institution, a mandatory PH alert page is activated to notify all parties involved that a patient on IV/subcutaneous (SC) prostacyclin therapy has arrived. Patients and caregivers are interviewed immediately with questions regarding drug, pump rate, next cassette change, and specialty pharmacy. Promptly following a mandatory physical check of the pump and verification of backup pump, supplies, and medication by a PH-certified rapid response team nurse and pharmacist, the pharmacy team places a call to the patient's specialty pharmacy to confirm proper dose, concentration, and dosing weight. All patients on epoprostinil are admitted to the PH-dedicated unit (CICU) despite need for critical care services. If on treprostinil, patients may be admitted to a dedicated telemetry unit if not warranting critical care.

Once admitted, an absolute double-check is performed in the pharmacy as well as at the bedside for all cassette or syringe changes. Barcode scanning is also utilized as an additional verification for all medications, and patients and caregivers are strongly encouraged to participate in the entire authentication process. All treprostinil and epoprostinil cassettes and syringes have brightly color-coded, drug-specific labeling. These labels and coordinating signage are applied to IV tubing, lines, pumps, etc, and storage is located within both the CICU and main pharmacy. Treprostinil is not stored on the unit but is requested one hour prior to cassette or syringe changes, whereas epoprostinil is kept refrigerated on the unit in properly marked bins.

Line errors also occur (including but not limited to) with improperly primed lines, flushing, and coinfusion of other medications. All lines are dedicated for prostacyclin-only administration and are clearly identified with brightly color-

coded "do-not-flush" labels, as well as color-coded, drug-specific labeling. For patients receiving prostacyclin infusion via a hospital pump, only one channel is made available for prostacyclin-only administration, and signage indicates this to prevent coinfusion with other IV medications. A backup hospital pump with color-coded, drug-specific signage with only one channel is also kept in the room in case of hospital pump failure. Moreover, it is mandatory that all infused prostacyclin patients receive placement of 2 dedicated peripheral IVs upon entering the institution in the event the central line is lost. All rapid response team RNs are trained to prime central lines and calculate proper dead space if a new line needs to be utilized. These RNs are also trained to withdraw prostacyclins prior to discontinuation.

Lastly, errors occur with home infusion pumps vs hospital pumps and switching between the two. All patients are maintained on home infusion pumps unless they are unable to present their backup pump within 24 hours of entering the institution. Patients are taught from initiation of any IV/SC prostacyclin to always travel—especially to the hospital—with all backup pumps, medications, and supplies. All fresh prostacyclin initiations are kept on hospital pumps throughout the initial titration process, and are then converted to home pumps the day of discharge. Rapid response team RNs have completed mandatory pump education classes designed to prepare them to manage home infusion pumps.

In our institution, awareness, education, and staff training are crucial in the prevention of errors. The utilization of a team approach is equally as vital. All those involved with caring for IV/SC prostacyclin inpatients have been well trained and educated and are supported by effective hospital policy, thereby enabling the team to function incredibly efficiently.

What is the most effective way to educate hospital staff on caring for a hospitalized infusion patient?

Sandra Lombardi, RN
Clinical Nurse Coordinator
University of California, San Diego
Pulmonary Vascular Program

Patients on prostacyclins are only admitted to specific nursing units in our cardiovascular center. These nurses are all prostacyclin-competent. University of California, San Diego (UCSD) provides many training sessions throughout the year. We also have quarterly "roaming in-services" featuring hands-on pump demonstrations. The nurses at UCSD are very comfortable with inpatients, as more than 50 infusion patients are admitted each year. Many of these patients endure lengthy stays in the hospital, so it is very likely that there is an infusion patient present at all times.

What is your opinion on keeping infusion patients on home infusion pumps vs transitioning to hospital pumps? If you do transition to a hospital pump, please describe your protocol for priming the Hickman line.

Michelle Calderbank, RN, BSN, CPN
Beth A. Coleman, RN, MSN, CPNP
Children's Hospital Colorado

Our experience has been that fewer dosing errors, microboluses, and infusion interruptions occur when the patient can be maintained on the home/micro-infusion pump (CADD Legacy and Crono5). As a large referral center, many of our patients are admitted to out-of-state institutions where prostacyclin is not on formulary, staff are unfamiliar with the drug, and maintenance on the home pump is safest.

If young patients hospitalized to our center are stable and able to manage their pump (or have a parent present who is competent in pump management), our policy is to maintain the prostacyclin patient on their home infusion pump. If a parent cannot be present or the patient becomes unstable, requiring escalation of care or transfer to the ICU setting, our procedure dictates that the patient be converted from the home infusion pump to the hospital syringe pump to allow for titration and management of the prostacyclin infusion by the health care team.

Each patient's central line internal volume is assessed at the time of line insertion and documented on the current prostacyclin dosing flow sheet. Many pediatric patients use miniaturized IV infusion pumps running at lower flow rates (0.3–0.5 mL/hr), and will require a concentration decrease to transfer to the hospital syringe pump to achieve a hospital minimum flow rate (1 mL/hr). This necessitates the more concentrated home prostacyclin be aspirated from the line to avoid bolusing, and the patient is then connected to the new infusion via the hospital syringe pump and prime via the syringe pump's prime function.

PROS for maintaining home pumps:

- Patient feels stable infusion rate
- Empowers the patient/family
- Less risk of error because the syringe or cassette is changed every 24 hours instead of every 8 hours

CONS to maintaining home pumps:

- Nursing staff less familiar with pump devices
- Not ideal for frequent dose changes

If an infusion patient has an interruption of infusion therapy—for instance, the Hickman line is clotted or cracked, or the SC catheter has fallen out—what is the best next course of action?

Joanna Wapner, ACNP-NP
Pennsylvania Hospital

First, remain calm. Assess the patient's vital signs. If warranted, place the patient on supplemental oxygen. If an inpatient is on an IV formation, he/she should ideally have an alternative access to ensure minimal interruption of therapy. If there is an issue with the Hickman, medication should be switched immediately to the peripheral access. For SC administration, nurses should check the site every 4 hours (half-life of the medication) to ensure timely identification of site loss. If a nurse notices that the site is lost, under ideal circumstances, a new site should be established and medication restarted. If the tools are not available to place a new site, the patient should be transitioned to IV remodulin through peripheral access until either a new SC site can be placed or, if circumstances warrant, central access is established.

Reference

1. Kingman MS, Tankersley MA, Lombardi S, Spence S, Torres F, Chin KS; Prostacyclin Safety Group. Prostacyclin administration errors in pulmonary arterial hypertension patients admitted to hospitals in the United States: a national survey. *J Heart Lung Transplant.* 2010;29(8):841-846.