Managing the Dynamic System of Gravity Infusion

Simple tools can improve a deceptively complex process

IV infusion is one of the most common healthcare procedures in any setting, and making those infusions accurate is critical to patient safety. While infusion pumps are useful tools that automate the process of IV infusions, there are many clinical settings where pumps are not a viable or efficient option. Whether it's home care, a disaster setting, or an acute care hospital, gravity IV infusions are commonly practiced.

Infusions that rely on the pressure of gravity and controlled by a roller clamp or dialed device are subtly complex and dynamic systems. In this paper we will explore **the challenges of gravity IV infusions** and steps clinicians can take to ensure patient safety while improving workflow.

The Mechanics of Gravity Infusion

From start to end, many factors can determine and alter gravity infusion rates. **Changes in venous pressure** and **plastic tubing "creep**" or "cold flow" causes the **flow rate to gradually lessen** as the plastic tubing in a regulator clamp deforms under pressure[1]. Changes in **atmospheric pressure, bed position, IV container height, clot formation, patient movement/position, blocked filters, infiltration, kinked or pinched tubing,** and **medication additions** can also **change the flow rate** of a gravity infusion over time[2]. Calculations cannot accommodate the environmental factors that alter the fluid rate, and those rate changes create the potential for inaccurate medication administration.

The Challenges of Monitoring a Gravity Infusion

To ensure the effectiveness of infusion treatment and enhance patient safety, clinicians often prescribe IV medications with a dose to be administered over a specific time interval, such as 60 milliliters of fluid per hour administered over six hours. When giving infusions via gravity, nurses often determine this rate though a manual calculation done by counting drops as they fall through the drip chamber. For standard drip sets, the nurse then moves the flow controller to tighten or loosen the space in the tubing, which will slow down or speed up the flow of fluid.

Monitoring drip rate calculations requires concentration and patience on the nurse's part -- for initial rate setting, and also in the subsequent checking of infusion rates. Roller clamps are cumbersome to use, making it easy to overshoot a target rate. Additionally, the time interval over which drops are counted is crucially important, with a full 60 seconds of counting necessary to reduce error rates caused by interval spacing. For example, when manually calculating drip rates using a 10 drop/mL tubing set with a 15 second counting period, the difference between 216 mL/hr and 264 mL/hr is only one drop. This error is easily made when a drop falls at the edge of the timing period, and it is unclear whether or not it should be counted. In addition to the potential for calculation error, **the time consuming process of calculating drip rates** is required each time the roller clamp is adjusted.

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The Challenges of Gravity Infusion for Nursing Workflow

When administering infusions via gravity, it is recommended to check an infusion rate during every bedside visit, as well as at least once an hour[3]. An internal Shift Labs study found that manually setting a drip rate takes an average of two minutes. If a nurse visits each patient only twice per hour, the time spent calculating infusions quickly adds up. These **two-minute checks every thirty minutes account for almost 600 hours per patient bed per year in nursing labor**[4]. Apart from costing time, infusion can affect nursing workflow and patient management. An infusion that is off by just a few drops per minute can have a **significant impact on infusion length**. Incorrectly predicting, or not being able to predict, infusion length makes it **difficult to notify patients or family members of clinic visit lengths, arrange transportation, and plan patient appointment times**.

Clinical Impact and Patient Safety

Unmonitored flow rates can also **affect the safety and effectiveness of infusions**. In order to achieve safe infusions, nurses must have the tools to closely monitor flow rates. Too slow and the **treatment may lose effectiveness**; too fast and the **patient risks toxicity**. In some cases, incorrect dosage can exacerbate illness or even cause death. When administering oxytocin during labor, too high or rapid of a dose may cause peripheral vasodilation, hypotension and increased pulmonary artery pressures[5]. **Accuracy and careful monitoring of even a simple fluid infusion is crucial** to prevent over-hydration and congestive heart failure when rehydrating malnourished pediatric patients[6]. Fluid and medication administration errors are common. A 2007 study undertaken to examine the prevalence and extent of infusion rate errors among trained nursing staff found that 74% of 207 bags were infused at the wrong rate[7]. A study conducted in 2008 found of the 50 subjects receiving gravity infusion only 1 in 5 was receiving an infusion that was within 20% of the charted rate[8].

Achieving Safe, Accurate IV Infusions

The **difficulty of calculating infusion rates, limited nursing time, and highly variable nature of gravity infusion create many possibilities for error**. Unmonitored gravity infusion is a burden on nurse workflow and a safety risk to patients. One option to **avoid the time-consuming technique of manually counting drops is to use an electronic IV infusion rate-monitoring device such as the DripAssist Infusion Rate Monitor**.

DripAssist is an IV infusion monitoring device used in conjunction with a gravity feed. DripAssist attaches to the drip chamber of a standard IV drip set and uses an infrared sensor to precisely detect and count drops in real time. DripAssist provides an accurate measure of the flow rate or total volume of an infusion, replacing the need for manual calculations. The optional alert function also allows the clinician to know when the flow rate of the drip changes without having to wait by the bedside. With the many barriers to accurate gravity infusions, using an infusion rate monitor like DripAssist is an easy and affordable step that clinics can take to ensure patients are receiving the prescribed and safe dose of IV fluids and medication.

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