Administration of Medication: Volume-Control Sets

What Is a Volume-Control Set?

› A volume-control set is a special type of I.V. infusion set designed to provide the accurate delivery of I.V. solutions and to permit the dilution of medication. Of note, volume-control sets are not widely used anymore. Their use has been largely replaced by volumetric and smart pumps

- What: A volume-control set (also called a solution set) is often referred to by the manufacturer brand name (e.g., Soluset, VoluTrol, Beretrol). They are similar to a standard I.V. tubing set-up with the addition of a calibrated volume chamber (Figure 1) located immediately above the drip-chamber of the tubing. The volume chamber holds up to 150 mL of fluid and includes a separate medication port and air filter. The volume-control set can be used with or without pump set tubing

- How: The chamber of the volume-control set can be used as a flow-through chamber when infusing a maintenance solution or set to deliver a specific amount of fluid. The steps to be followed when using a volume-control set are described in How To Use a Volume-Control Set, below

- Where and Who: Physicians, nurses, and other licensed clinicians working in outpatient, acute and critical patient care areas utilize volume-control sets to administer I.V. infusions. The nurse clinician is responsible for monitoring the progress of the I.V. infusion and assessing for potential complications or adverse effects of the medication; these tasks should not be delegated to assistive personnel. With appropriate education, patients and family members can learn to administer medications via volume-control set in the home

![Figure 1: The chamber of the volume-control set is calibrated to 100 to 150 mL to permit dilution and delivery of a small volume of intravenous fluid or medication. Copyright ©2016, EBSCO Information Services](image)

What Is the Desired Outcome of Use of a Volume-Control Set?

› Use of a volume-control set is indicated when administering intermittent I.V. medications or when a precise volume of fluid is desired. The volume-control set allows for dilution of
I.V. medications and to permit administration of the therapeutic amount or volume of I.V. medication while limiting the amount of I.V. fluid delivered

**Why Is Use of a Volume-Control Set Important?**

- Accurate control of the flow rate permits optimal patient management and prevents I.V. dosing errors. Control of the dose/flow rate is of particular importance when administering highly potent, irritating, or potentially toxic I.V. medications (e.g., antiarrhythmics, anticoagulants, inotropes, and analgesics) and electrolytes (e.g., magnesium sulfate, potassium chloride)
  - The medication port in the volume control administration set permits
    - administration of medications intermittently
    - separate administration of incompatible medications
    - dilution of medications that may be irritating if given via I.V. push
    - increased precision in delivery of I.V. fluids
- Pediatric and older adult patients are susceptible to fluid overload. Volume-control sets are particularly useful for delivering I.V. medication in a small amount of I.V. fluid

**Facts and Figures**

- Following delivery of I.V. medication using volume-control set, a small amount of the medication may remain within the tubing. For this reason, it is common practice to flush the tubing with a small amount of solution from the primary I.V. bag to deliver the residual medication. In a study conducted at the Children’s Hospital of Philadelphia, it was determined that the amount of flush required to administer > 95% of the medication to the patient was at least 2 times the volume of the tubing’s dead space (Ford et al., 2003)
- The Institute for Safe Medication Practices (ISMP) recommends use of I.V. infusion pumps with “smart pump” technology as a means of reducing medication errors and promoting patient safety. Smart pumps are programmed to deliver medication within safe dosage and volume limits, and can alert clinicians to potential errors before patient harm can occur (Institute for Safe Medication Practices, 2009)

**What You Need to Know Before Using a Volume-Control Set**

- When properly connected, the volume-control set should rest inline between the primary I.V. bag and the patient’s I.V. catheter. The chamber of the volume-control set is calibrated to allow the clinician to visualize how much of the primary I.V. solution is used to dilute the medication, and to regulate the medication flow rate (i.e., the volume of I.V. solution to be delivered over a set period of time). Control of the flow rate is crucial to controlling the dose of I.V. medication to be administered over the designated time frame, to maintain a therapeutic level of the medication in the patient’s bloodstream. This is especially true when rapid or uncontrolled infusion of the medication would be toxic or otherwise harmful
- Clinicians must be careful to label any medication added to volume-control sets to avoid the inadvertent addition of multiple different, potentially incompatible medications (Cohen, 2009)
- The clinician should become familiar with the type(s) of volume-control sets used in the facility
  - Although all volume-control sets work in a similar fashion, it is important to follow the manufacturer’s directions for use. It may be helpful to undergo didactic and/or hands-on training in use of the particular brand used in your facility prior to using it in clinical practice
  - Volume-control sets are useful for intermittent I.V. medication infusions because the air vent on the volume chamber prevents air from entering the I.V. line once the infusion is completed
- The clinician should be competent in administration of I.V. medications
  - When administering prescribed I.V. medications, adherence to the six “rights” of medication administration is crucial to the prevention of certain I.V. complications, including allergy, phlebitis, and infiltration. These rights include ensuring (1) the right patient, (2) the right drug, (3) the right dose, (4) the right time,(5) the right route, and (6) the right documentation. Additional rights to consider include right reason, right response, right to refuse, and right to be educated (**Figure 2**, **3**)
Adherence to infection control protocols and standard precautions is essential
- Aseptic technique must be maintained when spiking the I.V. bag, injecting medication into the volume-control set, and when connecting I.V. tubing to the patient’s I.V. catheter to avoid exposure of the I.V. solution, tubing, or catheter to microorganisms that could cause local or systemic infection
- Volume-control sets should be changed every 24–72 hours (as dictated by facility protocol) to minimize growth of microorganisms within the volume chamber or tubing

Preliminary steps include:
- Review facility protocol for I.V. medication administration, if one is available
- Review the treating clinician’s order for I.V. medication administration
- Review the instructions for all equipment to be used and verify that the equipment is in good working order
- Verify completion of facility informed consent documents
- Review the patient’s medical records for any allergies (e.g., to latex, medications, or other substances); use alternative materials, as appropriate

Gather supplies, which typically include:
- Personal protective equipment (PPE; e.g., nonsterile gloves; use additional PPE [e.g., gown, mask, eye protection] if exposure to body fluids is anticipated)
- Medication administration record
- Prescribed I.V. medication
- Primary I.V. set (I.V. bag and tubing)
• Volume-control infusion set
• I.V. pole
• Facility-approved antiseptic swabs
• Facility-approved I.V. medication label
• Written information, if available, to reinforce verbal education

How To Use a Volume-Control Set

› Perform hand hygiene and don PPE
› Identify the patient using facility protocol
› Establish privacy by closing the door to the patient's room and/or drawing the curtain surrounding the patient's bed
› Introduce yourself to the patient and family member(s), if present; explain your clinical role and assess the coping ability of the patient/family and for knowledge deficits and anxiety regarding the purpose of I.V. medication administration and related procedures (e.g., routine flushing of the I.V. cannula), as needed
• Determine if the patient/family requires special considerations regarding communication (e.g., due to illiteracy, language barriers, or deafness); make arrangements to meet these needs if they are present
  – Follow facility protocols for using a professional certified medical interpreter, either in person or via phone, when a language barrier exists
• Explain the purpose of medication administration; answer all questions and provide emotional support as needed
› Explain that the medication is injected into the chamber of the volume-control set, where it mixes with diluent (< 150 ml). The drip chamber of the volume-control set is then compressed until the chamber is half-filled with I.V. solution. Finally, the flow rate is adjusted by adjusting the roller clamp or setting the dial-a-flow to infuse the medication at the prescribed rate
To prepare the volume-control set for use, perform the following steps:
• Close both sets of clamps on the volume-control set, and open the air vent on the calibrated chamber
• Attach the volume-control set to the primary I.V. bag. Utilize the primary I.V. tubing as extension tubing, if needed, by connecting it to the end of the volume-control set tubing
• Open the upper clamp and fill the volume (top) chamber until it is about one-third full. Close the clamp
• Open the lower clamp and compress the drip (lower) chamber until the chamber is about one-half full. Allow the fluid to fill the remainder of the tubing, then close the clamp
• Add the medication and additional diluent to the volume-control set
› If not already prepared, prepare the I.V. medication by drawing it up into a syringe
  – Review the MAR to verify the first of the six “rights” of medication administration
    - Verify the “sixth right” of medication administration by completing the correct documentation in the patient’s medical record following administration
    - Understand further rights to be considered are right to refuse, right to be educated, right reason, and right response
  – Verify compatibility of the medication and diluent (see Red Flags, below)
• Clean the injection port on the calibrated chamber with a facility-approved antiseptic swab
• Insert the syringe into the injection port and inject the medication. Gently agitate the chamber to mix the medication and diluent
• Further dilute the medication, if necessary, by opening the upper clamp and adding additional fluid from the I.V. bag to the volume chamber. Close the clamp when the medication is diluted according to the prescriber’s instructions
• Administer the medication, as prescribed
› Connect the infusion set to the patient’s I.V. catheter per facility protocol
• Open and adjust the lower clamp to allow the medication to infuse at the prescribed flow rate
• Label the volume-control set with the medication name, date, time started, and your initials according to facility protocol
  – Be careful not to apply the label over the calibration lines on the volume-control chamber
• Monitor the patient for clinical effects of the medication and for adverse effects
• When the infusion is complete, close the air vent, unclamp the primary I.V. tubing, and reset the flow rate to allow the primary I.V. solution to infuse as prescribed. If a continuous infusion is not ordered, discontinue the infusion
• Discard used materials into the appropriate receptacle(s)
› Perform hand hygiene
Update the patient’s plan of care, as appropriate, and document the following in the patient’s medical record:

- Date and time the medication was prepared and the infusion begun
- Name of the medication/diluent and rate of infusion
- Patient’s status prior to and after administration of the medication
- Any unexpected outcomes and the interventions performed
- All patient/family education

Other Tests, Treatments, or Procedures That May be Necessary Before or After Using a Volume-Control Set

- Frequently monitor the patient to observe for and document his or her response to the infusion, especially for adverse effects related to the medication (e.g., allergy, fluid overload) or I.V. complications (e.g., infiltration, phlebitis)

What to Expect After Use of a Volume-Control Set

- The volume-control set is utilized appropriately and per the manufacturer’s instructions
- The I.V. solution is prepared correctly and infused at the prescribed flow rate with no adverse results

Red Flags

- Prior to mixing the medication and diluent, ensure that they are compatible by consulting a drug reference manual, facility-approved drug compatibility chart, or licensed pharmacist in order to avoid precipitation or degradation of medication
- The nurse clinician is responsible for monitoring the progress of the I.V. infusion and assessing for potential complications or adverse effects of the medication and for signs of volume overload
- Any syringe or volume control set containing a medication must be labeled with the time the syringe or set was prepared, the patient’s name, and drug name

What Do I Need to Tell the Patient/Patient’s Family?

- Explain to the patient/family/caregiver the purpose of and steps involved in I.V. medication administration, and address any questions or concerns they may have
- Reinforce to the patient the importance of notifying the clinician of discomfort or other symptoms experienced during the infusion

Note

- Recent review of the literature has found no updated research evidence on this topic since previous publication on March 4, 2016

References