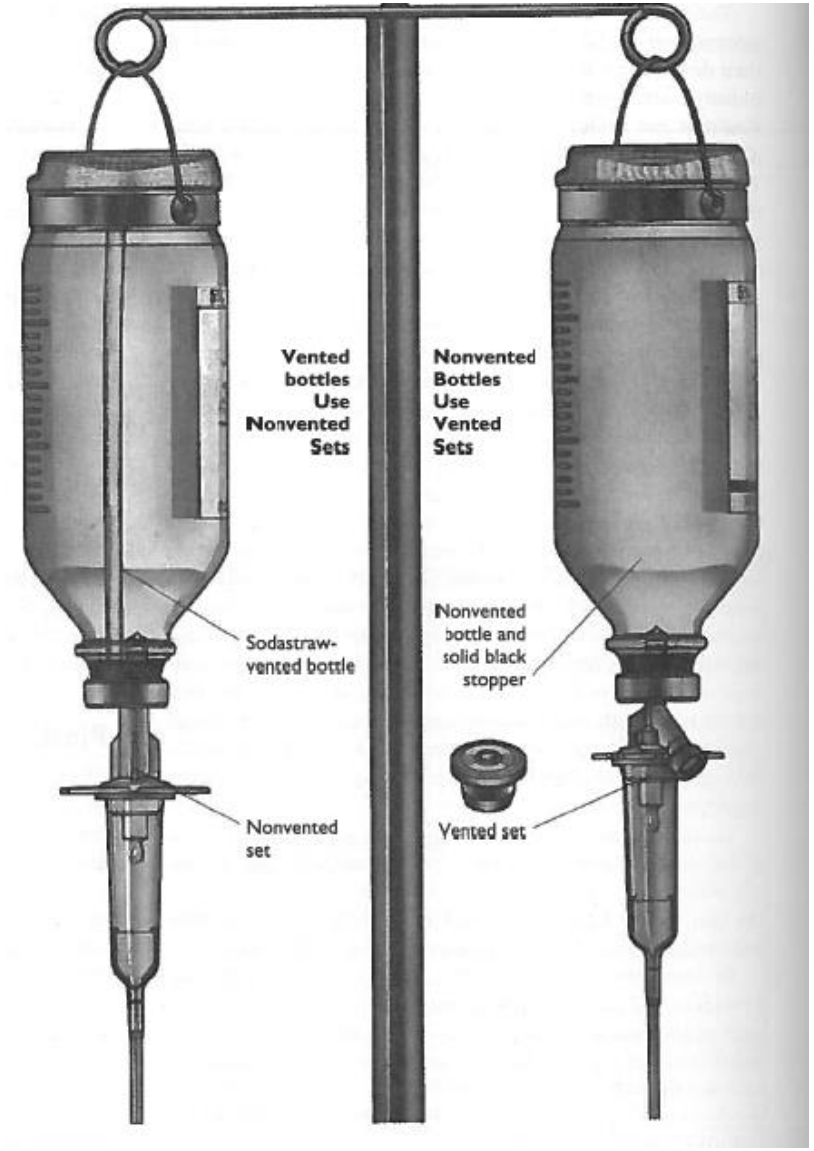
Advanced IV & VA

Session 4:

Medication Safety

GLASS

- Used for specific medications that will either degrade in plastic bags or become adsorbed by the plastic and become less effective
  - E.g nitroglycerin or lipid emulsions
- The glass system contains a partial vacuum
  - Needs to be vented
  - Specific vented tubing, or some tubing has both vented and non-vented features accomplished simply by opening a port at the top of the drip chamber.

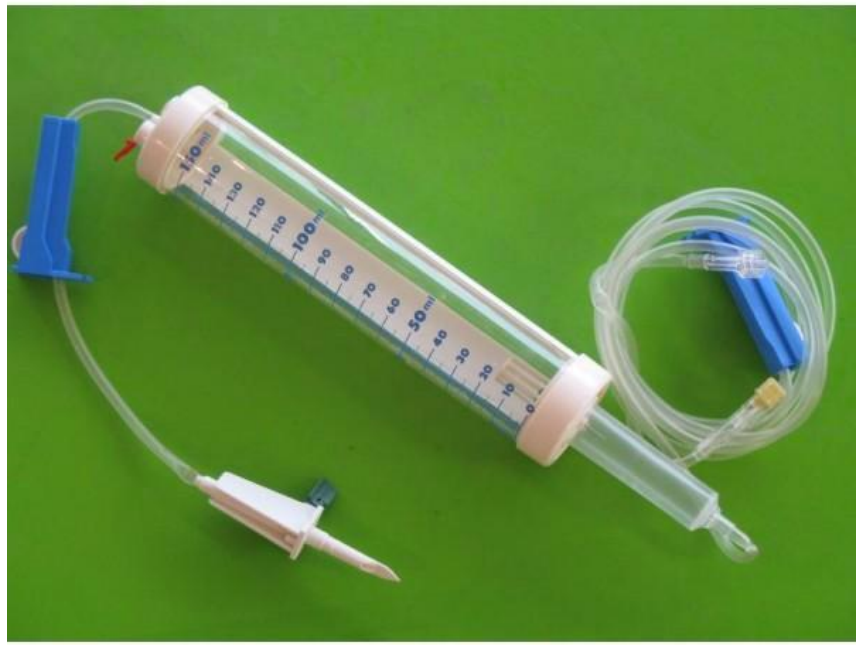


PLASTIC

- Flexible
- True closed system
- Check container before using
  - Squeeze to check for leaks
  - Visually inspect bag for discolouration, seam integrity and particles

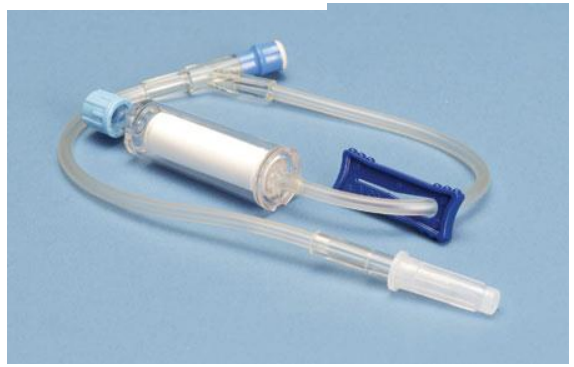
Buretrol/ Volutrol

- Add-on between IV bag and VAD.
- Acts as a volume control device
- Macrodrip or microdrip tubing.
- Max volume may be 60 – 150 mL
- Used in areas where strict fluid control is needed or with certain medications to safeguard against fluid overload or accidental infusion of certain medications.
- Neonates, paediatrics, elderly, renal or cardiovascular disease



ADD-ON DEVICES

- Stopcocks, ramping ‘traffic light’ systems, extension sets, blind hub caps, injectable caps/connectors, needleless systems and filters
- Must be Luer-Lok™ design
- SCRUB THE HUB! Allow to dry
- Stopcocks not recommended…WHY?
- All add-on devices change with each cannula or administration set replacement, or whenever the integrity of either product is compromised



FILTERS:

- Use an administration set with an integrated (preferred) or add-on filter to remove particulate and air from solutions and/or medications as needed for prescribed therapy

FILTERS

- All infusion sets should contain in-line filtration appropriate to the solution being administered.
- Clear fluids require 15 micron filtration (or less) which is usually provided by a standard clear fluid set
- For non-lipid-containing solutions that require filtration, an additional 0.2 micron filter containing a membrane that is both bacteria/particulate-retentive and air-eliminating should be used
- For lipid infusions or total nutrient preparations that require filtration, a 1.2 micron filter containing a membrane that is both bacteria/particulate-retentive and air-eliminating should be used
- In-line blood component filters (integral mesh filter 170-200µm pore size), appropriate to the therapy, should be used to reduce particulate matter and microaggregates in infusions of blood components

Filters may eliminate the following:

- Particulate matter
- Medication precipitates
- Residue
- Glass splinters
- Metal
- Rubber
- Air
- Fungi
- Bacteria
- Endotoxins produced by gram-negative organisms
- Filters will not remove pyrogens or viruses.

Examples for use:

- Mannitol infusions
- Dilantin infusions
- Digoxin infusions
- Amiodarone infusions

NEEDLESS CONNECTOR

- A Needless Connector automatically seals when the IV set or syringe is removed so that blood or fluids cannot leak out, air cannot enter in and introduction of microorganisms introduced can be minimized
- Categorized based on how fluid is displaced inside the device–negative, positive or neutral
- Need to know the type of device being used–flushing techniques differ
- Be aware–catheter hub a common source of infection

Needle-free Connectors

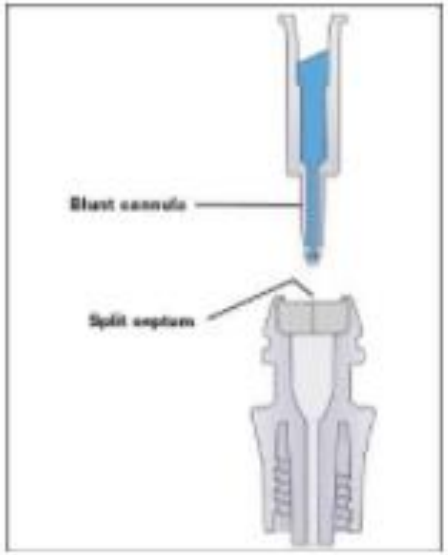
- Positive fluid displacement: produces a +ve fluid displacement upon disconnection. Brands: (Posiflow [BD], CLC 2000 [Abbott], SmartSite Plus [Alaris])
- Negative fluid displacement: Blood pulled back into the catheter tip. Brands: (Clearlink [Baxter], SmartSite [Alaris], Clave [ICU medical])
- Neutral Fluid Displacement : Device prevents blood reflux on connection and disconnection (debatable if this truly exists). Brands: (MicroClave (ICU medical], One-Link Needle-free [Baxter], InVision-Plus [RyMed Tech]

Best design: needleless connectors

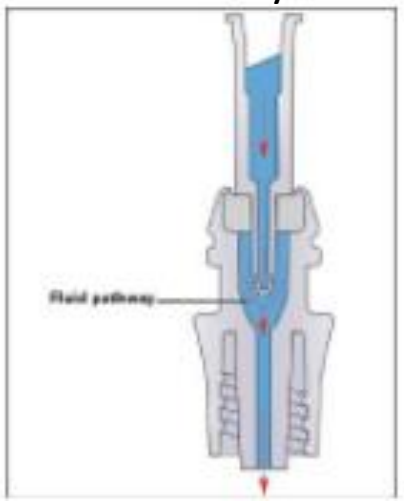
- **Septum surface**: Smooth with few or no gaps so that it can be easily & thoroughly disinfected
- **Seal:** tight seal between septum and housing to reduce or eliminate dead space for contamination or biofilm build up
- **Straight fluid pathway** = adequate flushing and reduces internal surface area for biofilm buildup
- **No dead space** in the fluid pathway. Dead spaces are difficult to flush clean; biofilm hides and lives in the dead spaces
- **No clamping sequence** or use only one type of NC that requires a specific clamp-disconnection sequence and make sure everyone knows how to do it
- **Visibility:** transparent preferred—able to see if any debris left after flushing
- **Blood reflux**: mechanical valve with little or no reflux
- **Flushing solution:** saline only is best.

Fluid pathway: Straight

- Split septum have no internal moving parts
- Allow fluid to flow directly thru the lumen



Courtesy BD.



Fluid pathway: complicated

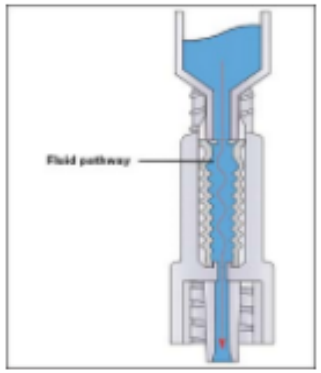


Figure 2. Mechanical valves that have negative displacement direct fluid through the middle of the centerpiece. Image courtesy of and (C) Becton, Dickinson and Company.

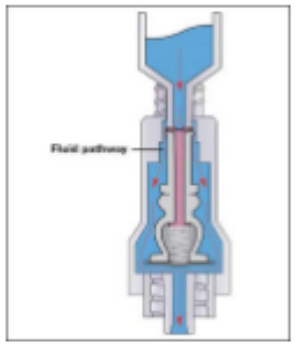


Figure 3. Mechanical valves that have positive displacement direct fluid between the outer housing and the movable centerpiece. Image courtesy of and (C) Becton, Dickinson and Company.

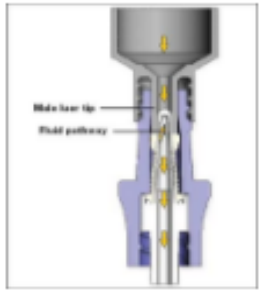


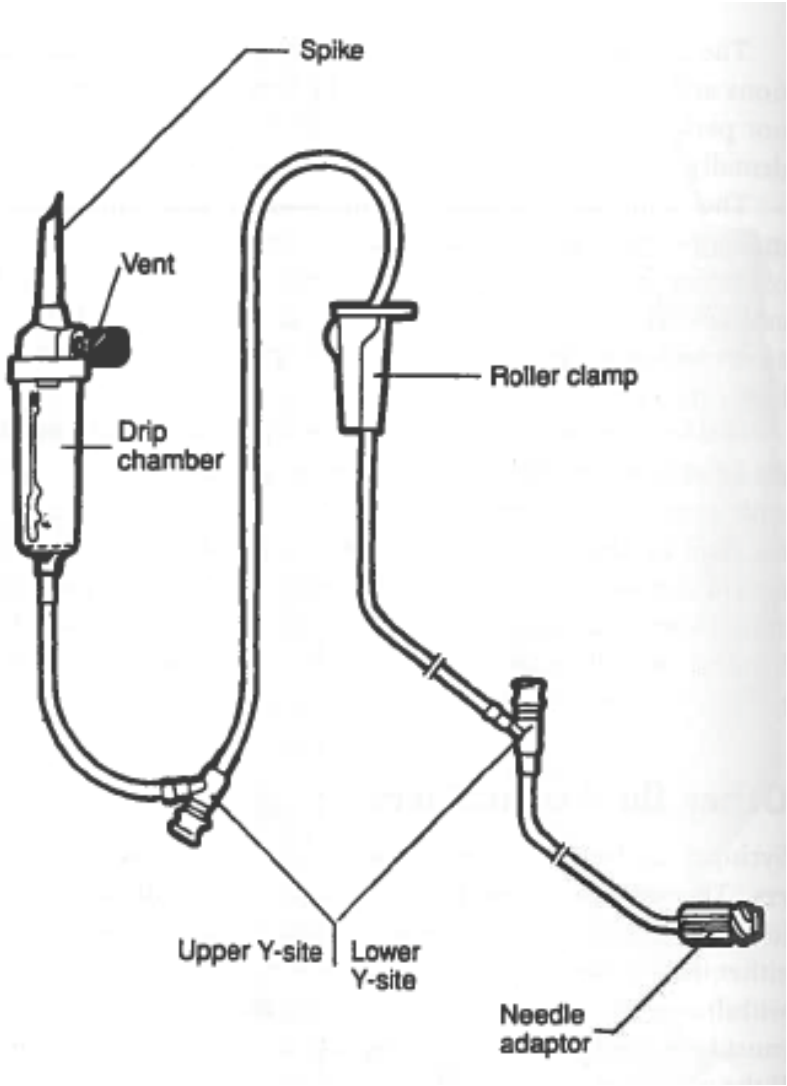
Figure 4. Some mechanical valves contain a reversed internal blunt cannula that connects with the male luer of the iv set or syringe and accepts fluid through its center. Image courtesy of Lynn Hadaway Associates, Inc.

L. Hadaway, AJN. 2012 Nov. 112(11); 32-44

Needle-free Connectors

- Negative displacement connector requires clamping before the syringe is removed (no fluid in the chamber)
- Positive displacement connect requires clamping after the syringe is removed (fluid in the chamber)
- Neutral displacement connector doesn’t require a specific clamping sequence

PRIMARY ADMINISTRATION SET

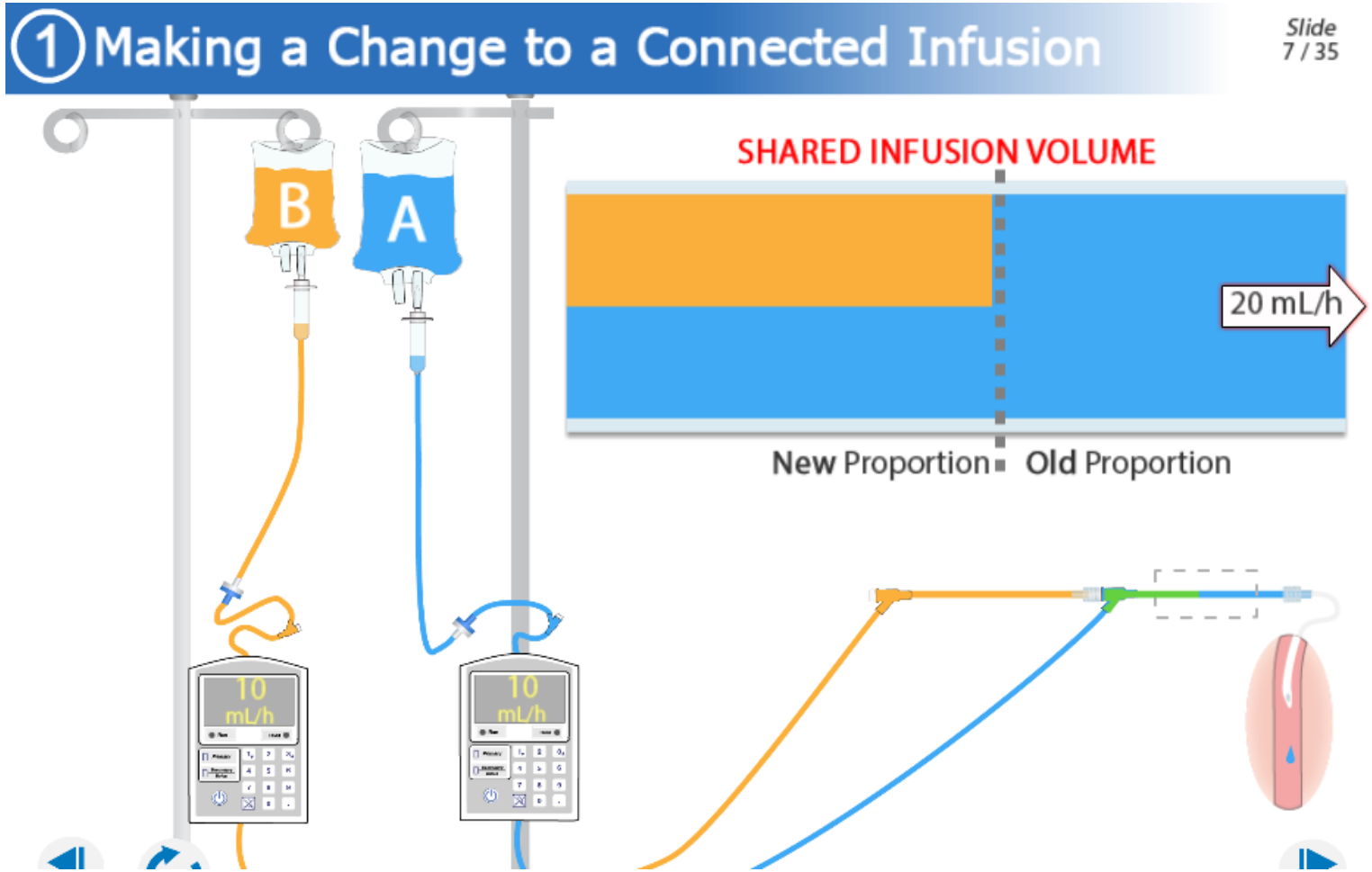


- typically the main tubing used to carry the infusing fluid form the container to the patient
- can be a single entity or can have many attachments and features
- should have Luer connectors to prevent accidental disconnection
- the use of needles to access administration set ports should be avoided; needless or needle-protective systems should be used

PRIMARY & SECONDARY SOLUTION ADMINISTRATION SETS (CONTINUOUS INFUSION)

- Primary and secondary solution administration sets used for a continuous infusion must be changed every 96 hours and immediately upon suspected contamination or when the integrity of the system has been compromised
- must be changed using aseptic technique
- type of solution administered via a primary or secondary continuous administration set (for example: parenteral nutrition, lipids, blood and blood components) should dictate whether the administration set is changed more frequently
- The drop factor (how many gtts/ mL) will be indicated on the infusion set packaging used

Shared infusion volumes



PRIMARY INTERMITTENT SOLUTION SETS

- Primary intermittent administration sets should be changed every 96 hours if remaining connected to the VAD.
- Change after each use if disconnected.
- should be disconnected immediately upon suspected contamination and discarded when the integrity of the product or system has been compromised

FLOW-CONTROL DEVICES

ELASTOMERIC BALLOONS

- made of soft, rubberized material capable of inflating to a predetermined volume
- delivers the infusate over the time determined by the balloon and tubing
- - used primarily to deliver antibiotics; intermittent, small-volume parenteral therapies are ideal
- typical volume are 50 to 100ml and are available in sized up to 250ml
- not reusable
- can deliver in intervals ranging from 3 days
- has a 0.2 micron filter in the kink-resis
- considered an ambulatory home infu

SPRING-COIL PISTON SYRINGES

- syringe volume ranges from 30 to 60 ml and has a spring with which to power the plunger in the absence of manual pressure
- one-time use only
- syringe is filled by withdrawing the position and overextending the spiring
- as the spring regains its shape, it forces the piston down, expelling its contents

SPRING-COIL CONTAINER

- combines the principle of the spring-coil piston syringe
- multiuser, small volume
- an overextended spring in an enclosed space between two disks seeks to collapse, pulling the top and bottom together and forcing the fluid contents out of the restricting office
- handy and convenient for the ambulatory patient

MANUAL FLOW CONTROL DEVICE

- generally provide a more consistent flow rate than do reattached roller clamps
- dose-error reduction system shall be considered in selection and use of electronic infusion devices
- may be used to regulate simple low-risk infusion
- When selecting an infusion device, consideration should be given to the patient's age and condition, prescribed therapy and the care s
  therapy is delivered

Baxter Interlink System Extension Set with Control-a-flow Regulator.

ELECTRONIC INFUSION DEVICES

- When to use:
- CVAD infusions
- Paeds
- When administering a vesicant medication, a low-pressure device should be chosen.—monitor every 10 – 15 min.
- arterial access (a high-pressure device)
- high-risk drugs, a device with anti-free-flow protection should be chosen.
- size, weight, and portability of the unit are important considerations in choosing a system

AMBULATORY INFUSION PUMPS

- small enough to be easily carried
- developed with the patient's home in mind
- capable of delivering most infusion therapies
- Memory programming with safety alarms
- Pump-specific tubing
- Power supply may be a challenge: battery vs electric power source

PATIENT-CONTROLLED ANALGESIA PUMPS

- available as ambulatory, semi-portable, or full-sized devices
- the distinguishing feature is the ability of the pump to deliver doses on demand
- volumetric pumps move the medication through the pump by a fill-and-empty cycle of very small increments
- syringe pump forces down own on the syringe piston, administering the syringe volume at a pre-set rate

Pharmacology

Drug Calculations – is the mathematical calculation in IV nursing practice. Its integral component is required to be able to administer correct, accurate doses of medication and solution at given time to patients

Pharmacology

- Flow Rate – amount of solution and delivery time

1. Determine the amount of solution to be administered then divide that number by the deliver time.

e.g. 1000ml (1L) by 8 hours

$$\frac{1000\text{ml (1L)}}{8\text{ hours}} = 125\text{ml / hr}$$

2. Note the drop factor of the set being used. Macrodrip – 10, 15 & 20

$$\frac{\text{ml/hr x drop factor of set}}{60} = \text{drop/mins}$$

*** Microdrip for pediatric – use the same equation***

Pharmacology

- Dosage calculation – rate of administration of IV drugs. Ratio and proportion or “desired over have”. e.g.

12, 500 heparin sodium in 250ml IV solution. Ordered dose 800U/h

1. IV solution (ml) divided by drug dose

    X = 250 / 12500

    X = 0.02

2. Then calculate the rate with ordered dose: rate multiply with ordered dose

    0.02 ml x 800 U = 16ml/hr

Pharmacology

- Percent Solution – relationship between the amount of solute and the total quantity of solution expressed as percentage or ratio.

  - Percent weight in weight – weight of solute (drug) compared the weight of the solution (g drug / 100 g solution)

  - Percent weight in volume – weight of solute compared to volume of the total solution

  - Percent of volume in volume – volume of solute compared to volume of the total solution

Opioids

- Definition: Opioids are medications that relieve pain
- Options for pain control
- Systemic analgesics and adjuvant drugs (PO, IM, IV, SC by continuous infusion or PCA
- Intraspinal opioids
- Regional analgesia
- Electrical analgesia – transcutaneous electrical stimulation or electro acupuncture
- Psychological analgesia – hypnosis, relaxation techniques

Opioids

- Opioids are effective when they bind with particular opioid receptors
- Side Effects
    - Respiratory distress – 8 to 10b/m
    - Change in mental status
    - Urinary system – urinary retention
    - Nausea
    - Pruritus
    - Constipation – slow peristaltic action

Opioids

- Methods of opioid administration
- Intravenous patient controlled analgesia – allows patient to control delivery of analgesia and maintain therapeutic serum drug levels
- Ambulatory electronic infusion devices – manage acute, post op and chronic pain in hospital or alternative care setting
- Subcutaneous narcotic infusion – use when IV access is unacceptable. Common complication – local irritation and subcutaneous scarring on the insertion site

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History of IV Push

1662

First IV injection in a living man.
Next 100 years in cadavers.

1853

Widespread use of subcutaneous injections

1900s

1910 – Salvarsan IV
1953 – 1st ICU
Changing RN and MD roles

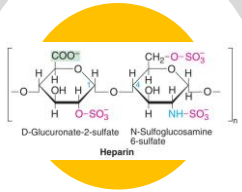
ICU

1960-1970s

Rapidly increasing specialization in ICUs
Increased use technology, IIVs
Gahart publishes text on IV meds

2000s

DVT/PE prophylaxis
Pain management standards
More IV route drugs



Today

IV push used in all settings
New guidelines for IV push
New risks for IV push

"While much emphasis has been placed on the improvement of infusion safety, little published evidence or best practices are associated with IV *push* medications."

*Shastay AD. Nsg **2016**. 46(10)*

IV Push Safety

FACT: errors with injectable medications are higher than with other forms of medications[1-2]

FACT: half of all harmful medication errors originate during the drug administration phase[3-4]

FACT: two-thirds of harmful errors involve injectable medications[3-4]

1 Taxis K, Barber N. Ethnographic study of the incidence and severity of intravenous medicine errors. Br Med J. 2003;326:684-7.
2 Cousins DH, Sabatier B, Begue D, et al. Medication errors in intravenous medicine preparation and administration: a multicentre audit in the UK, Germany and France. Qual Saf Health Care. 2005;14:190-5.
3 Bates D, Spell N, Cullen DJ, et al. The cost of adverse events in hospitalized patients. JAMA. 1997;227:307-11.
4 Bates DW, Cullen DJ, Laird N. Incidence of adverse drug events and potential adverse drug events: implications for prevention. JAMA. 1995;274(1):29-34.

Procedures Vary

Lippincott[1] says flush before and after IV push, even with running IV line.

No reference to rate of flush after med

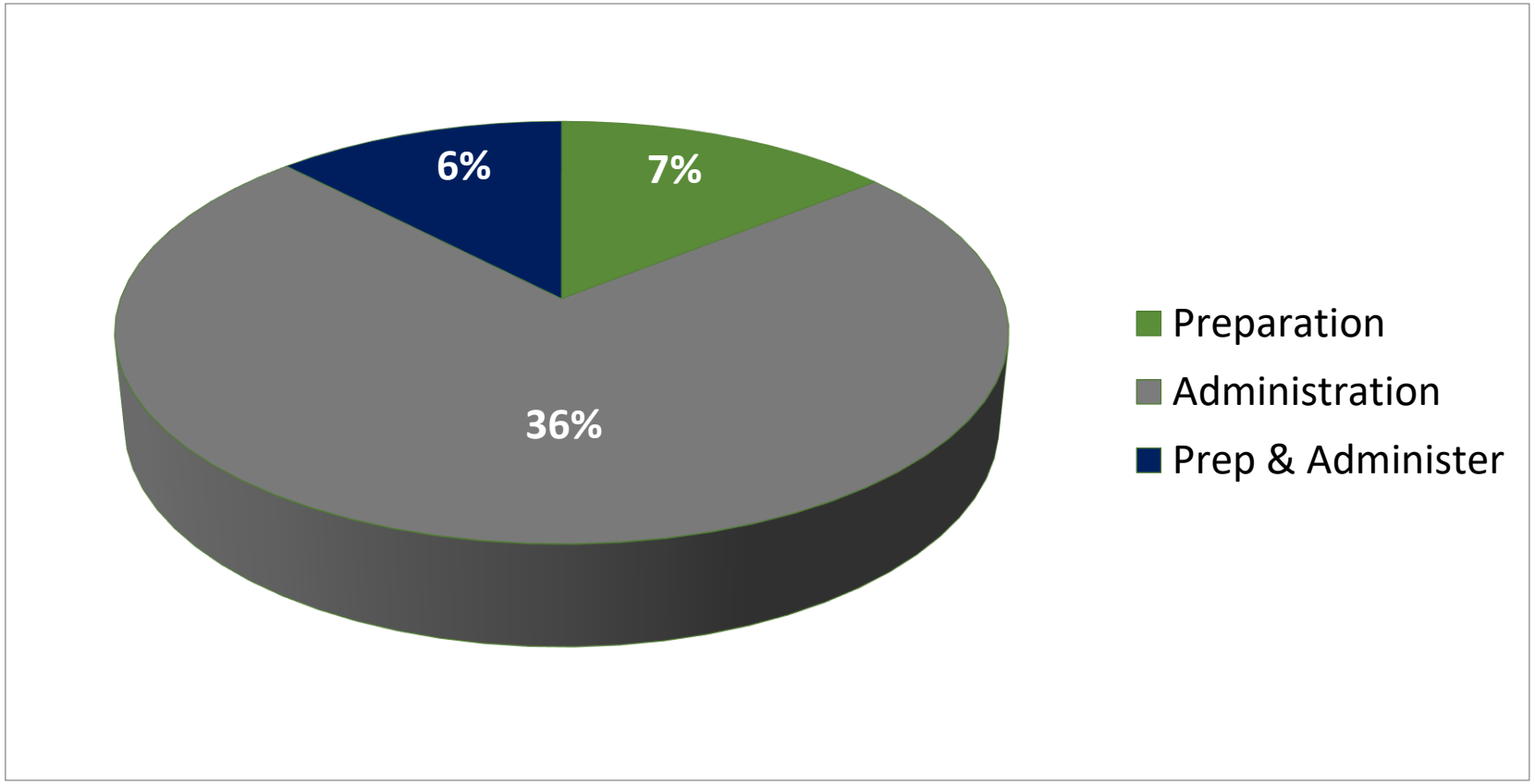
Mosby[2] says attach medication syringe, pinch IV tubing, inject med using IV to flush after med.

For IV lock, rate of flush should be same as rate of med.

[1]Lippincott (2015-10-06). Lippincott Nursing Procedures (Kindle Locations 32706-32712). LWW. Kindle Edition.

[2]Perry, Anne Griffin; Potter, Patricia A.. Mosby's Pocket Guide to Nursing Skills and Procedures (Nursing Pocket Guides) (Kindle Location 2571). Elsevier Health Sciences. Kindle Edition.

Medication Preparation Error Rates



Taxis K, Barber N. Ethnographic study of incidence and severity of intravenous drug errors. *Br. Med J.*2003; 326:684-7

Factors Contributing to **IV Push** Medication Errors

- Medication preparation
- Labeling
- Ambiguous & undefined terminology (language)
- Risk of contamination: manipulation of ready to administer medications
- Dilution & Diversion

Labeling & Language

Google Image

Language

- “IV push,” “IV,” “IV bolus,” “IV over X minutes,” and “slow IV push”
- Unclear order:
  - IV injection or infusion
  - Rate of administration missing…
  - Open to interpretation by pharmacist or nurse

ISMP. Adult IV push medication safety summit. 2015

ISMP Recommendation

- Intravenous push or IV push:
  - Direct manual administration of a medication using a syringe
  - May or may not include IV bolus dose
- IV bolus
  - Distinct dose of medication or solution given rapidly over a short period of time

ISMP. Adult IV push medication safety summit. 2015

Risk of contamination

- Transmission of bloodborne virus and microbial pathogens continues to occur due to improper injection, infusion and medication practices by health care professionals in various clinical settings.

APIC position paper: safe injection, infusion and medication vial practices in health care. 2010

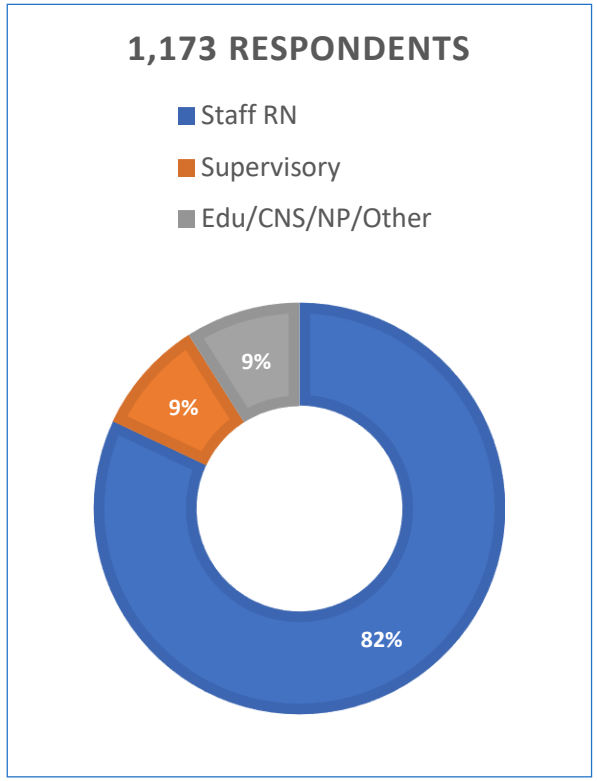
Risk Mitigation

Google Images

There *is* evidence *against* dilution

There is no evidence for dilution of IV push medications

Dilution dilemma



83% dilute IV push meds
50% dilute multi-dose vials or prefilled syringes (Carpuject™ , Simplist™)
20% dilute pharmacy prepared syringes

46% always/often dilute opiates
50% always/often dilute anti-anxiety/anti-psychotic drugs
>33% always/often dilute antiemetics
~20% always/often dilute cardiovascular drugs

Least often diluted: Naloxone, Flumazenil, Insulin, Heparin

ISMP. (2014) Some IV medications are diluted unnecessarily in patient care areas, creating undue risk. ISMP Web site. Available at: https://www.ismp.org/newsletters/acutecare/showarticle.aspx?id=82. Accessed September 14, 2015.

Dilution is not needed for most injectable drugs

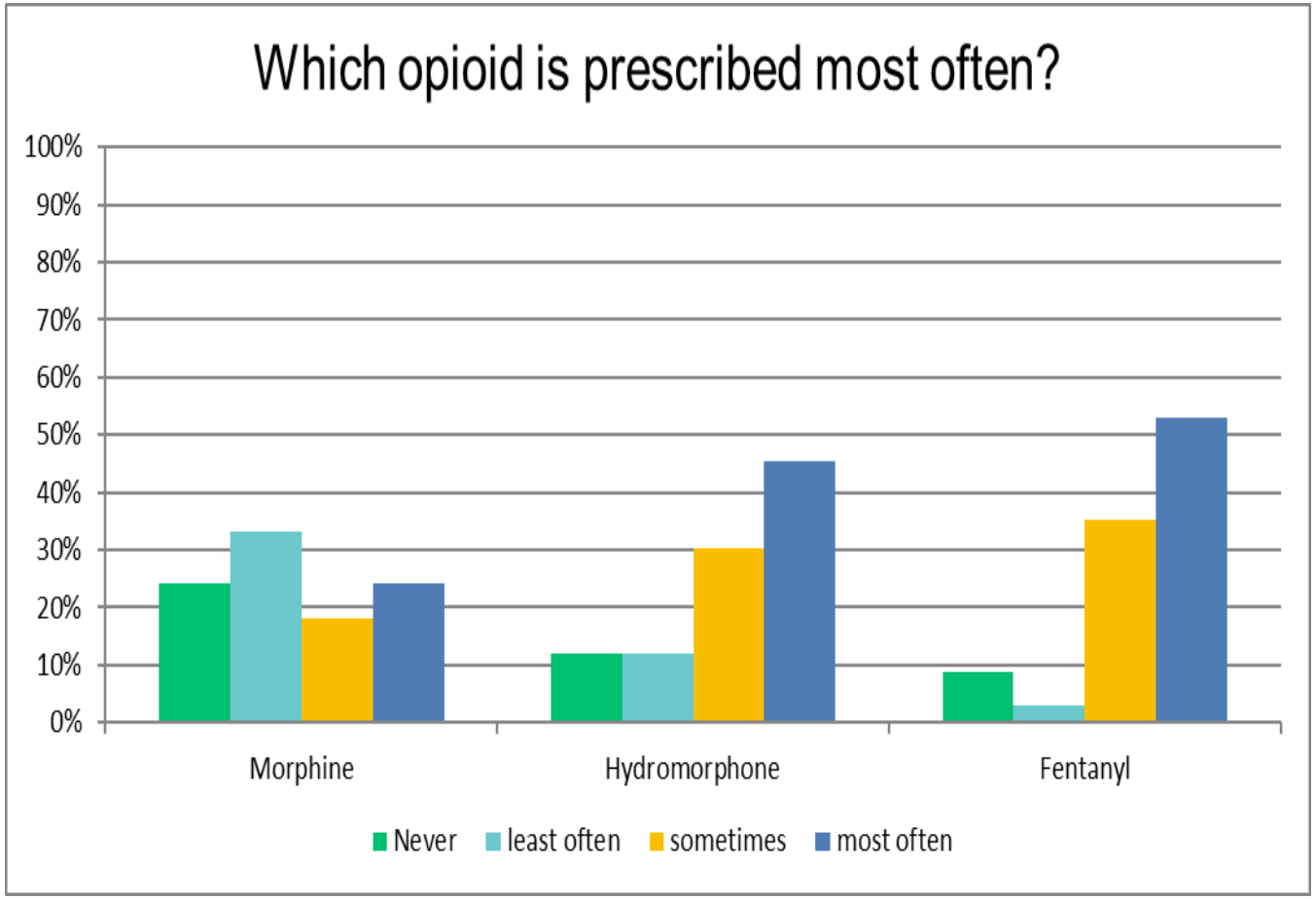
Pantoprazole (Protonix)
Famotidine (Pepcid)
Lorazepam (Ativan)
Promethazine (Phenergan)
Levothyroxine (Thyroid

- Pain versus sensation – Δ T 25°
- Not irritating – pH, osmolality WNL
- Most drugs are approved for IM and IV route
- If you can give it IM, it does not cause extravasation injury

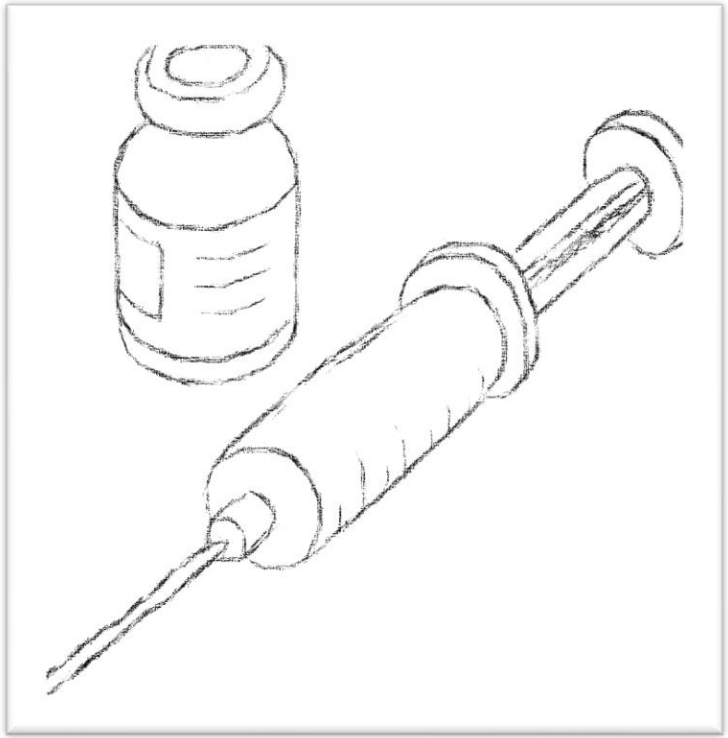
Unapproved use of prefilled saline syringe

- Transfer of drug into saline syringe increases risk of microbial contamination
- Not approved by FDA for drug dilution
- Syringe gradations not calibrated for accuracy of dosing
- Mislabeled syringes

Current practices for IV push Opioid Prep & Admin

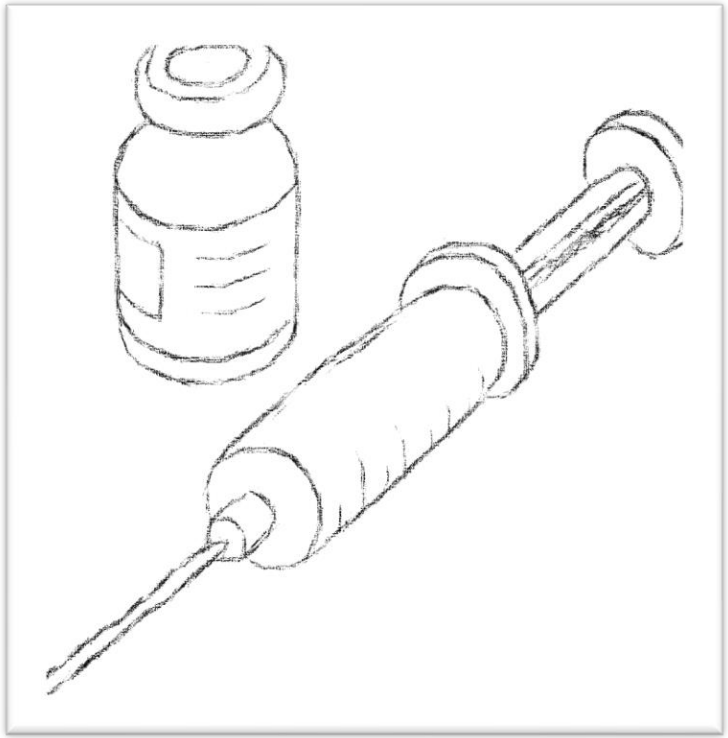


Other Findings



- No standard way to dilute IVP
- Use 10-mL syringe per policy for CVAD
- No preprinted labels – tape vial to syringe
- Save partial dose for later use

Other Findings



- Hydromorphone subcutaneous route
- Some units stock high dose Fentanyl to compound drips
- Some Fentanyl 250 mcg/10-mL syringe
- Save partial dose for later use – not secured, may pass to next shift

Preparing IV Medications

- Use sterile technique
- Use filter needle to withdraw IV meds from glass or stopper vials
- Do NOT withdraw IV meds from commercially available pre-filled syringes into another syringe for administration
- Do NOT dilute or reconstitute IV meds by drawing up the contents into a commercially available, prefilled flush syringe of 0.9%NaCl

YIKES!!

IV Push medication preparation

- Any admixture (dilution or reconstitution) outside a pharmacy sterile compounding area is to be done immediately before administration in a clean, uncluttered and functionally separate location (with all needed information and supplies)
  - Instructions and access to proper diluent if admixture to be done outside pharmacy

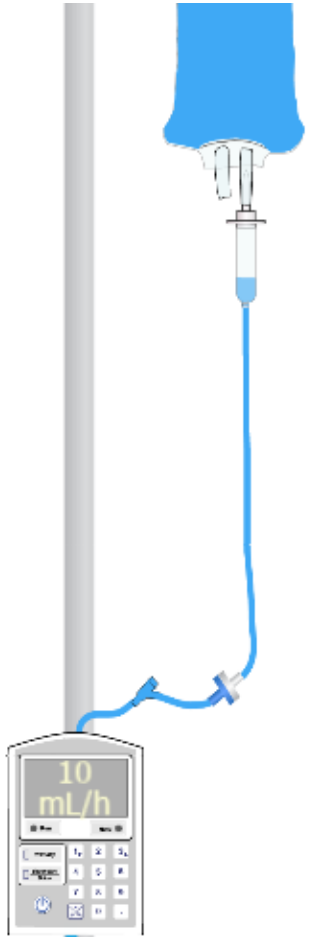
IV Push medication preparation

- NEVER use IV solutions in containers intended for infusion, including mini-bags as a common-source to prepare IV flush syringes or as a diluent for admixture
- Label all clinician prepared syringes or solutions unless it is prepared at the patient's bedside and immediately administered.
- Discard any unlabeled, unattended syringes

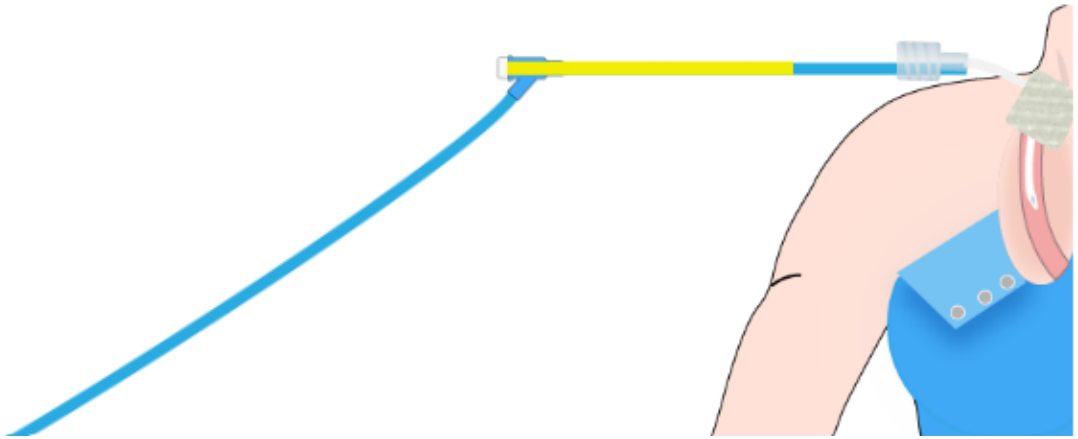
IV Push Meds administration

- Perform an appropriate clinical and vascular access site assessment before and after administration of IV push medications
- Administer IV push medications and subsequent flush at the rate recommended by manufacturer for the medication given.
  - Use an appropriate volume of the IV flush to ensure the entire drug dose has been administered.

Shared infusion volume IV push



2 mL (20mg) Furosemide
over 1 minute



Key Recommendations

- Administer IV push medications and any subsequent IV flush at the rate recommended by the manufacturer, supported by evidence in peer-reviewed biomedical literature, or in accordance with approved institutional guidelines.

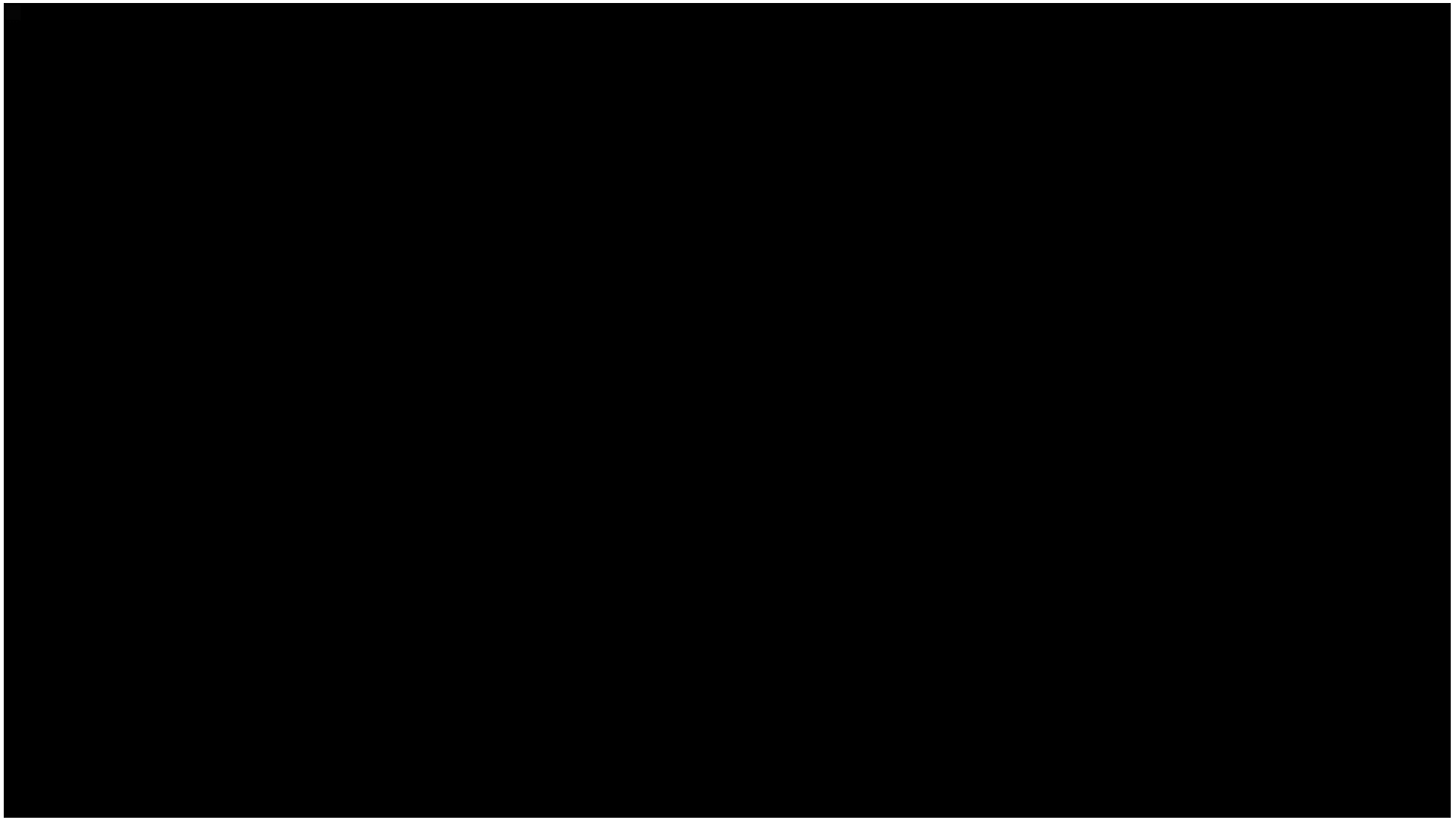
The rate and volume of the subsequent flush can also result in unintended rapid or delayed administration of a drug. The medication left in any dead space in tubing or catheters will be flushed into the vascular system at the same rate that the flush or associated compatible IV solution is being administered.

ISMP. ISMP Safe Practice Guidelines for Adult IV Push Medications. 2015.Available at: http://www.ismp.org/Tools/guidelines/ivsummitpush/ivpushmedguidelines.pdf.

IV push meds via CVAD

- Assess CVAD patency using 10mL diameter-sized syringe filled with preservative free 0.9%NaCl.
- Once patency is confirmed, IV push medication can be given in a syringe appropriately sized to measure and administer the dose.

IV Push Technique



IV Push Medications video

- IV Push Medications increasing safety choosing best practice