



NATIONAL LEADERS IN MEDICINE

COMPLETE DRUG DELIVERY AND RESIDUAL VOLUME: CHALLENGES AND LESSONS LEARNED

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BARNES-JEWISH HOSPITAL

WASHINGTON UNIVERSITY PHYSICIANS

DISCLOSURE

- No disclosures for speakers

INTRODUCTION

- Meghan McDannald
 - Clinical Nurse Specialist, Oncology Service Line
- Rebecca Meyer, PhD, RN, NPD-BC
 - Senior Practice Project Coordinator, Center for Practice Excellence

OBJECTIVES

1. Identify challenges for ensuring complete drug delivery for both nursing and pharmacy.
2. Describe the education process for secondary infusion administration.
3. Describe implementation of secondary infusion practices in an acute care setting.
4. Discuss other challenges to provide complete drug delivery.





Barnes Jewish Hospital is a large, academic, acute care hospital in St. Louis, MO

- 1,269 Licensed inpatient beds
- ~ 4,000 RNs
- Part of larger BJC System: 13 hospital + ambulatory centers

Infusion Platform

- BD Alaris large volume pumps
- Smiths/ICU Medical CADD PCA/Epidural
- Excelsior Mini-Infuser
- MedFusion Syringe pumps for research meds in oncology/other limited use

EMR

- EPIC
- No pump integration

NOT SO ANCIENT HISTORY....



THE CLINICAL PROBLEM

- Variable practice for intermittent medication administration
- More awareness of this problem highlighted this issue
- Many intermittent, small volume drugs are administered on a primary line
- Variable clinical practice and preference between units
- Infusion pump data focusing on small volumes showed that many were administered as a primary infusion



INFUSION DEFINITIONS



PRIMARY INFUSION



SECONDARY INFUSION

Do infusion pumps alone ensure complete drug delivery?

INFUSION DEFINITIONS



PRIMARY INFUSION

What about the tubing below the pump?

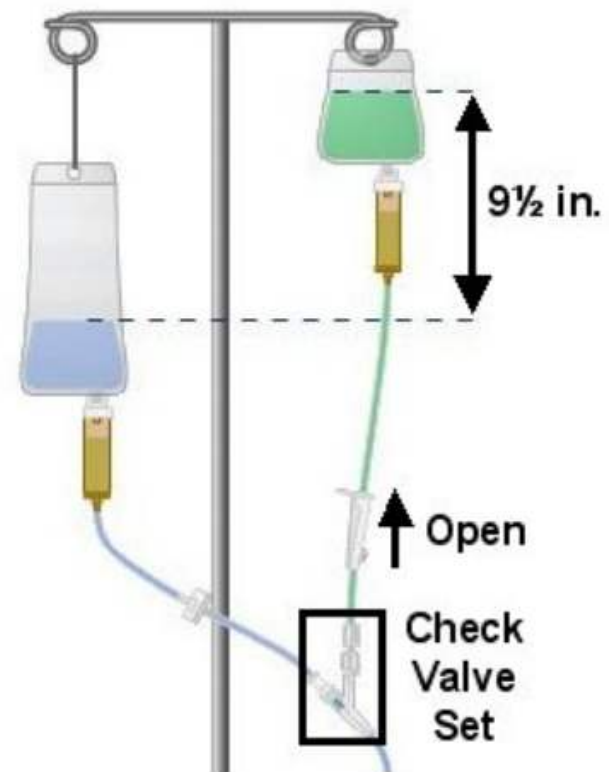


SECONDARY INFUSION

Requires some specific actions and considerations to ensure complete delivery.

IS SECONDARY PERFECT?

- Depends on pump as to how easy this is to set up...
- Tubing matters!
- Must unclamp!
- Height may matter!
- Correct volume and volume limitations!
- Compatibility matters!

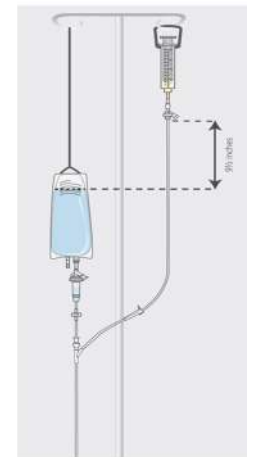


SYRINGE ADMINISTRATION

- 3 routes at our facility
- Mini-infuser
- Alaris Primary Syringe Set
- Gravity Secondary Syringe Set

Challenges

- Limited equipment availability
- No standardized flushing
- Preference
- Lack standardized training on each method
- Supply disruptions can heavily impact this type of administration
- Secondary syringe has same challenges



BACKGROUND

- Previous chemotherapy and cancer treatment work on flushing standardization
 - High risk hazardous drugs administered on a primary line
 - Previous work discovered challenges with secondary administration on our plump platform
- Assumptions and beliefs around residual drug volume
 - *Doesn't the pump alone deliver the entire medication?*
 - *Is any residual drug acceptable???*
 - Previous oncology work took a “good to the last drop approach” to expect complete drug delivery

**Good to the last
drop...**



**Do your policies, procedures ,and training
address complete drug delivery?**

THE CLINICAL PROBLEM

- Variable practice for intermittent medication administration
- Outpatient infusion inquired about this issue
- Agency nurses questioning practice variability
- Increased awareness in healthcare



AWARENESS

The Cost of Not Flushing IV Medications

| Drug | Typical Dose in MG | MG/ml final dilution | Typical Volume (ml) | Total Cost | Cost per ml | Cost of not flushing | Percent of dose lost unflushed |
|--------------------|-----------------------|-------------------------|---------------------------|------------|-------------|-------------------------|-----------------------------------|
| Famotidine* | 20 | 0.4 | 50 | \$ 22 | \$ 0.43 | \$ 4.73 | 22% |
| Magnesium* | 2000 | 40 | 50 | \$ 41 | \$ 0.82 | \$ 9.02 | 22% |
| Valproate* | 1000 | 16.7 | 60 | \$ 25 | \$ 0.42 | \$ 4.62 | 18% |
| Zosyn* | 3.375 | 0.1 | 65 | \$ 19 | \$ 0.30 | \$ 3.30 | 17% |
| Casirivimab^ | 600 | 5.5 | 110 | - | - | - | 15% |
| Belatacept^ | 500 | 4.2 | 120 | \$ 6,334 | \$ 52.78 | \$ 844.48 | 13% |
| Levetiracetam* | 1000 | 10 | 100 | \$ 117 | \$ 1.17 | \$ 12.87 | 11% |
| Tacrolimus* | 1 | 0.01 | 100 | \$ 878 | \$ 8.77 | \$ 96.47 | 11% |
| Cefepime† | 1000 | 50 | 20 | \$ 14 | \$ 0.72 | \$ 1.44 | 10% |
| Ceftriaxone † | 2000 | 100 | 20 | \$ 15 | \$ 0.77 | \$ 1.54 | 10% |
| Leucovorin* | 150 | 1.3 | 115 | \$ 64 | \$ 0.56 | \$ 6.16 | 10% |
| Methyprednisolone* | 1000 | 8.6 | 116 | \$ 96 | \$ 0.83 | \$ 9.13 | 9% |
| IVIg* | 3500 | 10 | 350 | \$ 8,055 | \$ 23.01 | \$ 253.11 | 3% |
| Rituximab* | 1000 | 1.7 | 600 | \$ 35,232 | \$ 58.72 | \$ 645.92 | 2% |

*Standard Alaris pump tubing, no added filter (11ml below pump in tubing)

† Alaris Syringe tubing, no added filter, non-piggyback (2ml below pump in tubing)

^ Standard Alaris pump tubing, with 0.2 micron filter (16ml below pump in tubing)

Cost is the actual drug cost if paid in cash by patient.

Table credit: Leslie Echterhoff, Staff RN BJH Outpatient Infusion

GUIDELINES

What guidelines exist?

- Infusion Nursing Society
- Institute for Safe Medication Practices
- Oncology Nursing Society

Policy statement – system medication administration policy

BJC POLICY STATEMENTS

Key Points: Some infusion bags are overfilled by manufacturer. Verify all medication has been administered at the end of each infusion to ensure patient receives complete dose. Practices to assure that medication is not left in tubing must be instituted. This may include appropriately flushing the line if using a primary infusion or providing a carrier fluid if setting up infusion as a secondary.

Why were staff not administering intermittent medications as a secondary infusion?

- Talking with colleagues
- Asking about unit culture
- Asking new grads and agency
- Survey
- Looking at training
- Looking at resources

BARRIERS: ACCESS TO FLUIDS

- We realized not everyone had access to fluid orders for the primary “flush line
- 2 options for nurses to take in this situation:
 - Override for needed fluids
 - Don't secondary, and put the drug on a primary line



BARRIERS

➤ ICU concerns

- Fluid overload
- Extra pump/channel required
- Too many bags of fluid

➤ Infusion volume issues

- Variance in bag volume – manufacturer overfill
- Epic total volume vs. label vs. manufacturer

➤ Clearing the line for secondary infusion (incompatible)

➤ Disbelief that drug loss is a clinical problem

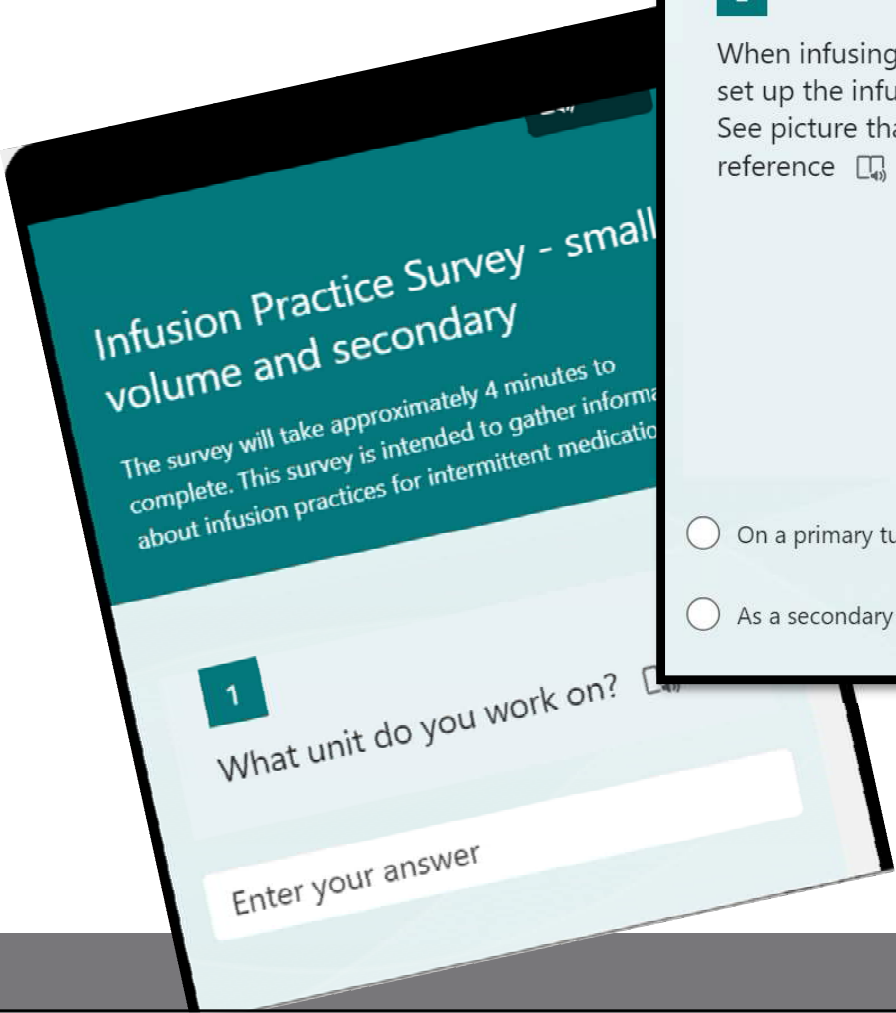


BARRIERS

- Secondary gravity flow
 - Head height
 - Nurse knowledge
 - Volume to be infused
- Access to fluids for flushing
 - Access to NS – override
 - Orders for carrier fluids
 - MD/Provider unfamiliarity with carrier fluid order – “unchecking”
- No standard work or policy
- Training
 - Pump set-up
 - Appropriate fluids for secondary
 - Flushing



SURVEY

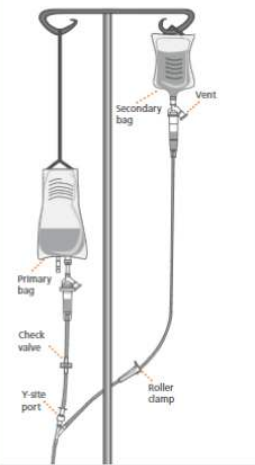


2

When infusing an intermittent medication in a bag, how do you typically set up the infusion?

See picture that depicts a secondary or "piggyback" infusion for reference

Accurate secondary mode infusion depends on hanging the secondary container sufficiently higher than the primary container.



- On a primary tubing set
- As a secondary / piggyback (see picture)

SURVEY RESPONSE

➤ Infusion Practice Survey – Small Volume and Secondary 2021

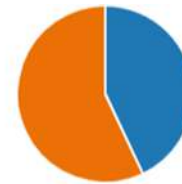
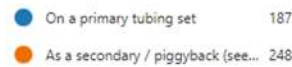
- Baseline practice on intermittent bags and syringes
 - Shared with all patient care units
 - 435 responses



SURVEY

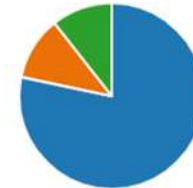
- Setting Up Secondary Infusions

- Approximately 75% set up the infusion as a secondary



- Usual practice on unit split between primary, secondary, and mixed

- Approximately 75% know secondary tubing is available

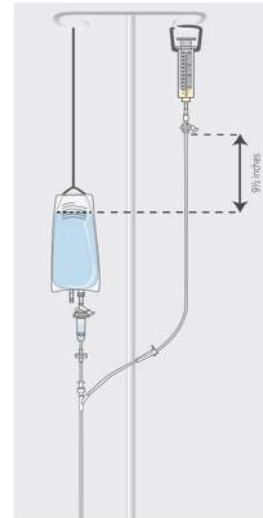
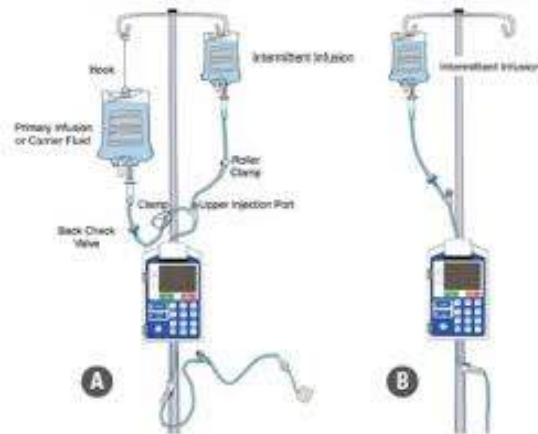
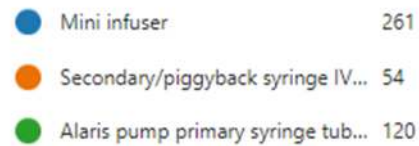


- Approximately 95% knew how to set-up a secondary infusion



SURVEY: SYRINGE ADMINISTRATION

- Setting Up Syringe Infusion
 - Preferred method



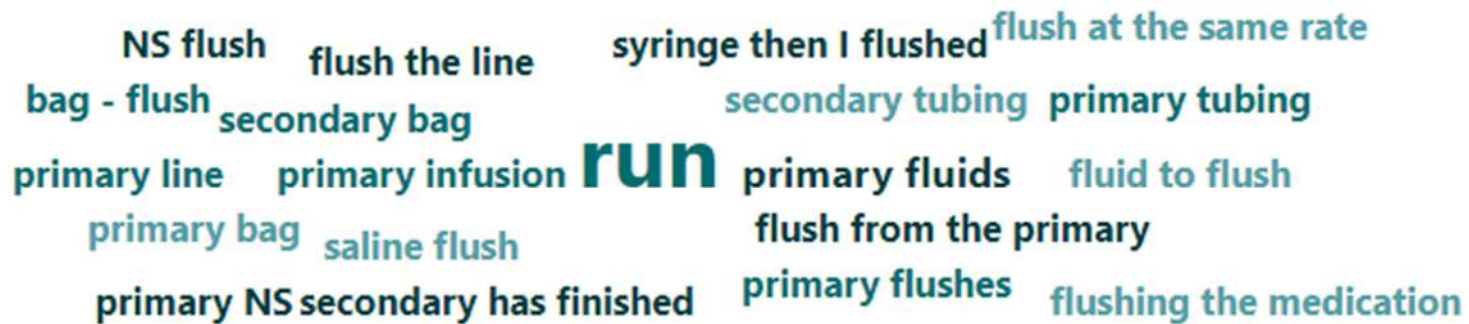
SURVEY

- Flushing Practices for bag infusion

- Approximately 40% flushed post infusion



- Flushing method



SURVEY

- **Flushing Practices for Syringes**

- Process after using mini-infuser or primary Alaris syringe set

- ● Attach saline syringes to infuse ... 172
- ● Attach saline syringes to the tub... 86
- ● Other manner of flushing the tu... 15
- ● I don't flush the tubing in any m... 159



SURVEY

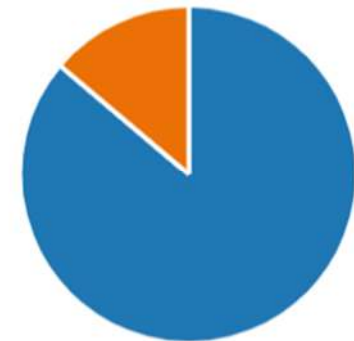
- Flushing Orders
 - Intermittent products

● Yes 152
● No 281



- Blood products

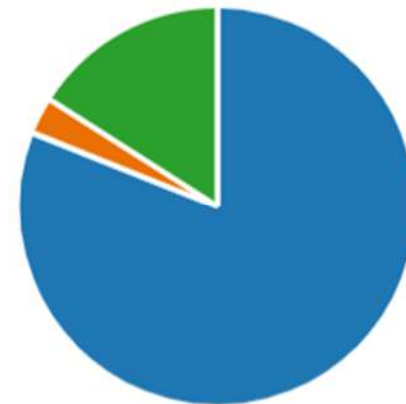
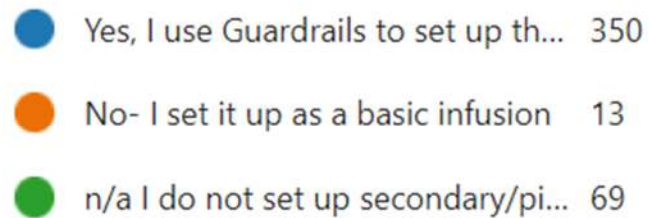
● Yes 374
● No 60



SURVEY

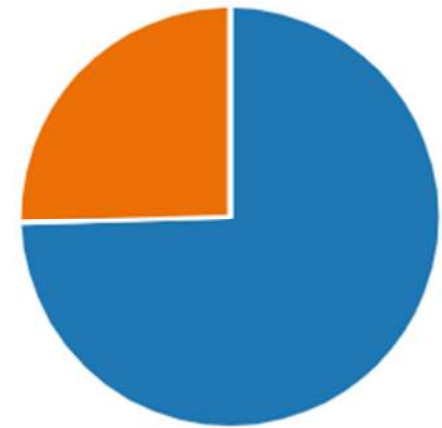
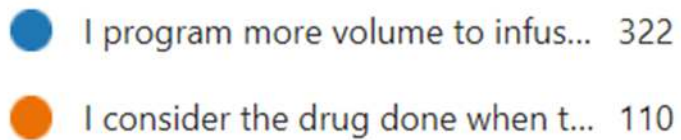
- **Guardrail (DERS) use for secondary infusion**

- 81% use Guardrails
- 19% do not use Guardrails



SURVEY

- **Process when infusion is 'complete' but fluid remains in the bag**
 - 75% program more VTBI
 - 25% consider infusion complete



SURVEY

- **Barrier comments on the survey:**
 - Secondary/IVPB infusion
 - Compatibility
 - Concerns about attaching a secondary to ordered hydration
 - Pump unreliability
 - Overfilled IVPB, must add more volume to completely infuse
 - Not enough pump channels, brains
 - Not common practice
 - Wasting a NS bag of fluids
 - Lack of supplies – tubing
 - Forgetting to unclamp the line

NEXT STEPS

- Multiple medication administration concerns
- Complete drug delivery for intermittent medications is a multifactorial issue



CARRIER FLUID ORDER

Carrier Fluids for Secondary Infusion - 0.9% Sodium Chloride [Ⓔ] Dose: 30 mL : intravenous : As needed : For priming tubing and/or flushing : 



Admin Instructions:

0-250 ml/hr to flush line after IV infusions when no maintenance IV ordered. Infuse 30mL at the same rate as the secondary infusion. Run as primary IV, not intended for KVO.

Ordered Admin Dose: 30 mL

Frequency: As needed

Route: intravenous

Ordered Dose: 30 mL

Priority: Routine

Order ID:

Order Start Time: Today 10/25/23 at 0937

PRN Reasons: For priming tubing and/or flushing

Phase of Care: Pre-Procedure (IR)


Dispense Location: BJ-4XRAY ADS

References: [Micromedex Drug Info](#)

[LexiComp Drug Info](#)

[Patient Handouts](#)

Linked Line: [Not Linked](#)

[Click to hide details](#) 

EDUCATION

Secondary Infusion and Syringe Infusion

- Administering intermittent infusions (antibiotics, electrolytes, etc.) as a secondary infusion is the best way to ensure that the entire dose of a drug is being given.
- The secondary set up ensures that drug remaining in the tubing is flushed into the patient.
- Drug left behind in tubing may cause a SIGNIFICANT drug loss to the patient, especially for smaller volume medications.
- Syringes for infusion can be administered multiple ways (primary Alaris syringe, mini-infuser, and secondary gravity syringe set. It is also important for any syringe administration to include flushing of drug remaining in tubing.

Why is it important to administer entire doses of medication?

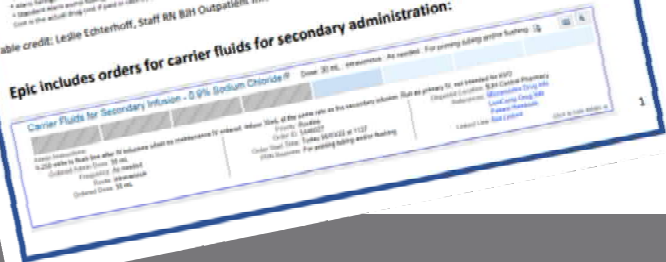
- Ensures entire drug is given as ordered
- Ensures therapeutic drug levels
- See below for examples of % and cost that is lost when entire drug is not administered and flushed

The Cost of Not Flushing IV Medications

| Drug | Typical Dose (mg) | Typical Total Infusion (mg) | Typical Volume (ml) | Total Cost | Cost per ml | Cost of not flushing | Percent of dose not flushed |
|--------------|-------------------|-----------------------------|---------------------|------------|-------------|----------------------|-----------------------------|
| Amoxicillin* | 250 | 100 | 5 | 22.5 | 0.45 | 0.15 | 22% |
| Amoxicillin* | 500 | 200 | 5 | 45.0 | 0.90 | 0.30 | 33% |
| Vancomycin* | 500 | 200 | 5 | 225.0 | 4.50 | 1.50 | 33% |
| Vancomycin* | 1000 | 400 | 5 | 450.0 | 9.00 | 3.00 | 33% |
| Zinc† | 4.0 | 1.0 | 5 | 0.50 | 0.10 | 0.03 | 30% |
| Vancomycin* | 500 | 200 | 5 | 225.0 | 4.50 | 1.50 | 33% |
| Vancomycin* | 1000 | 400 | 5 | 450.0 | 9.00 | 3.00 | 33% |
| Vancomycin* | 500 | 200 | 5 | 225.0 | 4.50 | 1.50 | 33% |
| Vancomycin* | 1000 | 400 | 5 | 450.0 | 9.00 | 3.00 | 33% |
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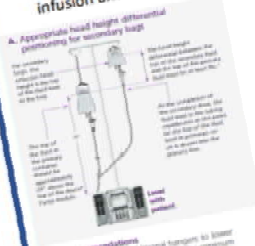
Table credit: Leslie Eberhoff, Staff RN BHI Outpatient Infusion

Epic includes orders for carrier fluids for secondary administration:



Making Sense of Secondary Infusions

- Scan the QR code below to the right to watch a video of how to set up a secondary infusion and how to backprime a secondary set with fluid.



- Page 4 of this packet is a tip sheet on Secondary set up on the Alaris pump
- Remember to unclamp the secondary tubing when starting the medication!
 - Lower the primary bag, opening the hanger completely; this will help prevent primary infusion at the same time, potentially causing some of the secondary infusion to be infused.
 - Open the clamp (no one intends to forget this; please be intentional remembering)
 - Make sure the medication is dripping before you walk away! LOOK UP chamber of the secondary infusion, initially and every time you come room. Be sure you see the drug dripping!

Making Sense of Syringe Infusions

- There are three main ways to administer a syringe infusion:
- Gravity secondary syringe adaptor (see tip sheet on page 5; this is a secondary set up and the primary fluids will flush the line when the medication is done)
- Video for gravity secondary syringe set-up:



- Mini-Infuser
- Alaris Pump Set vented syringe adaptor (see tips below on use and how to flush)

Tips for use with Mini-Infuser

- Mini-infuser tubing is small bore (low priming volume) and should be attached to compatible primary fluids
- After the syringe is done, a 10 ml Normal Saline syringe can be attached and infused at the same rate as the drug to flush the line

Tips for use with the Alaris Pump Set Vented Syringe Adapter:

- This should be y'd into the closest y-site on a primary compatible fluid line
- The syringe is attached to the top and the vent should be kept closed while priming
- You may also prime the tubing upside down with a saline syringe
- Once primed, attach medication syringe, open vent
- Insert the tubing into the pump channel. If the set is properly vented, the syringe plunger will not advance
- When the infusion is done, flush the line to ensure the patient receives the complete dose. Attach a 10 ml NS syringe/compatible fluid and flush at same rate of infusion. The fill volume of the tubing is 4 ml



CHALLENGES

- Staff turnover
 - Agency staff
 - “Set in their ways”
- Medications that can't/shouldn't be secondary
 - Hazardous drugs prepared on primary line
 - Others with specific flushing instructions
 - Titrated drugs
 - Larger volume intermittent medications
- How does the RN determine what should be primary vs. secondary?



WHERE ARE WE NOW?

- 38% increase since June 2021.

| | Percent Secondary Infusion | Percent Secondary Infusion | Percent Secondary Infusion | Percent Secondary Infusion | Percent Secondary Infusion | Percent Secondary Infusion | Number of Primary Infusions | Number of Secondary Infusions |
|-----------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|-----------------------------|-------------------------------|
| <i>Facility</i> | June 2021 | January 2022 | July 2022 | November 2022 | February 2023 | July 2023 | | |
| BJH | 16% | 22% | 19% | 29% | 29% | 42% | 4336 | 3196 |

FUTURE STATE

- Ongoing work!
- Evaluating new infusion platforms
 - Comprehensive procedures and training to ensure complete drug delivery
- System standardization
- Pump interoperability
- Short sets, syringe administration, and microbore tubing?



OTHER RESIDUAL DRUG CHALLENGES

- Flushing standards: flushing at the same rate of drug
- Syringe pumps
 - Do policies and practice include flushing tubing?

OTHER RESIDUAL DRUG CHALLENGES

- Primary infusions
 - What is left in tubing when drug is complete?
 - Correct volume on the bag and manufacturer overfill

| Vendor Labeled Volume | Volume including Maximum Overfill | | |
|-----------------------|-----------------------------------|-----------------|-----------------|
| | Viaflex Bag (Baxter) | Excel (B Braun) | VisIV (Hospira) |
| 25 ml | 34 ml | n/a | n/a |
| 50 ml | 63 ml | n/a | n/a |
| 100 ml | 115 ml | n/a | n/a |
| 150 ml | 175 ml | n/a | n/a |
| 250 ml | 285 ml | 270 ml | no info |
| 500 ml | 565 ml | 532 ml | 541 ml |
| 1,000 ml | 1,070 ml | 1,058 ml | 1,052 ml |



- Pump integration, secondary infusion, and flushing practices

TAKE AWAYS

- Evaluate:
 - Policies
 - Training
 - Nursing practice
 - Variance from established practice protocols
 - Understand your pump platform



Do your institution's policies and practices ensure complete drug delivery?

QUESTIONS

-

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REFERENCES

Gorski, Lisa A.; Hadaway, Lynn; Hagle, Mary E.; Broadhurst, Daphne; Clare, Simon...& Alexander, Mary. Infusion Therapy Standards of Practice, 8th Edition. Journal of Infusion Nursing 44(1S):p S1-S224, January/February 2021. | DOI: 10.1097/NAN.0000000000000396

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