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# Maximizing Syringe Pump Safety, Minimizing Risk

REMEDI conference

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## Disclosure

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Debbi Child is an employee of Smiths Medical



## Learning objectives:

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- Recognize the impact of syringe size and selection related to flow dynamics, flow continuity and infusion rates.
- Describe the appropriate use of accessory devices and syringe infusion pumps.
- Evaluate the importance of priming the pump and tubing when starting an infusion or changing a syringe.
- Discuss how syringe pump height and location can adversely impact continuous infusions.
- Consider tubing occlusions and the role they play in flow continuity.
- Identify resources for clinician education on syringe infusion pump best practices.

## Scenario

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Full term 2.5 kg NICU patient with meconium aspiration. Transferring to PICU for ECMO. Patient receiving multiple medications including vasopressors and sedation infusions.

What should be evaluated when setting up and programming the syringe infusion pumps for this patient?

- a. Sizes of syringes used for medications
- b. Tubing and accessories
- c. Pump placement relative to the patient
- d. All of the above

## FDA safety communication

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- Issued August 25, 2016
- Audience:
  - Health care professionals who use or who train users on programmable syringe pumps
  - Health care professionals responsible for maintaining programmable syringe pumps
  - Health care professionals who are responsible for how drugs are mixed for use in programmable syringe pumps

## FDA Definition: Syringe infusion pumps

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- Used to deliver medications, fluids, enteral feedings, and blood products
- Infusions can be continuous, intermittent and bolus type
- Infusion rates vary depending upon need (e.g. 0.01 mL/hr – 1130 mL/hr)
- Frequent adjustment for intensive care patients

## FDA Purpose: Focused on flow

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- Safety Communication focuses on *slow flowing continuous type infusions*
  - Infusion rates < 5 mL/hr = low flow
  - Special focus on flow rates < 0.5 mL/hr
- Lack of flow continuity
  - Delay of therapy
  - Over/under infusion
  - Unintended bolus
- All syringe pumps could be affected
- **Benefits of pump use outweigh risk**

## FDA Recommendations

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1. Syringe Size and Selection
2. Use of Accessory Devices
3. Starting an Infusion or Changing a Syringe
4. Height and Location of the Syringe Pump system
5. Occlusion Considerations



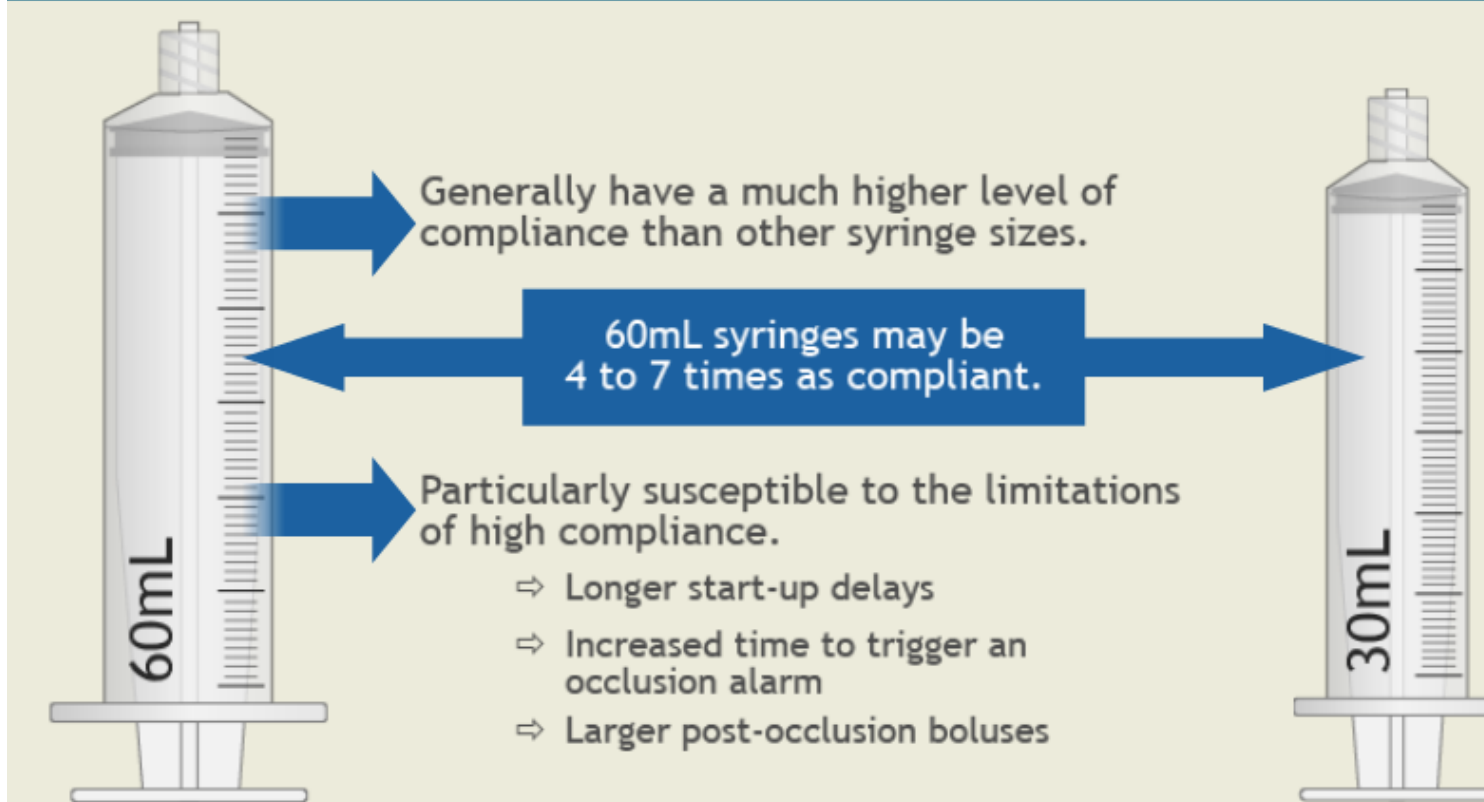
## Syringe Size and Selection

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- Verify syringe model/size is pump compatible
- Syringe size can impact flow dynamics by increasing system compliance
  - Larger syringes at low flow rates can affect pump performance
  - Increased friction and plunger tip compliance
- Select smallest appropriate syringe size

# Syringe compliance comparison

## COMPLIANCE EXAMPLE - 60mL SYRINGES



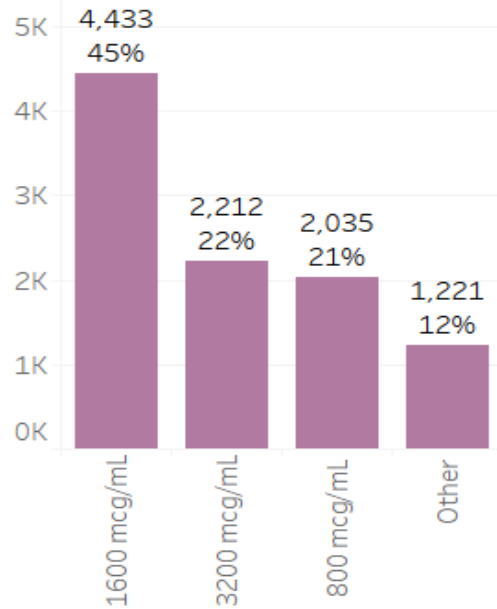
# Medfusion® Data Review: DOPamine

## DOPamine # Records by Weight Range

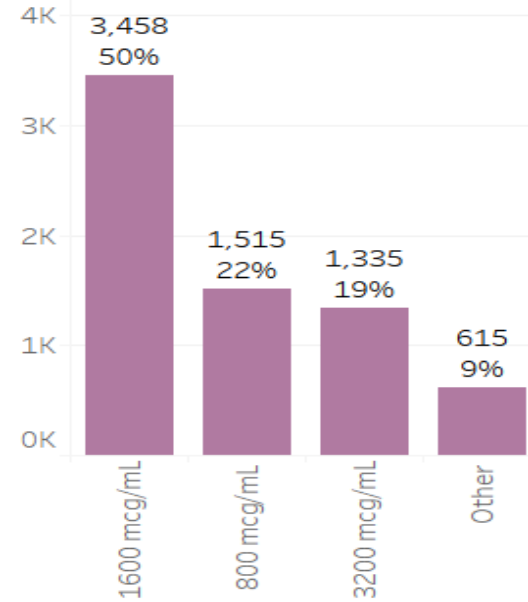
### Weight Range

0 - 5 kg	6,923
5.1 - 10 kg	1,212
10.1 - 20 kg	856
20.1 - 30 kg	238
30.1 - 40 kg	169
> 40.1 kg	503
<b>Grand Total</b>	<b>9,901</b>

### DOPamine Concentrations



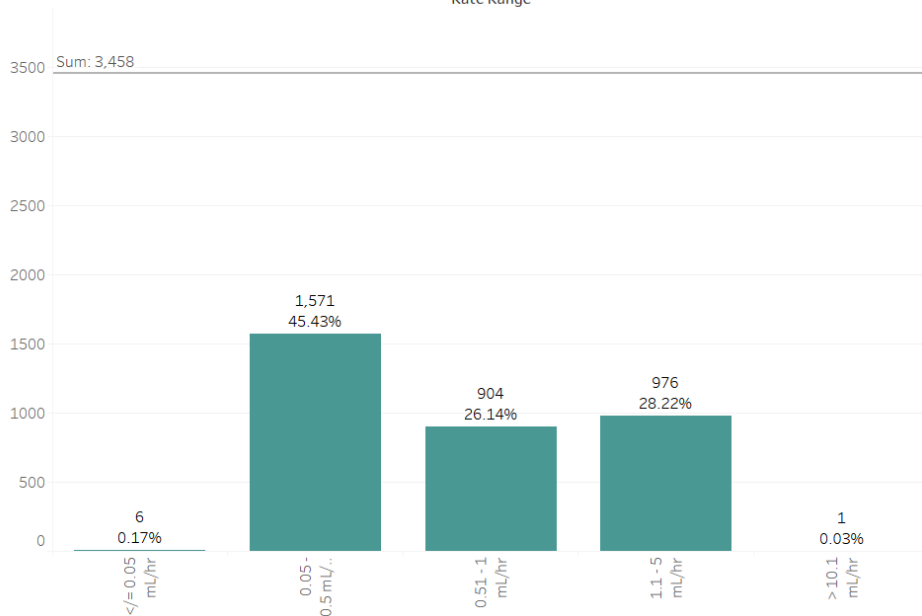
### DOPamine Concentrations, 0-5 kg



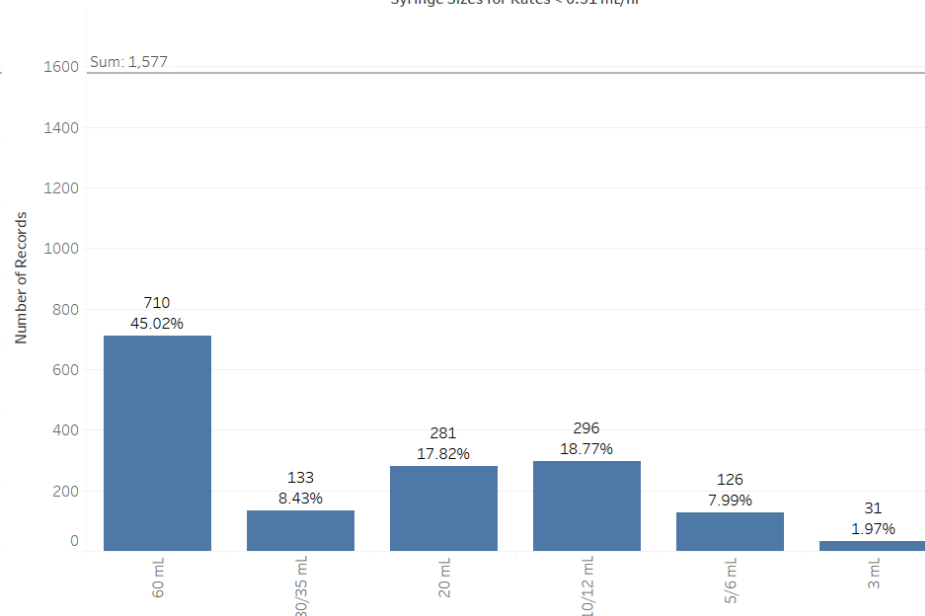
Other: 400 mcg/mL, 600 mcg/mL, 1000 mcg/mL, 4000 mcg/mL, 6000 mcg/mL, 6400 mcg/mL, 10 mg/mL, 40 mg/mL

# DOPamine 1600 mcg/mL, Weight 0-5 kg

Rate Range



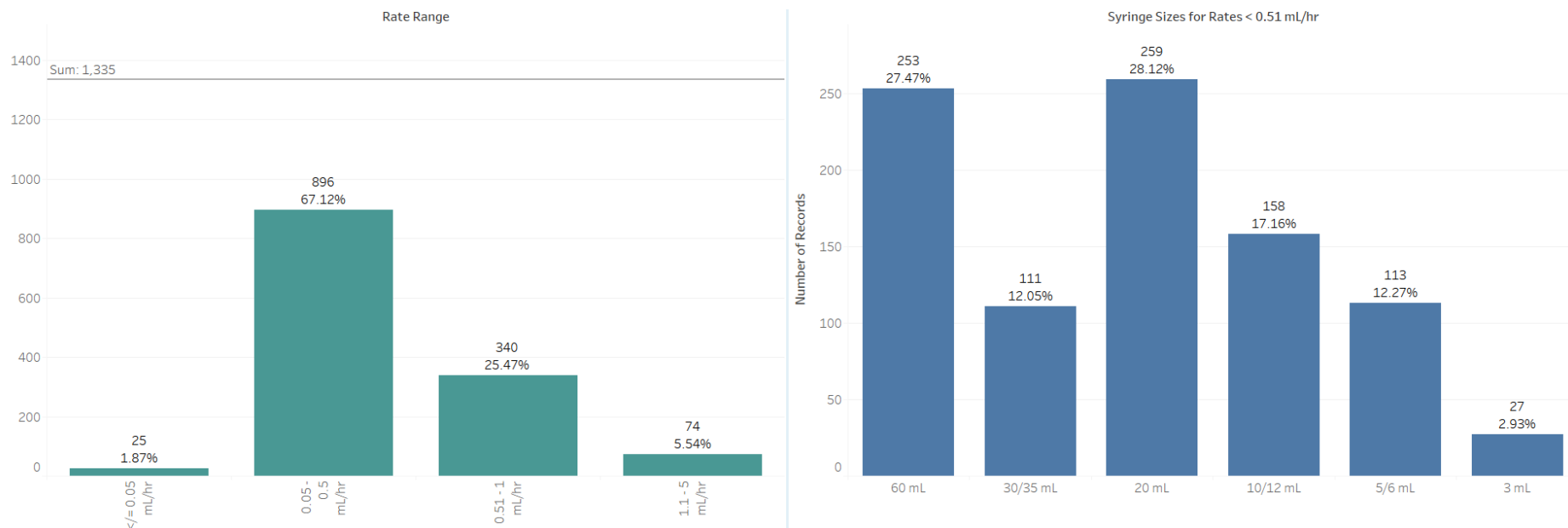
Syringe Sizes for Rates < 0.51 mL/hr



## DOPamine 1.6 mg/mL, 0-5 kg, Rate < 0.51 mL/hr

Syringe Size	# Records	# Titrations	Min. Titrations	Max. Titrations	Median Titrations	Mean Titrations	Std. dev. Titrations
60 mL	710	6,216	1	104	4	8.8	$\pm 12.3$
20 mL	281	2,630	1	94	5	9.4	$\pm 11.9$

# DOPamine 3200 mcg/mL, Weight 0-5 kg



## DOPamine 3.2 mg/mL, 0-5 kg, Rate < 0.51 mL/hr

Syringe Size	# Records	# Titrations	Min. Titrations	Max. Titrations	Median Titrations	Mean Titrations	Std. dev. Titrations
60 mL	253	4,069	1	240	7	16.1	±25.6
20 mL	259	2,567	1	315	5	9.9	±21.3

## Use of Accessory Devices

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- Syringes, tubing, stopcocks, manifolds, filters, etc.
- Target smallest internal volume or dead space
  - Low infusion rates = small or micro bore tubing
  - Avoid high pressure port valves
  - Limit y-sites and attachments
- Connect nearest to patient as possible
- Collaborate with other clinicians for best practices

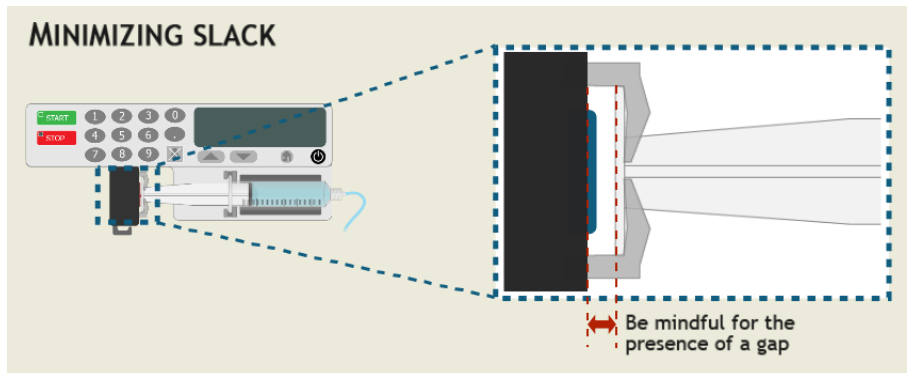
## Starting an Infusion or Changing a Syringe

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- Verify syringe size and model during pump programming
- Manual prime versus priming on the pump
- Pump priming feature
  - Engages pumping mechanism to remove mechanical slack
  - Reduces syringe friction and stiffness

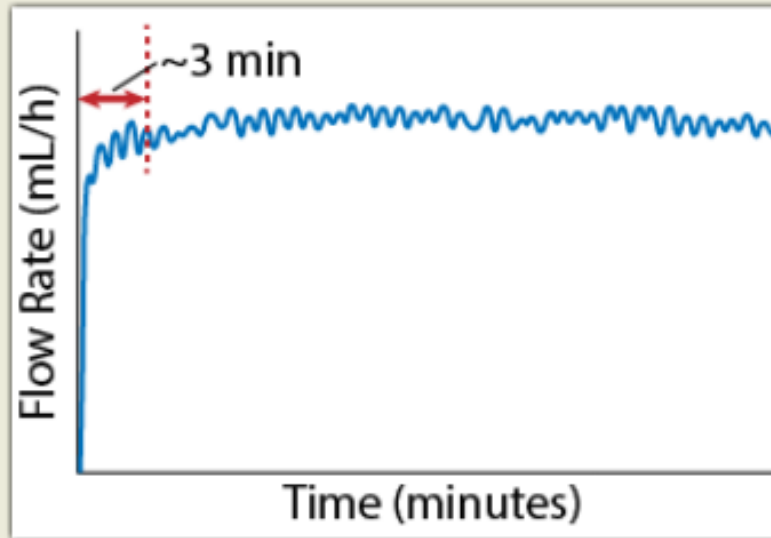
# Mechanical slack

- Motor engagement with syringe driver
- Plunger overcoming force
- Overcoming the gap

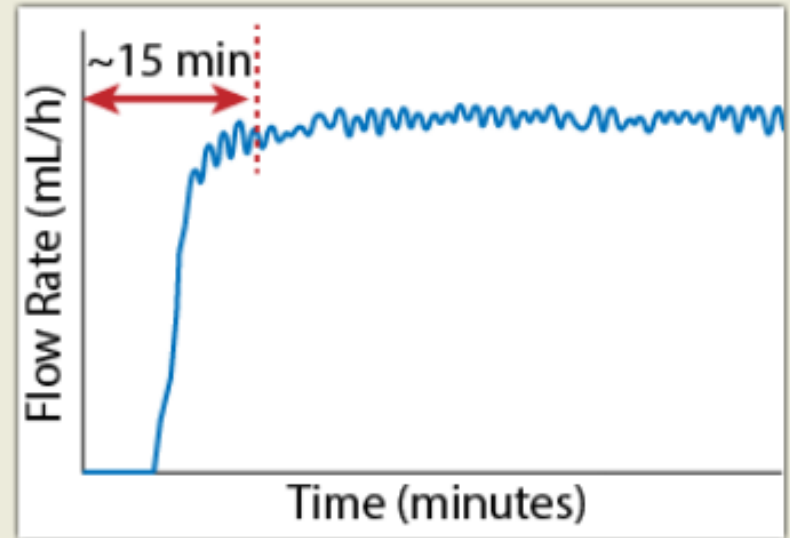




## Priming the pump



Priming on the Pump  
Performed



Priming on the Pump  
NOT Performed

## Using Data to review practices

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Drug Program	Conc	Conc Units	Profile	Category	Infusion Type	Weight/BSA	Dose	Rate (mL/hr)	Primed Amount (mL)
Propofol 10 mg/ml (BD 60ml)	10	mg/mL	Anesthesia	Quick Library	dose/kg/min	75 kg	75	33.8	0.088

## Scenario

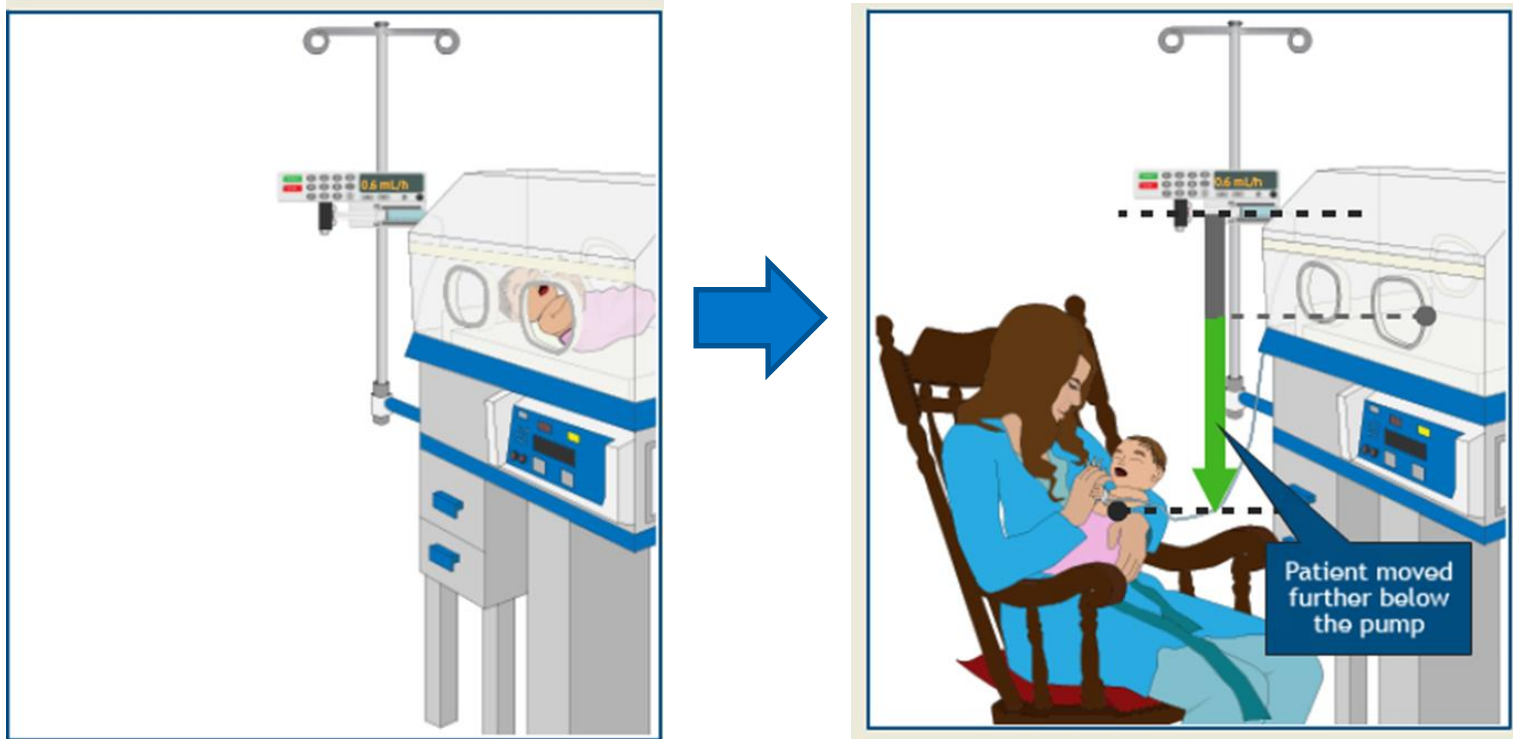
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PICU has safely received the patient. Upon shift change, the new nurse adjusts the pump set up such that the medications will be in alphabetical order from top to bottom on the IV pole, making it is easier for her to chart.

Is this an appropriate way to determine pump placement?

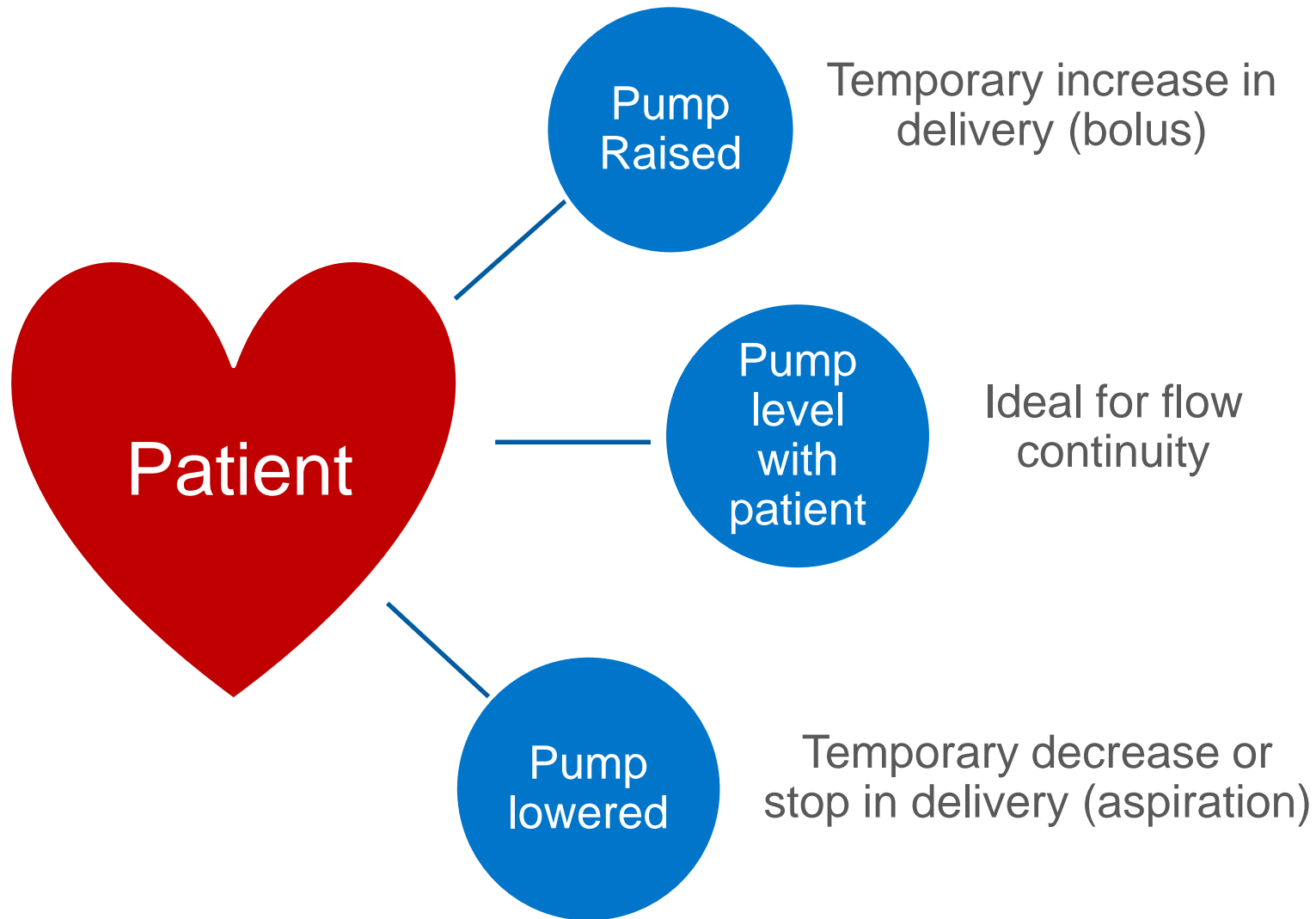
## Syringe Height and Location

- Best practice: pump level with distal end of catheter
- Vertical displacement
- Bed height adjustment
- Minimize changes to placement



## Vertical displacement activity

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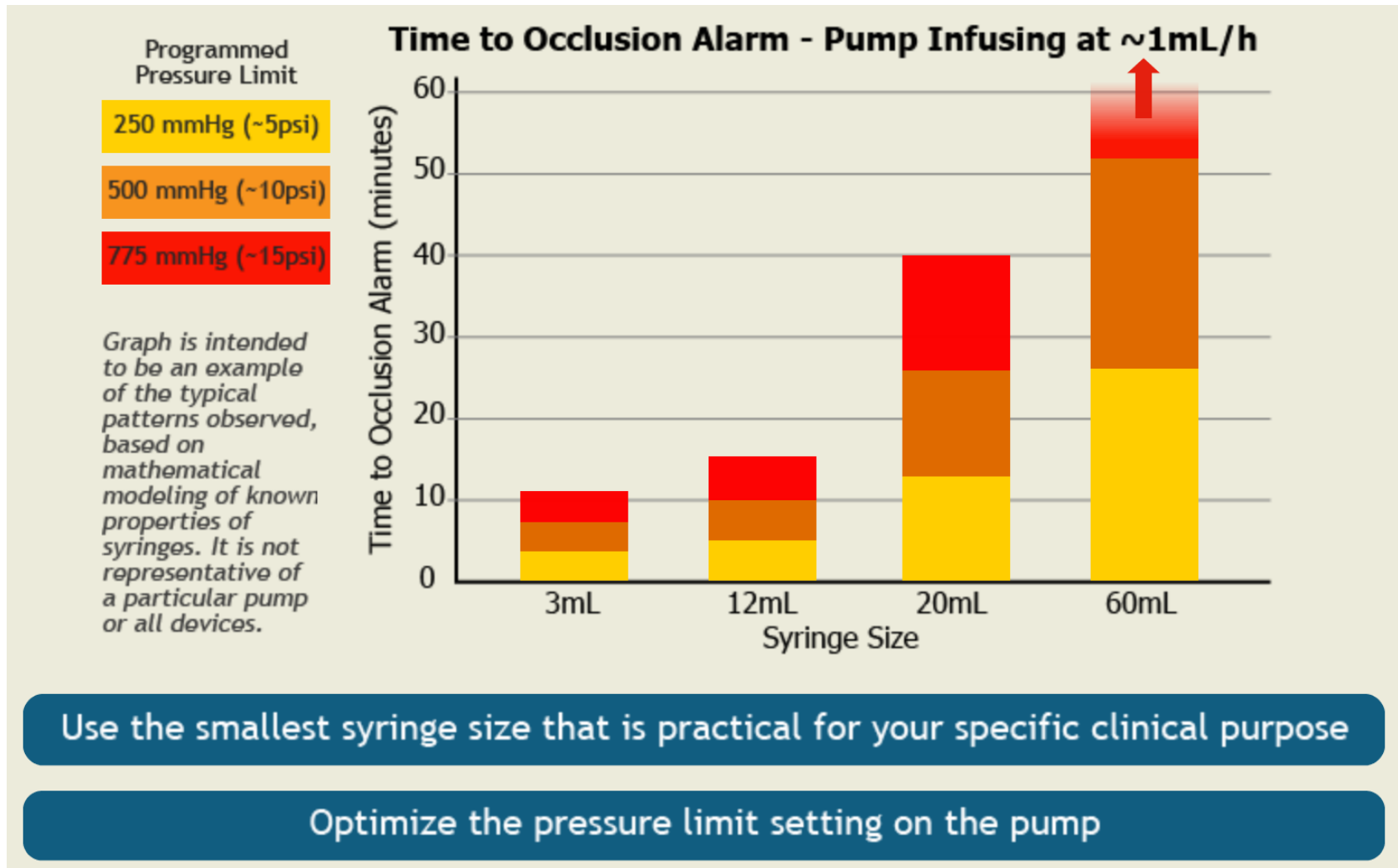
# Occlusions and flow continuity

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Goal is to decrease time to occlusion alarm

- Occlusion limit settings
- Syringe size selection
- Priming
- Decrease accessory device use

# Occlusion pressure setting



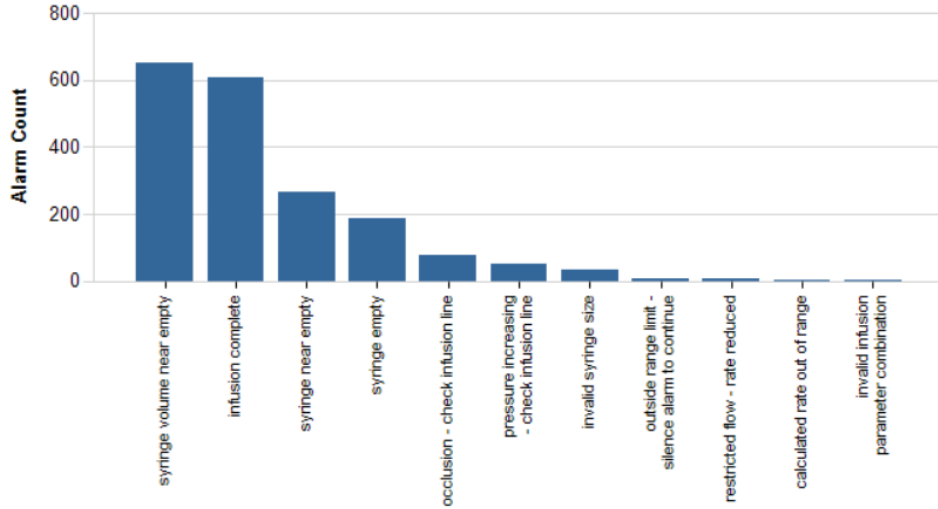
## Resolving occlusions

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- Stop/prevent flow to patient
  - Evaluate options and risk
- Reduce post occlusion bolus
  - Consider syringe size relative to bolus
  - Automatic bolus reduction



# Using Data to Review Practices



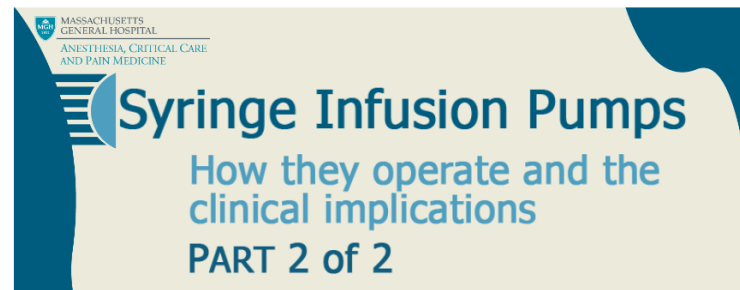
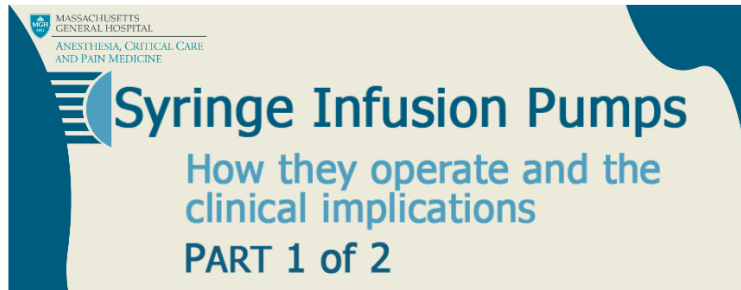
Alarm Type	Alarm Count
syringe volume near empty	650
infusion complete	606
syringe near empty	265
syringe empty	186
occlusion - check infusion line	79
pressure increasing - check infusion line	51
invalid syringe size	33
outside range limit - silence alarm to continue	9
restricted flow - rate reduced	5
calculated rate out of range	1
invalid infusion parameter combination	1
<b>Total</b>	<b>1,886</b>

Profile	Category	Drug Program	Conc	Conc Units	Infusion Type	Last Delivery Rate (mL/hr)	Syringe Model	Syringe Size	Date & Time Silenced	Time Interval Alarm Active (D HH:MM:SS)
Anesthesia	Anesthesia A-Z	propofol 10 mg/mL	10	mg/mL	dose/kg/min	22.5	B-D	60 mL	10:37:16	00:00:38
General Peds/Surgery	Gen Peds/Surg A-B	acyclovir 5 mg/mL	5	mg/mL	dose/kg/time	13	B-D	20 mL	16:03:08	00:00:20
General Peds/Surgery	Gen Peds/Surg C	ceFAZolin 100 mg/mL < 40 kg	100	mg/mL	dose/kg/time	7	B-D	5 mL	18:15:22	00:04:19

## Education and resources

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- FDA website lists several resources and articles
- FDA's Infusion Pump Reduction Strategies for Clinicians
  - <https://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/GeneralHospitalDevicesandSupplies/InfusionPumps/ucm202498.htm>
- Partners Healthcare Education Modules: [syringeinfusionsafety.org](http://syringeinfusionsafety.org)



- Syringe pump manual and education
- Publications
- Colleagues

## Summary

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- Understand syringe infusion pumps
- Know best practices for infusion safety and flow continuity
- Collaborate with internal team to develop policies and procedures
- Utilize vendor knowledge to form best practices

## Additional References

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1. Syringe Pump Problems with Fluid Flow Continuity at Low Infusion Rates Can Result in Serious Clinical Consequences: FDA Safety Communication (2016, August 25)  
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4. Syringe Infusion Pumps: How They Operate and the Clinical Implications (n.d.). Retrieved from January 11, 2017, from <http://www.syringeinfusionsafety.org>
5. Infusion Pump Risk Reduction Strategies for Pharmacists. (n.d.). Retrieved January 11, 2017, from <http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/GeneralHospitalDevicesandSupplies/InfusionPumps/ucm205407.htm>