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Clinical Meeting & Exhibition

(Management Case Study) Clinical Decision Support System Enhancements to Reduce Order Entry Errors for Pediatric Infusion Orders

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Disclosure

- The program chair and presenters for this continuing education activity have reported no relevant financial relationships.

Learning Objectives

- Identify types of medication errors associated with medication infusion orders.
- Describe the process for medication drip concentration auto-selection.
- Outline how automation processes improves patient safety.

Self-Assessment Questions

- Question 1

  Implementing clinical decision support in the medication order entry process will improve patient safety.

- Question 2

  Using patient's daily fluid maintenance as a guide to determine medication drip concentration can avoid potential fluid overload.

- Question 3

  Pharmacists are not equipped to provide input in system design.

NewYork-Presbyterian

- Ranked #1 New York metropolitan area and #6 nationally
- 2650 beds (2,515 certified beds and 135 bassinets), 6,900 affiliated physicians (residents/fellows and attending physicians)
  - Columbia University Medical Center
  - Weill Cornell Medical Center
  - The Komansky Center for Children's Health
  - The Allen Hospital
  - Morgan Stanley Children’s Hospital
  - Lower Manhattan Hospital
  - Westchester Division

Rationale/Challenges

Rationale for the project

- Intravenous medications account for more than 56% of total medication errors[1]

1. Am J Health Syst Pharm. 2003;60(10):1046-2487

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- Delivering continuous infusions in pediatric and neonatal patients is an error-prone process[2,3,4,5]

1. Am J Health Syst Pharm. 2003;60(10):1046-2487
2. Pediatrics. 2005 Jul;116(1):e21-5
3. Arch Pediatr Adolesc Med. 1996 Jul;150(7):748-52
4. BMJ. 1995 May 6;310(6988):1173-4
5. Crit Care. 2008;12(2):208

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  - Weight – based dosing

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Rationale for the project

- Intravenous medications account for more than 56% of total medication errors[1]
- Delivering continuous infusions in pediatric and neonatal patients is an error-prone process[2,3,4,5]
  - Weight – based dosing
  - Critically ill
  - Multiple infusions
  - High alert meds

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Rationale for the project

- Complex calculations
  - Weight based dose - per minute vs per hour

- Various units of measure
  - Milligram, microgram, gram – 1000X difference
  - microgram/kg/min vs microgram/min

- Higher risk of medication error

Other Challenges

- Potential errors during order entry
  - Wrong dose
  - Inappropriate infusion line
  - Inappropriate concentration
  - Conversion error between dosing and concentration units
  - Wrong infusion rate calculation
  - Misplacement of decimal points
  - Inappropriate infusion volume
  - Drug and diluent incompatibility

Other Challenges

- Fluid maintenance in critically ill patients
  - Weight gain first week of ICU stay[6,7]
  - Children with respiratory failure[7]
  - Worsening oxygenation in pediatric ICU patients[8,9]
  - Worse outcome and mortality for adults and children[10,11,12]

6. Crit Care Med. 2002 Oct;30(10):2175-82
7. Pediatr Crit Care Med. 2012 May;13(3):253-8
8. Crit Care Med. 2004 Aug;32(8):1771-6
9. Pediatrics. 2001 Jun;107(6):1309-12
10. Pediatr Nephrol. 2004 Dec;19(12):1394-9
11. Crit Care. 2008;12(3):R74
12. Blood Purif. 2010;29(4):331-8

Clinical Background

Maintenance Daily Fluids

Fluid that is needed to maintenance homeostasis and daily physiologic processes (urine, sweat, respiration, and stool)

Maintenance Fluids

- Calculation of Fluid Therapy:[17]
  - Body Weight Method
    - < 10kg = 100 mL/kg/day
    - 10-20 kg = 1000 mL + 50 mL/kg for each kg >10 kg
    - >20 kg = 1500 mL + 20 mL/kg for each kg > 20 kg
  - Hourly Rate Method
    - < 10 kg = 4 mL/kg/hour
    - 10-20 kg = 40 mL/hr + 2 mL/kg for each kg > 10 kg
    - > 20 kg = 60 mL/hr + 1 mL/kg for each kg > 20 kg
- Specific Requirements
  - VLBW neonates may need 180-220 ml/kg/day
  - neonates with congenital heart disease (PDA) may require fluid restriction to < 100 ml/kg/day

17. Holliday-Segar Method. Pediatrics 1957;19:823-832

Optimization of Concentrations

- Standardization of infusion concentrations[13,14,15,16]
  - Pediatric patients come in different sizes
  - One size (infusion concentration) does not fit all
  - Limit each infusion med to 2-3 different concentrations
  - Premixed infusion concentration
- Percentage of maintenance fluid each infusion occupies[13,14,15,16]
  - Fluid load management on patient with multiple medications
  - Standardized fluid restriction
  - 3-8% of daily maintenance fluid
- Standardization infusion diluent[13,15,16]
  - Compatibility and stability considerations
  - Separate nutrition with medication administration

13. Qual Saf Health Care 2004;13:265–271
14. Am J Health-Syst Pharm. 2010; 67:58-69
15. Hospital Pharmacy Volume 41, Number 11, pp 1102–1106
16. Hospital Pharmacy Volume 39, Number 5, pp 433–459

Peripheral vs. Central infusion

- Osmolarity is a limiting factor in the ability to infuse an IV peripherally.
  - A hyperosmotic infusion may destroy vascular cells by pulling water out of those cells in an attempt to regain isotonicity.
  - A solution with high osmolarity infused into a small peripheral vein may cause irritation and pain, with damage to the vessel, which may necessitate frequent changes in the IV site.

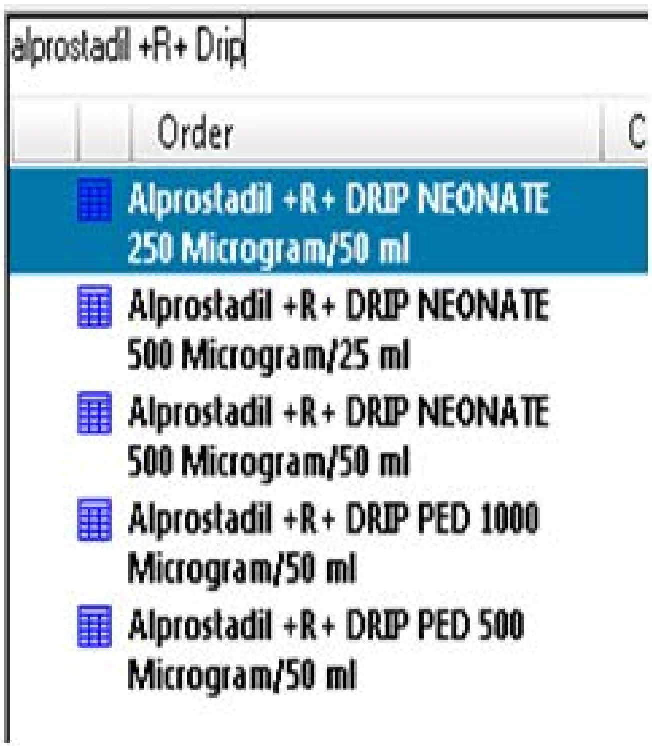
Automation designs

Define data

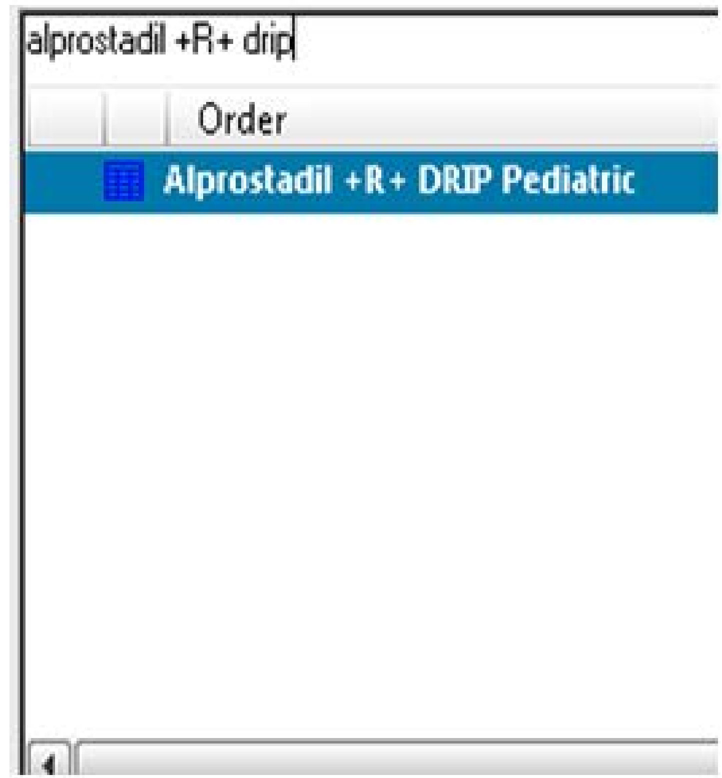
	A	B	C	D	E	F	G	H	I	J
1	**ordername**	**maxSoftDose**	**maxHardDose**	**minSoftDose**	**minHardDose**	**doseCalcType**	**conc**	**concuom**	**infuseLine**	**titrationType**
2	Alprostadil +R+ DRIP	NULL	0.4	0.01	NULL	microgram/kg/min	5	microgram/ml	P	Cardiac2
3	Alprostadil +R+ DRIP	NULL	0.4	0.01	NULL	microgram/kg/min	10	microgram/ml	P	Cardiac2
4	Alprostadil +R+ DRIP	NULL	0.4	0.01	NULL	microgram/kg/min	20	microgram/ml	P	Cardiac2
5	Aminocaproic Acid DRIP	NULL	35	25	NULL	mg/kg/hr	20	mg/ml	P	NULL
6	Aminophylline DRIP	1.5	NULL	0.5	NULL	mg/kg/hr	4	mg/ml	P	NULL
7	Aminophylline DRIP	1.5	NULL	0.5	NULL	mg/kg/hr	8	mg/ml	P	NULL
8	Amiodarone DRIP	0.9	NULL	0.1	NULL	mg/kg/hr	0.5	mg/ml	P	Cardiac2
9	Amiodarone DRIP	0.9	NULL	0.1	NULL	mg/kg/hr	2	mg/ml	P	Cardiac2
10	Amiodarone DRIP	0.9	NULL	0.1	NULL	mg/kg/hr	6	mg/ml	C	Cardiac2
11	Bumetanide DRIP	0.02	0.04	0.001	NULL	mg/kg/hr	0.1	mg/ml	P	NULL
12	Bumetanide DRIP	0.02	0.04	0.001	NULL	mg/kg/hr	0.25	mg/ml	P	NULL
13	Calcium Chloride Drip	30	55	5	NULL	mg/kg/hr	20	mg/ml	AC	NULL
14	Calcium Chloride Drip	30	55	5	NULL	mg/kg/hr	100	mg/ml	AC	NULL
15	Calcium Gluconate DRIP	25	90	2.5	NULL	mg/kg/hr	50	mg/ml	P	NULL
16	Calcium Gluconate DRIP	25	90	2.5	NULL	mg/kg/hr	100	mg/ml	C	NULL
17	Cisatracurium DRIP	5	NULL	0.5	NULL	microgram/kg/min	2	mg/ml	P	Cardiac
18	Dexmedetomidine Drip	1	3	0.2	NULL	microgram/kg/hr	4	microgram/ml	P	Sedation
19	DOBUTamine DRIP	25	40	1	NULL	microgram/kg/min	1	mg/ml	P	Cardiac
20	DOBUTamine DRIP	25	40	1	NULL	microgram/kg/min	4	mg/ml	C	Cardiac
21	DOBUTamine DRIP	25	40	1	NULL	microgram/kg/min	8	mg/ml	C	Cardiac
22	DOPamine DRIP	20	50	1	NULL	microgram/kg/min	400	microgram/ml	P	Cardiac
23	DOPamine DRIP	20	50	1	NULL	microgram/kg/min	800	microgram/ml	P	Cardiac
24	DOPamine DRIP	20	50	1	NULL	microgram/kg/min	3200	microgram/ml	C	Cardiac
25	EPINEPHrine DRIP	2	5	0.01	NULL	microgram/kg/min	10	microgram/ml	AC	Cardiac
26	EPINEPHrine DRIP	2	5	0.01	NULL	microgram/kg/min	20	microgram/ml	AC	Cardiac
27	EPINEPHrine DRIP	2	5	0.01	NULL	microgram/kg/min	120	microgram/ml	AC	Cardiac
28	fentaNYL DRIP	10	NULL	0.5	NULL	microgram/kg/hr	10	microgram/ml	P	Sedation
29	fentaNYL DRIP	10	NULL	0.5	NULL	microgram/kg/hr	20	microgram/ml	P	Sedation
30	fentaNYL DRIP	10	NULL	0.5	NULL	microgram/kg/hr	50	microgram/ml	P	Sedation
31	Furosemide DRIP	0.4	1.1	0.05	NULL	mg/kg/hr	0.5	mg/ml	P	NULL
32	Furosemide DRIP	0.4	1.1	0.05	NULL	mg/kg/hr	2.5	mg/ml	P	NULL
33	Furosemide DRIP	0.4	1.1	0.05	NULL	mg/kg/hr	10	mg/ml	P	NULL

Simplify order selection

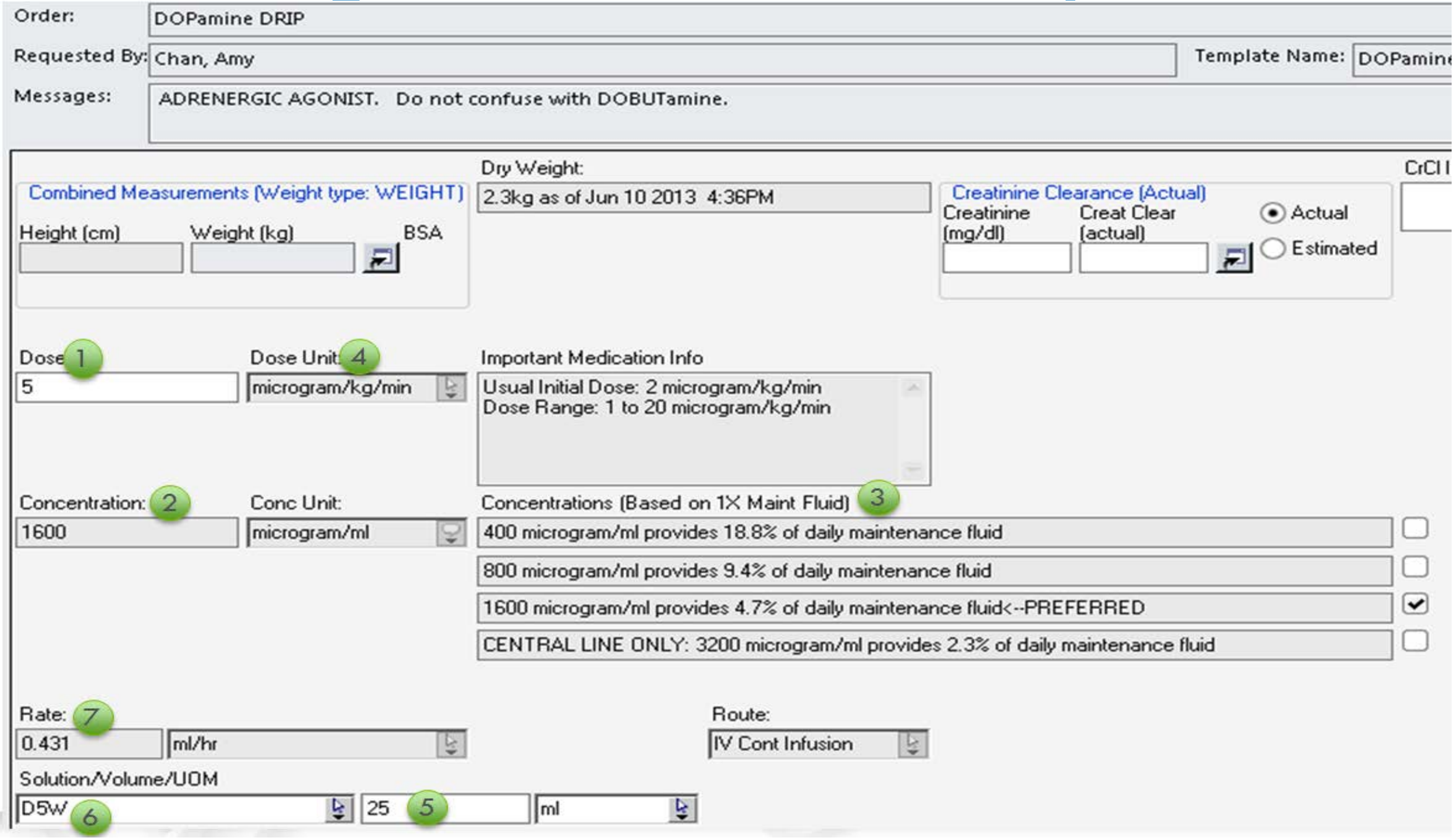
Before



New ordering process



Design the front – order entry form



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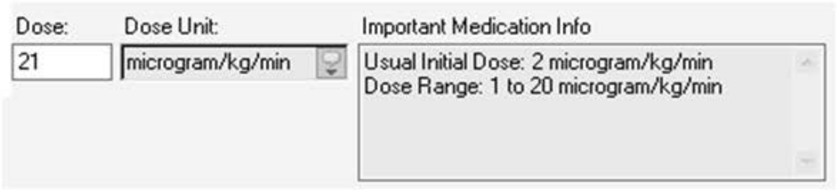
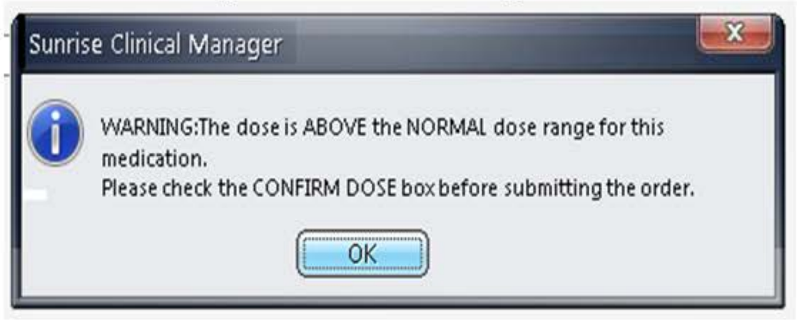
Dose alerts



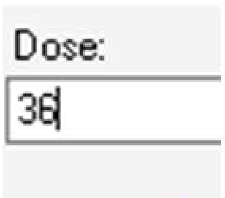
Hard stop –
Out of range, unconfirmed dose

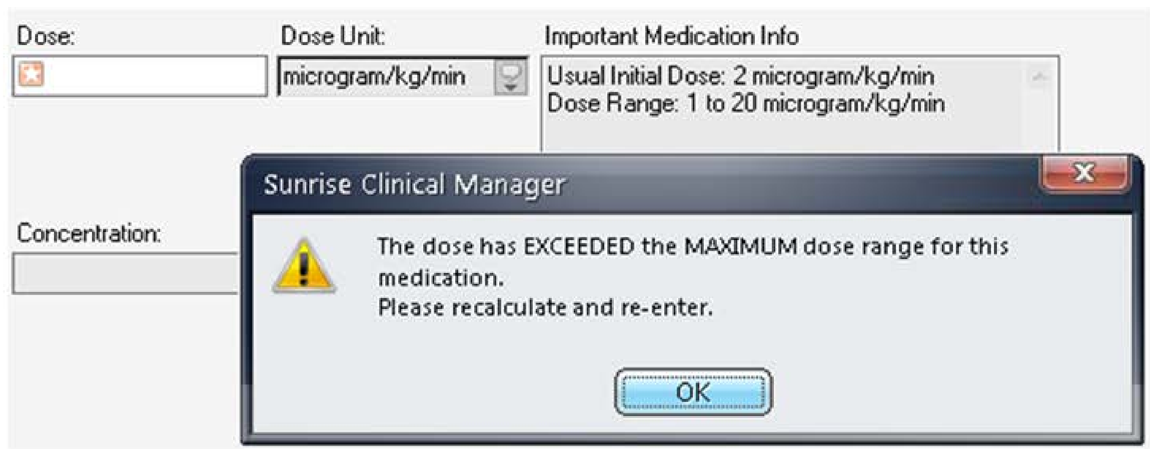
Soft stop – Out of range dose



1 Dose alerts

- Hard stop – when applicable





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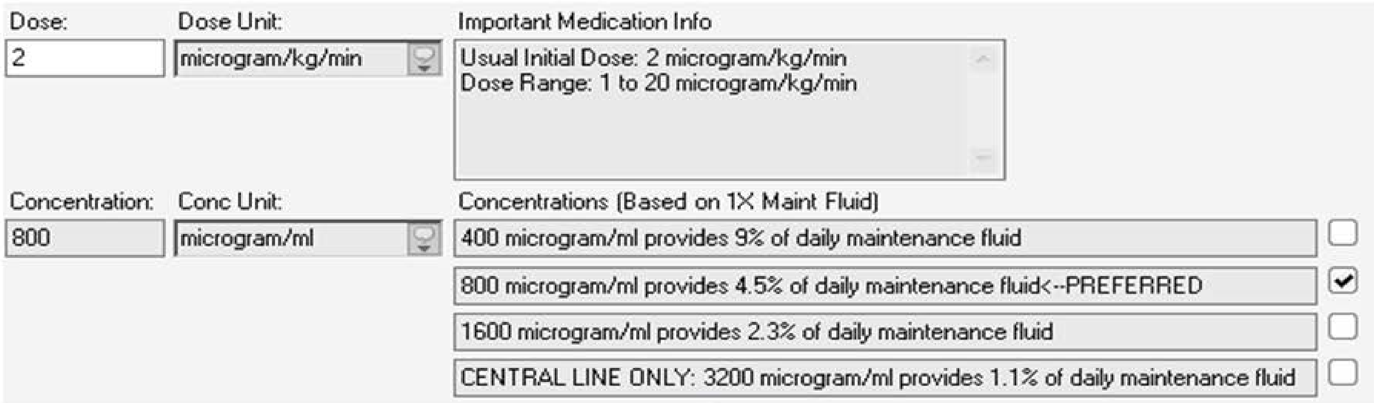
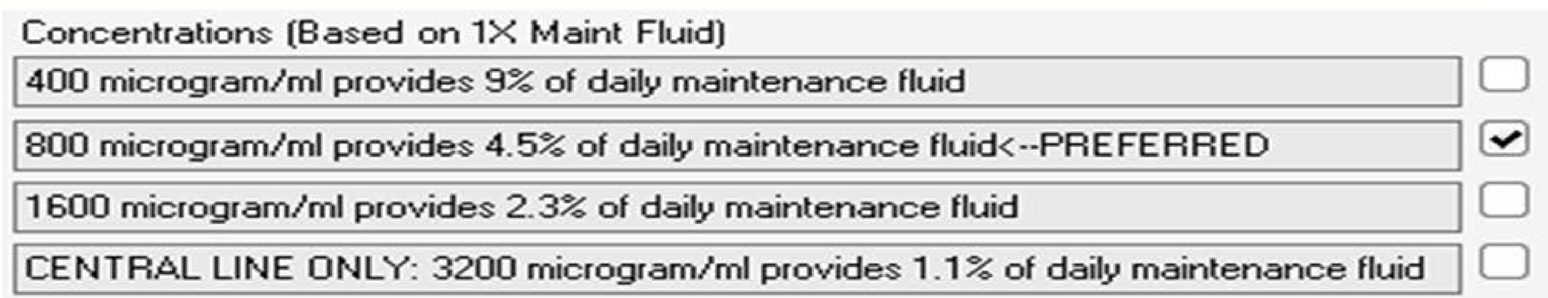
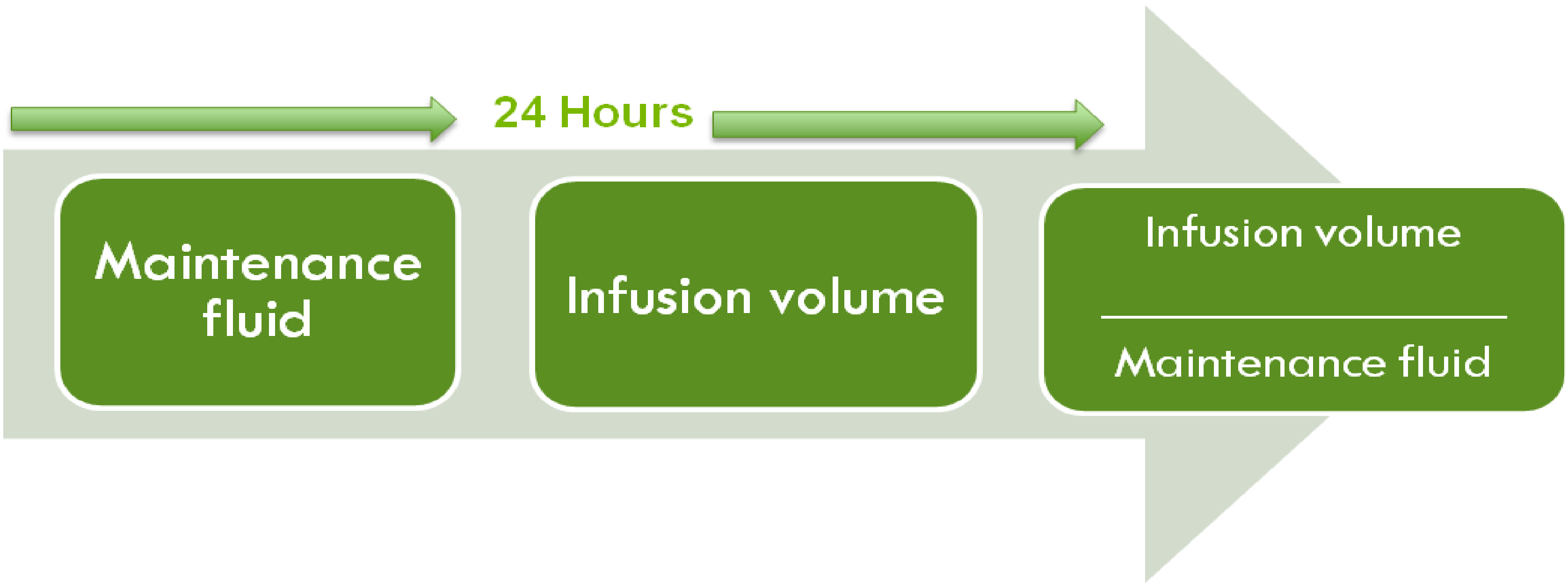
Concentration Selection





2 Concentration Selection

- 24 hour maintenance fluid
- 3-8% of the maintenance fluid load



Concentration Selection – Titration

Discontinue and re-order

Previous concentration

24 hours

Recalculate concentration

② Concentration Selection – Use preferred

Concentrations (Based on 1X Maint Fluid)

- [ ] 400 microgram/ml provides 11.2% of daily maintenance fluid
- [x] 800 microgram/ml provides 5.6% of daily maintenance fluid<--PREFERRED
- [ ] CENTRAL LINE ONLY: 3200 microgram/ml provides 1.4% of daily maintenance fluid

↓

Concentrations (Based on 1X Maint Fluid)

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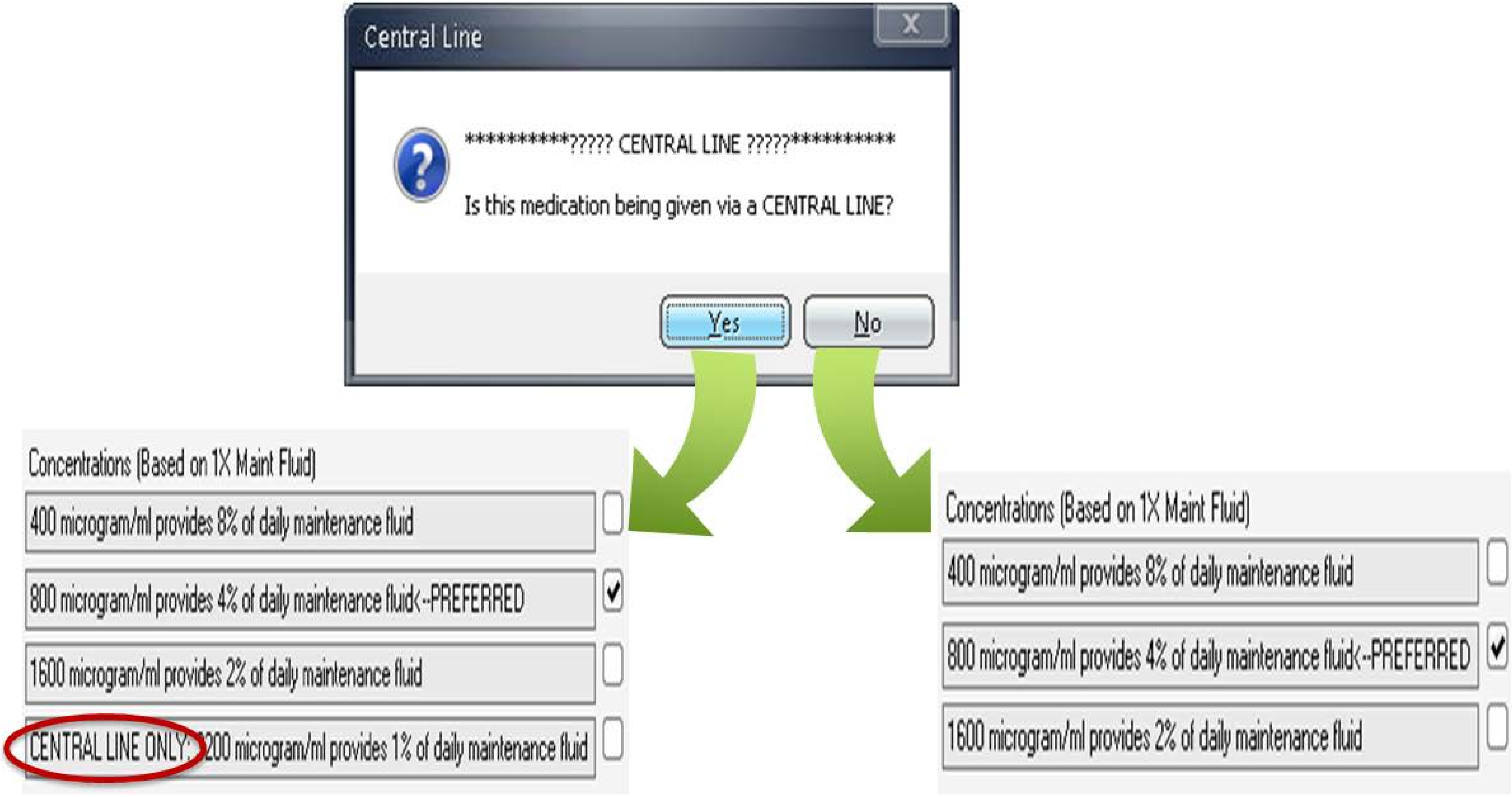
- [ ] 800 microgram/ml provides 5.6% of daily maintenance fluid
- [x] CENTRAL LINE ONLY: 3200 microgram/ml provides 1.4% of daily maintenance fluid

③ Infusion Line



4 UOM Conversion

Dose: 5

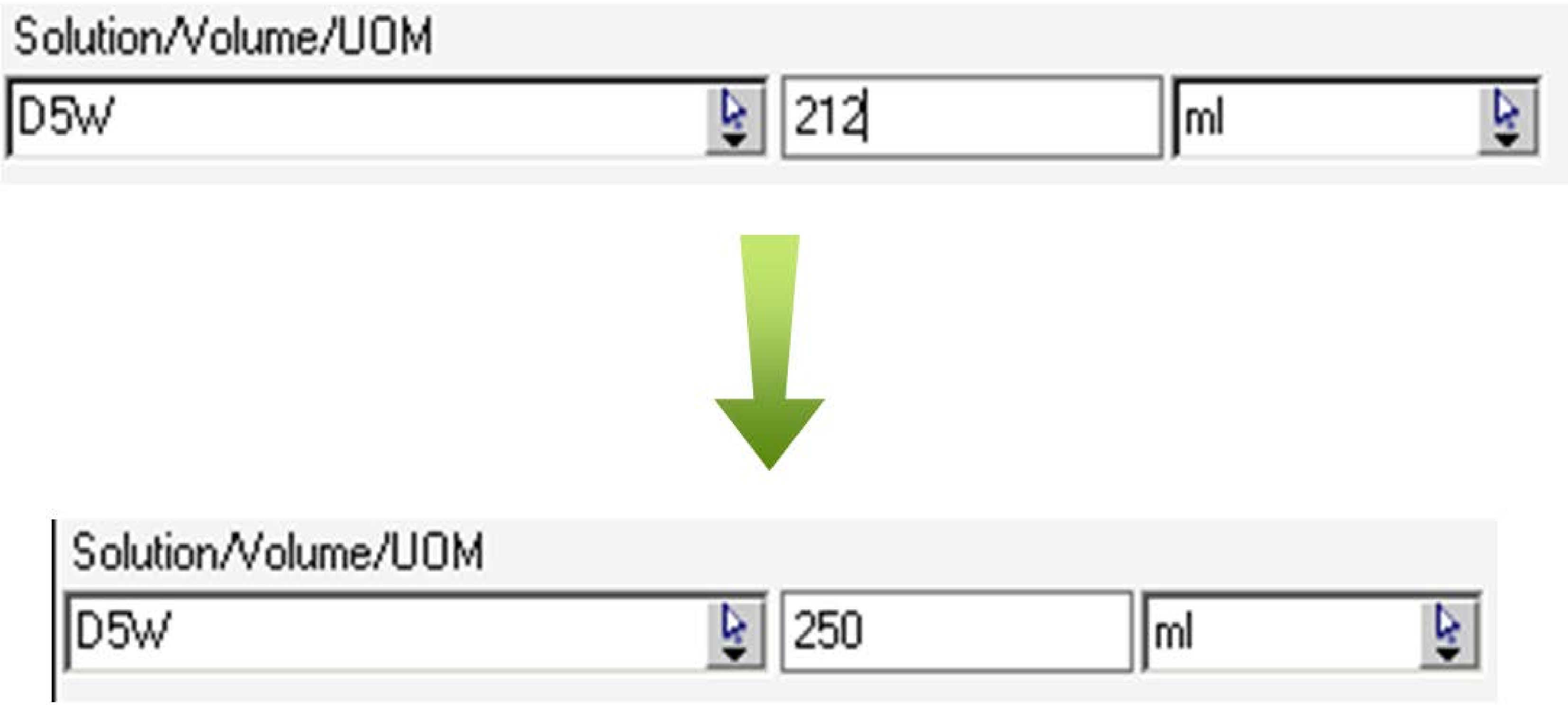
Dose Unit: microgram/kg/min

↓

Concentration: 4

Conc Unit: mg/ml

5 Infusion Volume



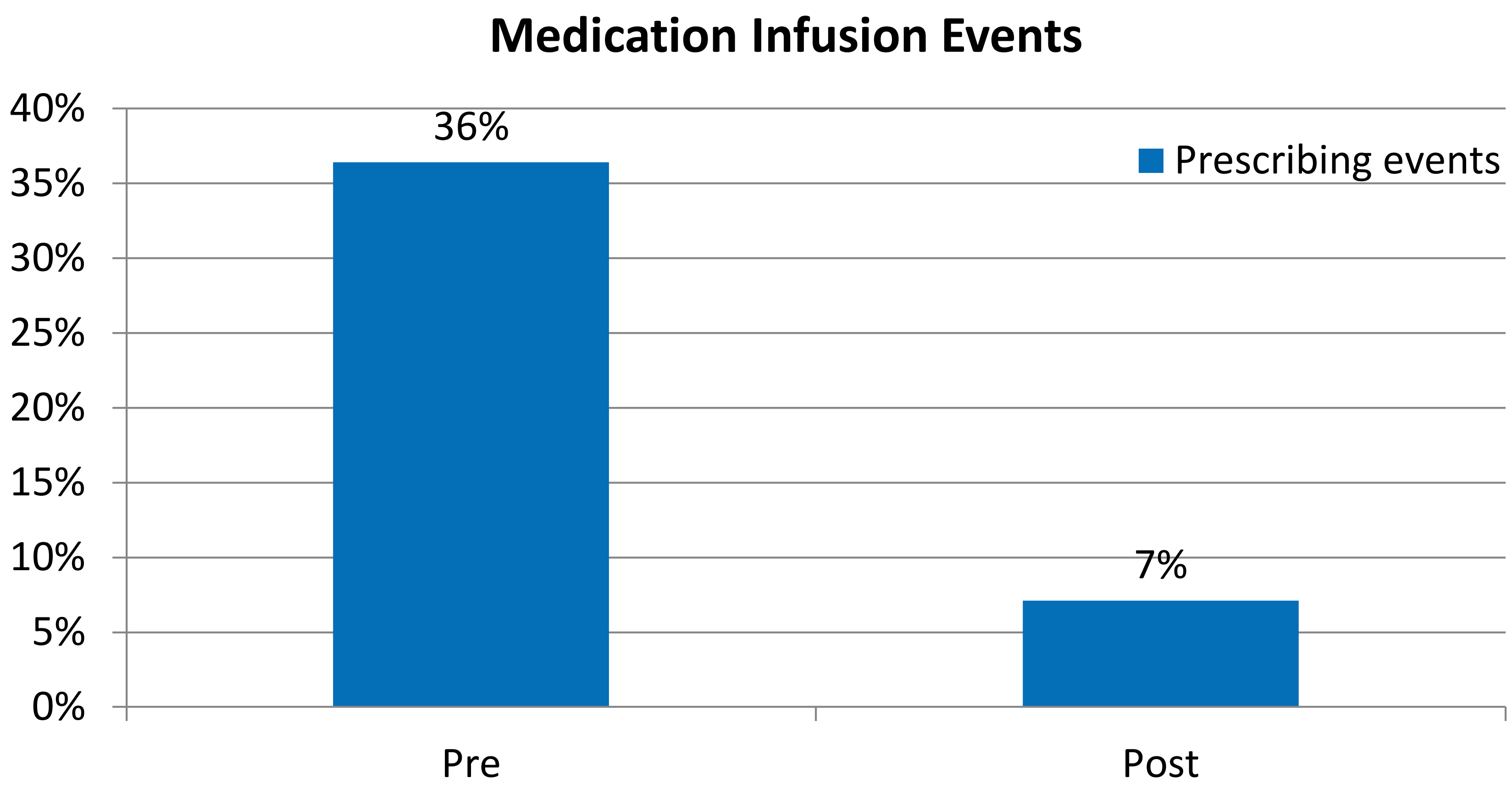
5 Diluent

- Default diluent
- Alternative compatible diluent choices
- Alerts when change to a diluent that is not available for the concentration selected

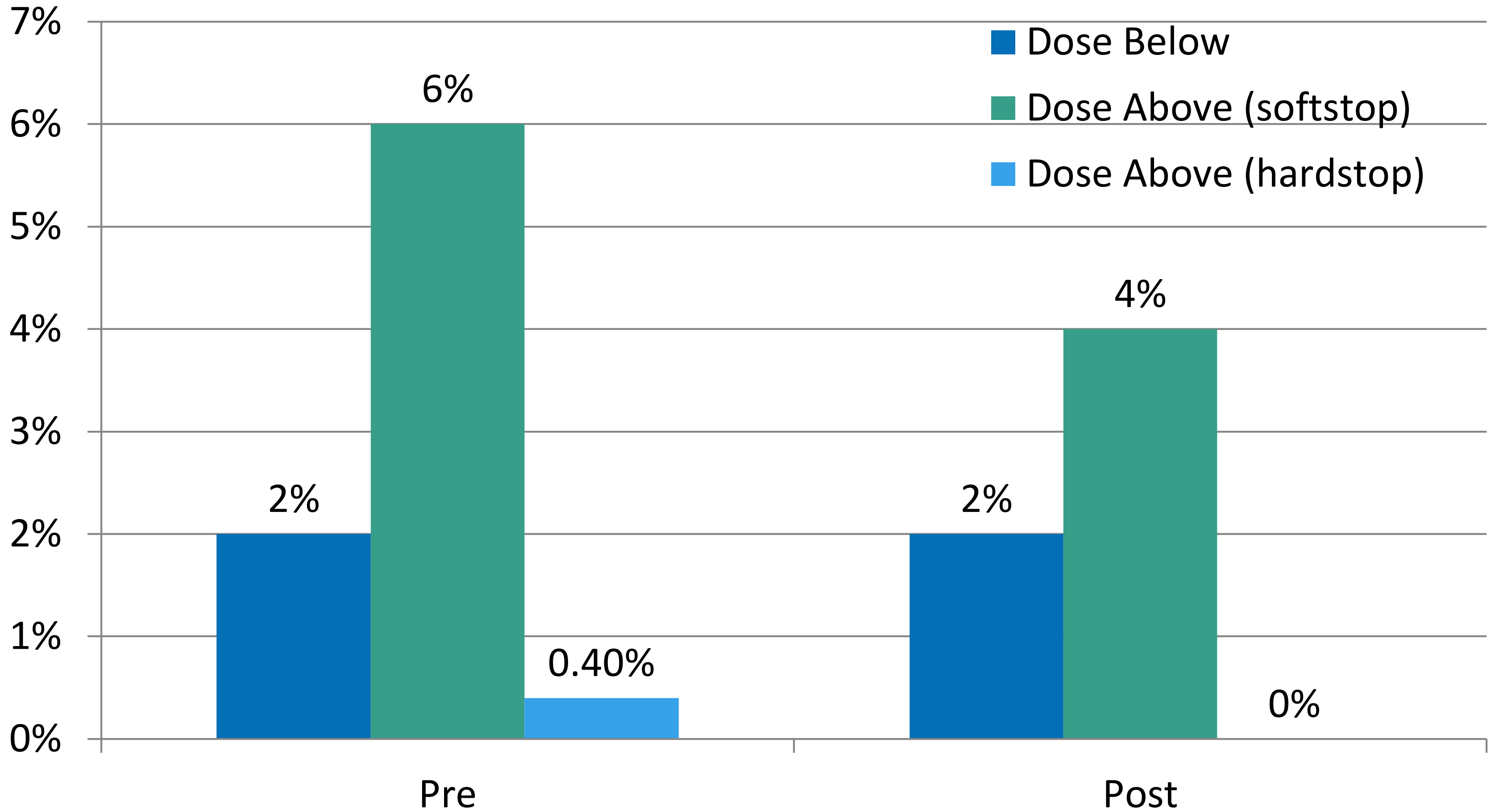
Data Analysis and Results

Events reported

Voluntary Reporting System



Dosage Data



*** Hard stop alert prevented 30 significant prescribing events over 12 months*

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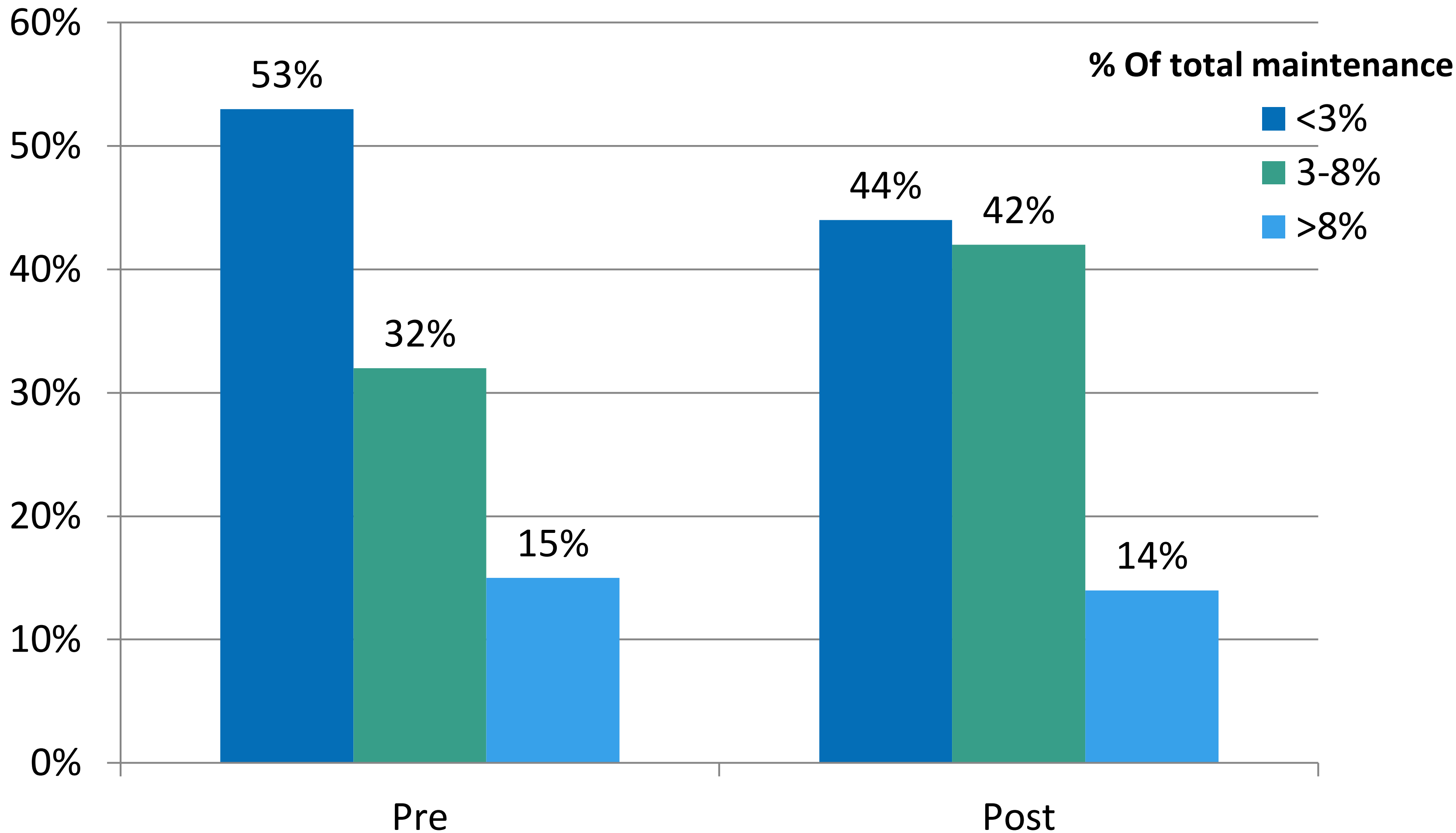
Concentrations



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Departments

Nursing / Medical staff / Pharmacy / EMT / BioMed / Service Desk

Equipment Center / IT

Self-Assessment Question 1

- Implementing clinical decision support in medication order entry process will improve patient safety.

Answer: True

Self-Assessment Question 2

- Using patient's daily fluid maintenance as a guide to determine medication drip concentration can avoid potential fluid overload to a patient.

Answer: True

Self-Assessment Question 3

- Pharmacists are not equip to provide input in system design.

Answer: False

Key Takeaways

- Key Takeaway #1
  - Review and limit existing infusion concentration to 2-3 concentrations
- Key Takeaway #2
  - Systemic approach to identify and involve all impacted departments at the start of the project
- Key Takeaway #3
  - Design logic to record alerts and user decisions that can be used for post deployment analysis and enhancements

References

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5. BMJ. 1995 May 6;310(6988):1173-4.Clinical review: medication errors in critical care. Crit Care. 2008;12(2):208.
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