

1.09 - Strategies for Canadian Hospitals to Facilitate Intravenous Drug Administration in the Event of an Intravenous Pump Shortage During the COVID-19 Pandemic - V1

March 2020

Intravenous (IV) pump shortages are a real possibility during the COVID-19 pandemic and would represent significant challenges when delivering care to critically ill patients as these are used routinely to administer medications, fluids and blood products. Centers in the US are already experiencing the effects of IV pump shortages and it is anticipated that Canadian Hospitals could also be affected. The following are mitigation strategies that could be considered in the event of a pump shortage.

The proposed strategies are suggestions for consideration and may not always represent best practice under ideal conditions. Local implementation will require consultation from users (i.e., front line staff, pharmacy, administrators) where risks, benefits and logistics are considered. Proposed strategies may not be appropriate for all institutions.

Proposed strategies focus on 1) General considerations; 2) Medications typically administered via pump that could be administered as an IV push instead; and 3) Administering IV medication using drip rates and drip charts instead of programable IV pumps.

Table 1- General Considerations to Minimize Pump Usage

Strategy	Examples
<p>Avoid IV Infusions</p> <ul style="list-style-type: none"> - Intermittent IV dosing instead - Enteral dosing where possible 	<ul style="list-style-type: none"> • Intermittent bolus dosing of furosemide (IV or enteral) instead of furosemide infusions • Intermittent dosing of beta-lactam antibiotics instead of continuous infusions • Cycling TPN overnight free up the pump during the day • Pantoprazole twice daily dosing instead of continuous infusions
<p>Alternative Routes for Medications</p>	<ul style="list-style-type: none"> • Opioid analgesics could be administered enterally or SC rather than infusions • Fentanyl patches instead of fentanyl / opioids infusions • Once or twice daily LMWH rather than heparin infusions for DVT/PE treatment • Switch insulin infusions to sub-cutaneous long acting insulin (i.e., NPH, Lantus) • Nitroglycerin patches (or oral isosorbide dinitrate) instead of infusions • Replace electrolytes enterally when appropriate as opposed to IV and only when clinically indicated • Daily consultation with dietitian for patients on TPN to consider appropriateness of switching to enteral feeds

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Preferentially use Enteral Route	<ul style="list-style-type: none"> Antimicrobials like ciprofloxacin, fluconazole have good bioavailability when administered enterally Early step down to enteral antimicrobial therapy when appropriate Furosemide can be as effective enterally as IV (enteral dose is double the IV dose) Digoxin loading and maintenance dosing can be done enterally instead of IV
Reduce Frequency of IV dosing when appropriate	<ul style="list-style-type: none"> Once daily ceftriaxone instead of four times daily cefotaxime Higher doses of antimicrobials less frequently (i.e., meropenem 1g q8h instead of 500mg q6h)

Table 2- Medications in Mini-bags via IV pumps that Could be Given IV push or IM instead

Drug Class	Drug	IV push	Intramuscular injections
Antimicrobials	Ampicillin	Concentration should not exceed 100mg/mL. Administer at a max rate of 100mg/min.	Yes
	Cefazolin	Administer over 2-3 minutes	Yes
	Cefotaxime	Administer over 2-3 minutes	Yes
	Ceftazidime	Administer over 2-3 minutes	Yes
	Ceftriaxone	Administer over 2-3 minutes	Yes
	Cefuroxime	Administer over 2-3 minutes	Yes
	Clindamycin	No	Yes
	Cloxacillin	Administer over 2-4 minutes	Yes
	Daptomycin	Administer over 2 minutes	No
	Ertapenem	No	Yes
	Gentamicin	No	Yes
	Meropenem	Administer over 5 minutes	No
Penicillin G	No	Yes	
Tobramycin	No	Yes	
Vasopressors	Epinephrine	No	Yes (IM & SC for hypersensitivity reactions)

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	Phenylephrine	Max concentration of 100mcg/mL, administer over 20-30 seconds	Yes (IM and SC)
Opioid Analgesics	Fentanyl	Administer undiluted or dilute in 10mL with NS or D5W. Give slowly over 1-5 minutes	Yes (IM, SC)
	Hydromorphone	Administer undiluted or dilute in 10mL with NS or D5W. Give over at least 2-3 minutes	Yes (IM, SC)
	Meperidine	Administer undiluted or dilute in 10mL with NS or D5W. Give over 4-5 minutes	Yes (IM, SC)
	Morphine	Administer undiluted or dilute in 10mL with NS or D5W. Inject at rate of 3mg/min	Yes (IM, SC)
	Nalbuphine	Administer undiluted or dilute in 10mL with NS or D5W. Inject each 10mg over 3-5 minutes	Yes (IM, SC)
Sedatives	Diazepam	Up to 10mg/dose. Administer at a rate of 5mg/min in adults and over a 3 minute period for children (do not exceed 0.25 mg/kg over 3 minutes) -Administer directly into large vein	Yes
	Etomidate	Propylene glycol formulation: inject as bolus over 30-60 seconds in large vein. Lipid emulsion formulation: Inject as bolus over 30 seconds in large vein	No
	Lorazepam	Dilute dose in syringe with equal volume of compatible solution. Do not exceed 2mg/min	Yes (IM and SC)

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	Midazolam	Rapid IV direct: 1mg/mL solution, inject over 20-30 seconds IV direct: 1mg/mL solution, inject over 2-3 minutes	Yes (IM and SC)
	Propofol	Yes	No
Antihypertensives	Enalapril	Inject slowly over at least 5 minutes	No
	Hydralazine	Inject over 1 minute in adults and over 3-5 minutes in children	Yes
	Labetalol	Inject at rate not exceeding 20mg over 2 minutes	No
Anticonvulsants	Phenobarbital	Inject slowly over 1 minute, not to exceed 60mg/min in adults. Do not exceed 1mg/kg/min up to 30mg/min in children and infants -For status epilepticus can administer 50-100 mg/min	Yes (IM and SC)
	Phenytoin	Rate should not exceed 50mg/min in adults, 25 mg/min in the elderly or those with CV disease, 1-3mg/kg/min in infants and children, and 0.5-3.0 mg/kg/min in neonates	No
Diuretics	Acetazolamide	500mg over at least 1 minute	No
	Furosemide	Administer over 2 minutes. Max dose 100 mg.	Yes (IM and SC)
Antiemetics	Dimenhydrinate	If using the IM formulation (50 mg/mL), dilute each 50 mg (1 mL) with 10 mL of NS or D5W and administer slowly over 2 minutes. If using the IV formulation (10 mg/mL), may administer undiluted over 2 minutes.	Yes (IM and SC)

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	Metoclopramide	For doses of 10 mg or less. Administer undiluted over 1-2 minutes	Yes (IM and SC)
	Ondansetron	Only for 4mg dose or less. Administer undiluted or diluted to 10mL with NS over 2-5 minutes	Yes (IM and SC)
Antihistamines	Diphenhydramine	Administer undiluted or diluted in 10mL NS. Max rate of 25 mg/min	Yes
Acid Suppression Medications	Famotidine	Max rate of 10mg/min	No
	Pantoprazole	Inject over 2-5 minutes	No
	Ranitidine	Dilute each 50mg dose in 20mL and inject over at least 5 minutes. Concentration should not exceed 2.5 mg/mL	Yes (IM and SC)
Corticosteroids	Dexamethasone	Administer over 1 minute	Yes (IM and SC)
	Hydrocortisone	Administer undiluted over 30 seconds to several minutes	Yes. Administer in large muscle, not deltoid as may cause subcutaneous atrophy
	Methylprednisolone	For doses of 125mg or less, administer over at least 5 minutes	Yes
NSAID	Ketorolac	Undiluted over at least 15 seconds, preferably over 1-2 minutes	Yes (IM and SC)
Antipsychotics	Chlorpromazine	Dilute with NS to maximum concentration of 1mg/mL. Maximum rate of administration is 1mg/min for adults and 0.5 mg/min children	Yes (IM and SC)
	Haloperidol	BP monitoring for doses > 5mg. Administer no faster than 5mg/min	Yes (IM and SC)
	Methotrimeprazine	No	Yes (IM and SC)

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Antiarrhythmics	Adenosine	Administer undiluted over 1-2 seconds	No
	Amiodarone	Cardiac arrest only	No
	Diltiazem	Administer over 2 minutes	No
	Lidocaine	Yes	SC for pain management
	Procainamide	Dilute each 100mg with 5-10mL D5W. Usual rate is 20mg/min, up to maximum 50mg/min	Yes
	Verapamil	Inject over at least 2 minutes, 3 minutes in the elderly	No
Neuromuscular Blockers	Cis-atracurium	Administer undiluted over 5-10 seconds.	No
	Succinylcholine	Administer over 30 seconds.	No
	Rocuronium	Administer non-diluted or diluted in SWFI. Given as rapid injection over 5-15 seconds	No

NOTE: The purpose of this table is to identify drugs that may be administered IV direct/push IM or SC. Please refer to local IV drug administration guidelines or consult your pharmacist for preparation and monitoring instructions.

3. Infusing medications using drip rates and drip charts instead of programmable IV pumps

Prior to programmable IV pumps, IV medications were administered using drip charts that described drip rates that corresponded to different infusion rates. In the event that programmable IV pumps are not available it is conceivable that this method could be employed in Canadian ICUs. In fact, programmable pumps are likely to be sequestered in the ICU and thus it may be ward patients on IV medications for whom this strategy is employed.

In order to convert infusion rates from mL/hr to drops per minute you must know the **Drip Factor** for the specific IV tubing you are using. The drip factor is reported on the packaging of the IV tubing you are using and denotes the number of drops per mL which can vary depending on the diameter of your tubing. For example, the CLEARLINK System® from Baxter has a drip factor of 10 drops/mL for primary lines, y-site lines and filtered tubing.

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In order determine the drip rate for your patient you need to know:

- 1)the concentration of the drug you are administering
- 2)the dose you want to deliver in mL/hour or mL/min
- 3)the drip factor (in drops/mL) of the tubing you are using

The formula is:

$$Dose\ in\ \frac{mL}{hr} \times \frac{1hr}{60min} \times drip\ factor\ in\ \frac{drops}{mL} = \frac{drops}{min}$$

Example:

Norepinephrine (8mg/250mL) has a final concentration of 32 mcg/mL. If the dose prescribed is 10 mcg/min the infusion rate will be 18.75 ml/hr (10 mcg/min x 60 min/hr ÷ 32 mcg/mL). Assuming our drip factor is 10 drops/mL we can use the formula above as follows

$$18.75\ \frac{mL}{hr} \times \frac{1hr}{60min} \times 10\ \frac{drops}{mL} = 3.1\ \frac{drops}{min}$$

The nurse would then adjust both the height of the bag and the drip valve to count the number of drop per minute.

Tables like the following are available as are drug specific drip rate infusion charts.

		Drops per min (gtts/min)																												
Tubing Drip Factor (drops/mL)	60 drops/mL	0	2	2.5	5	7.5	10	13	15	18	20	22.5	25	30	35	40	45	50	60	75	100	125	150	200	250	300	400	500	750	1000
	20 drops/mL	0.3	0.7	0.8	1.7	2.5	3.3	4.2	5	5.8	6.7	7.5	8.3	10	12	13	15	17	20	25	33	42	50	67	83	100	133	167	250	333
	15 drops/mL	0.3	0.5	0.6	1.3	1.9	2.5	3.1	3.8	4.4	5	5.6	6.3	7.5	8.8	10	11	13	15	19	25	31	38	50	63	75	100	125	188	250
	10 drops/mL	0.2	0.3	0.4	0.8	1.3	1.7	2.1	2.5	2.9	3.3	3.8	4.2	5	5.8	6.7	7.5	8.3	10	13	17	21	25	33	42	50	66.7	83	125	167
mL/hr -->		1	2	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25	30	35	40	45	50	60	75	100	125	150	200	250	300	400	500	750	1000

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