



Guidance for Addressing Product Shortages during Disruptions in Manufacturing

In response to the recent report on the operational disruption at Baxter's North Cove, NC facility due to Hurricane Helene, this guidance provides healthcare organizations with a structured approach for managing product shortages, particularly of diluents, parenteral nutrition (PN) products, and small and large volume parenteral solutions. This document outlines recommendations and considerations to help clinicians and healthcare professionals maintain patient care during these shortages.

The National Home Infusion Association (NHIA) is actively collaborating with regulatory agencies, suppliers, healthcare organizations, and clinicians to monitor the situation and provide updates. Our goal is to assist in addressing the shortage and ensure continuity of care through strategic resource management.

During a shortage period, the following measures may apply:

- Consider ways to conserve Dextrose 70% and Sterile Water for Injection (SWFI) for PN Compounding.
 - Work with clinical teams to identify which patients are in critical need of impacted IV solutions, such as pediatric patients or those entirely dependent on PN.
 - Consolidate PN compounding into fewer sessions or days and utilize remaining stock products at the end of the day to compound PN for the next day.
 - Use a combination of varying SWFI bag volumes (i.e. 1, 2, 3 liters) to minimize waste.
 - Compound PN in a single, central location to decrease inventory waste.
 - Consider a supply outreach to other facilities in your geographic location.
 - Consider multi-chamber bag formulations.
- Consider ways to conserve SWFI for reconstitution of compounded medications.
 - Batching the preparation of medications that require reconstitution with SWFI and scheduling compounding activities to minimize waste of SWFI available in bags.
 - Withdraw reconstitution volume from the final infusion container (e.g. mini-bag) used for compounding the dose when diluent is also appropriate for reconstitution.
 - Identify medications suitable for reconstitution with an alternative to SWFI (e.g.

NS, D5W, LR). See Table 1: Reconstitution Alternatives for Infusion Medications

- Consider changes in the electronic health record (EHR) to allow multiple options for compatible diluents and create better flexibility based on available products.
- Use EHR alerts or forced functions when a drug is compatible with only one diluent.
- Consider ways to conserve NS Small Volume Parenteral Bags:
 - Identify medications that are stable and compatible with alternative diluents (e.g., D5W, D5NS, LR) and prioritize their use.
 - Identify medications suitable for IV Push Administration or other option for medication delivery.
 - Medication lists for IV push administration are available online and may be used to develop internal lists specific to a pharmacy's inventory.
 - [Adult and pediatric IV push medication reference](#): Vizient, Inc. 2023
 - [ISMP Safe Practice Guidelines for Adult IV Push Medications](#): ISMP, 2015
 - [Intravenous Push Administration of Antibiotics](#): Hosp. Pharm, 2018.
 - Consider using NS flush syringes when possible, for medication protocols that use NS SVPs to flush vascular access devices after a complex IV administration (e.g. biologic, chemotherapy).”
- Consideration for compounding from large volume bags of SWFI or NS and repackaging into smaller sterile vials, syringes, or containers.
 - Consult stability references for storage conditions (e.g. container, temperature) and USP <797> for assigning beyond use dates for repackaged solutions.
- Changes to compounding procedures or workflows as a result of shortages increase the risk of errors. Report medication errors related to shortages to the Institute for Safe Medication Practices (ISMP) for broader learning and to help mitigate risks.
- Changes to procedures and workflows increase risk of additional drug shortages as supply of larger containers are used to compound smaller volumes.

Resources/Links:

American Society of Health-System Pharmacists (ASHP). Drug Shortage Resource Center. <https://www.ashp.org/drug-shortages/shortage-resources/publications/fluid-shortages-suggestions-for-management-and-conservation>

Table 1: Reconstitution Alternatives for Infusion Medications

Medication	Reconstitution Alternatives ^a	Special Considerations	Reference
Acyclovir	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports Acyclovir reconstituted with NS.	1, 2
Alglucosidase Alfa (LUMIZYME®)	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced manufacturer letter supports Alglucosidase alfa reconstituted with NS if SWFI is unavailable.	3
Ampicillin Sodium/Sulbactam Sodium	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	4, 5
Caspofungin Acetate	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	6
ceFAZolin Sodium	SWFI, NS	Cefazolin reconstitution information from the PI varies by vial size and concentration. The 10 gm bulk vial may be reconstituted with both SWFI and NS at concentrations of 100-200 mg/mL (PI Sagent 2018) The smaller vials and reconstitution of higher concentrations (225-330 mg/mL) SWFI is recommended to minimize risk of crystallization. Referenced study supports 1 gm vials reconstituted with NS.	7, 8, 9
Cefepime HCL	SWFI, NS, D5W	Manufacturer PI supports SWFI, NS, or D5W for reconstitution	10
Cefotaxime	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports Cefotaxime reconstituted with NS.	11
cefOXitin Sodium	SWFI, NS, D5W	Manufacturer PI supports SWFI, NS, or D5W for reconstitution	12, 13
Ceftaroline Fosamil	SWFI, NS, D5W, LR	Manufacturer PI supports SWFI, NS, D5W, or LR for reconstitution	14
cefTAZidime	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports Ceftazidime reconstituted with NS.	15
cefTAZidime/Avibactam Sodium	SWFI, NS, D5W, LR	Manufacturer PI supports SWFI, NS, D5W, or LR for reconstitution	16
Ceftolozane/Tazobactam Sodium	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	17
cefTRIAxone Sodium	SWFI, NS, D5W	Manufacturer PI supports SWFI, NS, or D5W for reconstitution	18
Cefuroxime	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports Cefuroxime reconstituted with NS.	19
DAPTOmycin (original formulation)	NS, SWFI	Manufacturer PI recommends reconstitution in NS. Referenced manufacturer letter supports DAPTOmycin reconstituted with SWFI.	20
Doxycycline Hyclate	SWFI, NS, D5W, LR	Manufacturer PI supports SWFI, NS, D5W, or LR for reconstitution	21
Ertapenem Sodium	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	22
Imipenem/Cilastatin Sodium	NS, D5W, D5NS	Manufacturer PI supports NS, D5W, or D5NS for reconstitution	23
InFLIXimab (Remicade®)	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced manufacturer letter supports InFLIXimab reconstituted with NS if SWFI is unavailable.	24
Meropenem	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports meropenem reconstituted with NS.	15
MethylPREDNIsolone sodium succinate	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports reconstitution with NS.	25
Micafungin Sodium	NS, D5W	Manufacturer PI supports both NS or D5W for reconstitution	26
Nafcillin Sodium	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	27
Oxacillin Sodium	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	28
Penicillin G Potassium	SWFI, NS	Manufacturer PI supports both SWFI or NS for reconstitution	29
Penicillin G Sodium	SWFI, NS, D5W	Manufacturer PI supports SWFI, NS, or D5W for reconstitution	30
Pentamidine Isethionate	SWFI, D5W	Manufacturer PI supports both SWFI or D5W for reconstitution	31
Piperacillin Sodium/Tazobactam Sodium	SWFI, NS, D5W	Manufacturer PI supports SWFI, NS, or D5W for reconstitution	32
Remdesivir	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced manufacturer letter supports Remdesivir reconstituted with NS if SWFI is unavailable.	36, 37
Telavancin HCL	SWFI, NS, D5W	Manufacturer PI supports SWFI, NS, or D5W for reconstitution	33
Tigecycline	NS, D5W, LR	Manufacturer PI supports NS, D5W, or LR for reconstitution	34
Vancomycin	SWFI, NS	Manufacturer PI recommends reconstitution in SWFI. Referenced study supports reconstitution with NS.	35

^a Abbreviations: SWFI: Sterile Water for Injection, NS: Sodium Chloride 0.9%, D5W: Dextrose 5% in Water, D5NS: Dextrose 5% in Sodium Chloride 0.9%, LR: Lactated Ringers

Notes:

- Neither the FDA nor pharmaceutical manufacturers can make recommendations outside of product labeling. Primary literature or tertiary sources may have information about the suitability of alternatives to SW for injection.
- Normal saline reconstitution of medications for IV push administration may produce solutions at or near the solution's saturation point.
- Do not dilute or reconstitute IV push medications by drawing up the contents into a commercially available, prefilled flush syringe of 0.9% sodium chloride.³⁸

References:

1. Acyclovir Sodium [Package Insert]. Eatontown, NJ: Westward Pharmaceuticals; December 2018.
2. Ling J, Gupta VD. Stability of acyclovir sodium after reconstitution in 0.9% sodium chloride injection and storage in polypropylene syringes for pediatric use. *Int J Pharm Compd.* 2001;5(1):75-7. PubMed PMID: 23981803.
3. Lumizyme (Alglucosidase Alfa) [Personal Communication] MIS 1-1277662768. Gaithersburg, MD: Genzyme; August 2018.
4. Ampicillin Sodium and Sulbactam Sodium Injection Powder [Package Insert]. New York, NY: Pfizer Injectables; April 2018.
5. Ampicillin Sodium and Sulbactam Sodium Injection Powder [Package Insert]. Lake Forest, IL: Sandoz, Inc. March 2017.
6. Cancidas (caspofungin acetate) [Package Insert]. Whitehouse Station, NJ: Merck and Co, Inc; August 2021.
7. Cefazolin Sodium [Package Insert] 1 gm vial. Schaumburg, IL: Sagent Pharmaceuticals; December 2020.
8. Cefazolin Sodium [Package Insert] 10 gm Bulk Vial. Schaumburg, IL: Sagent Pharmaceuticals; September 2018.
9. Gupta VD. Chemical stability of cefazolin sodium after reconstituting in 0.9% sodium chloride injection and storage in polypropylene syringes for pediatric use. *Int J Pharm Compd.* 2003;7(2):152-4. PubMed PMID: 23979546.
10. Cefepime HCL [Package Insert]. Lake Forest, IL: Hospira Inc.; August 2021.
11. Gupta VD. Stability of cefotaxime sodium after reconstitution in 0.9% sodium chloride injection and storage in polypropylene syringes for pediatric use. *Int J Pharm Compd.* 2002;6(3):234-6. PubMed PMID: 23979191.
12. Cefoxitin [Package Insert] Bulk Vial. Schaumburg, IL: Sagent Pharmaceuticals; September 2018.
13. Cefoxitin [Package Insert] SDV. Schaumburg, IL: Sagent Pharmaceuticals; September 2018.
14. Teflaro (cetaroline fosamil) [Package Insert]. Madison, NJ: Allergan USA, Inc.; September 2021.
15. Gandhi RG, Steiger SN, Elshaboury RH, Lund JT. I.V. push administration of medications reconstituted with 0.9% sodium chloride injection. *Am J Health Syst Pharm.* 2018;75(12):851-2. doi: 10.2146/ajhp180132. PubMed PMID: 29880520.
16. Avycaz (ceftazidime avibactam) [Package Insert]. Madison, NJ: Allergan USA, Inc.; October 2019.
17. Zerbaxa (ceftolozane sodium tazobactam) [Package Insert]. Whitehouse Station, NJ: Merck & Co., Inc.; September 2020.
18. Ceftriaxone Sodium [Package Insert]. Weston, FL: Apotex Corp.; November 2019.
19. Gupta VD. Chemical stability of cefuroxime sodium after reconstitution in 0.9% sodium chloride injection and storage in polypropylene syringes for pediatric use. *Int J Pharm Compd.* 2003;7(4):310-2. PubMed PMID: 23979702.
20. Cubicin® (daptomycin) [Personal Communication] 008298. Lexington, MA. Cubist Pharmaceuticals. February 2015.
21. Doxycycline [Package Insert]. New York, NY: Pfizer Inc.; September 2013.
22. Ertapenem [Package Insert]. Weston, FL: Apotex Corp.; January 2019.
23. Imipenem Cilastatin [Package Insert]. Lake Forest, IL: Fresenius Kabi; August 2018.
24. Remicade® (infliximab) [Personal Communication] 02835133. Horsham, PA. Jansen Biotech. June 2021.
25. Gupta VD. Chemical stability of methylprednisolone sodium succinate after reconstitution in 0.9% sodium chloride injection and storage in polypropylene syringes. *Int J Pharm Compd.* 2001;5(2):148-50. PubMed PMID: 23981837.
26. Mycamine (micafungin sodium) [Package Insert]. Northbrook, IL: Astellas Pharma US, Inc.; July 2020.
27. Nafcillin Sodium [Package Insert]. Schaumburg, IL: Sagent Pharmaceuticals; September 2020.

28. Oxacillin Sodium [Package Insert]. Schaumburg, IL: Sagent Pharmaceuticals Inc; April 2020.
29. Penicillin G Potassium [Package Insert]. New York, NY: Pfizer Injectables; November 2019.
30. Penicillin G Sodium [Package Insert]. Toronto, ON: Fresenius Kabi; July 2016.
31. Pentamidine [Package Insert]. Schaumburg, IL: APP Pharmaceuticals LLC.; March 2008.
32. Piperacillin Tazobactam [Package Insert]. Philadelphia, PA: Pfizer Injectables, Inc.; May 2012.
33. Telavancin [Package Insert]. Nashville, TN: Cumberland Pharmaceuticals; July 2020.
34. Tygacil (tigecycline) [Package Insert]. Philadelphia, PA: Pfizer Injectables; June 2021.
35. Masse M, Genay S, Martin Mena A, Carta N, Lannoy D, Barthelemy C, et al. Evaluation of the stability of vancomycin solutions at concentrations used in clinical services. *Eur J Hosp Pharm.* 2020;27(e1):e87-e92. Epub 20200205. doi: 10.1136/ejhpharm-2019-002076. PubMed PMID: 32296513; PubMed Central PMCID: PMC7147549.
36. Velkury (remdesivir) [Package Insert]. Foster City, CA: Gilead Sciences, Inc. February 2021.
37. Velkury (remdesivir) [Manufacturer Letter]. Foster City, CA. Gilead Sciences, Inc; December 2021.
38. Safe Practice Guidelines for Adult IV Push Medications. Horsham, PA: Institute for Safe Medication Practices (ISMP); 2015.

DISCLAIMER: The National Home Infusion Association (NHIA) produces educational resources as an aid to good clinical practice that reflects the input of its members and experienced clinicians in the field. Information offered in NHIA resources is intended as a guide for information purposes only and does not replace or remove clinical judgment or the professional care and duty necessary for each specific situation. While great effort has been made to assure all information is complete and accurate as of the time this resource was issued, given the continuously evolving health care environment and the particular circumstances of individual cases, no assurance can be given that the information is entirely complete or accurate in every conceivable respect (and, as such, NHIA and its board members, committee/work group members, officers and employees disclaim all liability for the accuracy or completeness of this resource, and disclaim all warranties, express or implied to its incorrect use).