Infusate Consideration Companion

Does the infusate have irritant or vesicant potential?

BD

Introduction

Why build an Infusate Consideration Companion (ICC)?

There are multiple types of infusates that are administered every day into patients' veins. How much do you know about infusates and infusion complications? Thrombosis, thrombophlebitis, phlebitis, necrosis following extravasation of a vesicant drug, and pain during the infusion are known potential complications. When selecting a vascular access device, are you considering these complications? The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC)[1] requires clinicians to identify if a drug is a vesicant or irritant when determining if a central or peripheral device is appropriate for a patient.

An irritant according to the INS Standards of Practice (Infusion Nurses Society, 2021) is an agent capable of producing discomfort (e.g., burning, stinging) or pain as a result of irritation to the internal lumen of the vein with or without immediate external signs of vein inflammation[2]. A vesicant is an agent capable of causing tissue damage and necrosis (or tissue death) when it escapes from the intended vascular pathway into surrounding tissue[2]. With so many infusates, it is difficult for the clinician to know which drugs have vesicant or irritant side effects. The clinician could consult the drug manufacturer's Instructions for Use (IFU), infusion handbooks, and reference studies for infusate-related vascular access complications. However, digging through these types of reference documents can be time-consuming. The ICC was designed to provide this information on select, commonly-used drugs, and compiled in an easy to read, consolidated booklet.

How can the Infusate Consideration Companion (ICC) support your practice?

Vascular access is a necessary part of most, if not all, hospitalizations. Infusion therapy and vascular access device (VAD) requirements also affect many outpatient settings. The patient may receive fluids, medications, blood products, nutrition, and may have diagnostic testing through an intravenous catheter. Planning on which device ought to be used for administration of infusion therapy can be a challenging decision-making process based on many factors. The decision for VAD selection should be a collaboration between the clinician, patient, and caregivers. Consideration of peripheral vein preservation and minimizing harm should always be a factor in VAD selection.

While clinicians may have a general understanding of the considerations, it is often not well understood which medications can cause complications. A critical step in reducing the risk of complications is to identify and recognize which medications and solutions may be associated with patient harm. The ICC may help you collaborate with an interprofessional team to identify medications that should and should not be given in peripheral veins.

Selecting the appropriate device for a patient is a critical part of a clinician's job. These materials are being provided for your information only and are not a substitute for clinical judgment.

Device considerations[2]:

- Vascular access device planning
- Prescribed therapy
- Treatment regimen
- Duration of therapy
- Ability and resources to care for device
- Vascular characteristics
- Comorbidities
- History of infusion therapy
- Preference for VAD location

How does the Infusate Consideration Companion (ICC) work?

The ICC will provide the reader with an awareness of complication/adverse event information on select, commonly-used infusates (see Example). The flipbook design will allow for quick navigation. The drugs are categorized by family and assigned a color. You will find all of the drugs in the table of contents alphabetically, identified by color, with the brand names listed in parenthesis.

Each drug family is tabbed. Flip to the drug class to find a series of tables which contain the drug, the pH range, and noted complications as identified in the pharmaceutical monographs and references.

A colored dot in the table indicates the presence of the complication, supported by the researched references. In some instances a diamond is used to indicate additional considerations are required; these considerations are listed on the reverse page of the flipbook.

Detailed drug information is beyond the scope of the tables and not every intravenous drug was included. The tables do not include a comprehensive list of all drug incompatibilities. Please consult manufacturer's Instructions for Use (IFU) for a full list of incompatibilities.

It is important to note that the ICC only cites vascular-access related complications. If additional information is needed about the infusate, the reader should seek the information from their pharmacy department, additional formulary, or other resources and references.

These materials are being provided for your information only and are not a substitute for clinical judgment.

Who built the Infusate Consideration Companion (ICC)?

The drugs selected for this book were chosen and compiled from several hospital formulary lists, the Medication Management Solutions drug database, and with guidance from Dr. Judith Jacobi PharmD, FCCP, MCCM, BCCCP and Dr. Ryan Scott PharmD, MBA, MHA, CSP.

Drug monographs are a predetermined checklist which includes description/classification, mechanism of action, pharmacokinetics, administration, indications, dosage, interactions, contraindications, precautions, and adverse reactions. To build the ICC, the data were retrieved from the drug monograph and from Gahart's 2021 Intravenous Medications, 37th Edition: A Handbook for Nurses and Health Professionals authored by Betty Gahart, Adrienne Nazareno, and Meghan Ortega.[3]

Lynn Hadaway MEd., NPD-BC, CRNI, Lori Kaczmarek MSN, RN, VA-B and Nadine Nakazawa BS, RN, VA-BC, as paid consultants on behalf of BD®, collected the data and reviewed each drug by researching the monograph, textbook, and supplemental references. The marked columns in the infusate tables are a reflection of their efforts.

Kathy Kokotis RN, BS, MBA, Debbie Boyce MSN, RN, CRNI, VA-BC, and Aimee Kilpack-Francis MBA, BS reviewed the research, and directed the development and publication of the ICC.

Example

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
ampicillin[1,2]	8.0-10.0		●						●		◆
ampicillin and sublactam[1,3]	8.0-10.0	●	●			●			●		◆

Guidelines, statements, and standards to consider when using the Infusate Consideration Companion (ICC)

Organization	Date	pH for peripheral vascular acces device (PVAD) administration	Osmolarity for peripheral administration	Irritant or vesicant for peripheral administration	Comments
Proper Indication and Use of Peripheral Venous Access (ERPIUP)[4]	2021	5-9 short to mid-term infusion with peripherally compatible fluids	<600 mOsm/L <800-850 mOsm/L parenteral nutrition Short to midterm infusion via PVAD	Peripheral administration any drug or solution not associated with potential endothelial damage	Solutions with potential irritant effects on vein wall by other mechanisms not involving pH or osmolarity should be preferably delivered by a CVAD. PVADs are contraindicated in the following circumstances: infusion of vesicant drugs or prolonged infusion (>30 min) of peripherally incompatible solutions.
Infusion Nurses Society: Infusion Therapy Standards of Practice[2]	2021	Ideally a physiological pH. Infusion of extremes of pH and osmolarity should be avoided to reduce endothelial damage.[2]	≤10% and/or 5% Restricted dextrose and protein concentration for peripheral nutrition (PN) <900 mOsm/L (PN)[2]	Avoid use of continuous infusion of medication with irritant or vesicant properties (see irritant definition)[2] Do not use midline catheters for continuous vesicant therapy, PN, or infusions with extremes of pH or osmolarity Evaluate the risk and benefit of intermittently infusing vesicant medication for more than 6 days[2]	For time-critical infusions of life-saving therapies such as vasopressors, begin the infusion through a PIVC until a CVAD can be safely inserted. Insert CVAD as soon as possible within 24-48 hours for vasopressors[2]
Michigan Appropriateness Guide for Intravenous Catheters (MAGIC)[1]	2015	Not cited	Not cited	PIVC, USG PIV and midline are not recommended for non-peripherally compatible infusates ≤5 days PIVC ≤14 days USG PIV, midline, acute CVC, PICC	Definition of non-peripherally compatible (e.g., irritants and vesicants) including parenteral nutrition and chemotherapy[1]
GAVeCeLT DAV Expert[5] Note: Choice of device for venous access Adult Election Intra-hospital were chosen on algorithm app	2021	<5 and >9	<800-850 mOsm/L	Non-irritant and non-vesicant drugs for peripheral administration "The choice between central venous access and peripheral venous access depends on the type of use envisaged for the device." http://vadexpert.gavecelt.it/	"Indications for a central venous access include: The need for intravenous infusion of drugs and solutions not compatible with the peripheral route because they are potentially associated with endothelial damage. This category includes vesicant drugs, drugs with pH >9 or <5, markedly hyperosmolar solutions (above 800-850 mOsm/L) and many other drugs that with different mechanisms, even independent of pH and osmolarity, are able to cause irritation and/or damage to the endothelium; lists of peripherally compatible and non-compatible drugs can be found on the web (www.gavecelt.info) or textbooks (GAVeCeLT Manual of PICCs and Midlines)"
Nursing Best Practice Guideline: Assessment and Device Selection for Vascular Access Registered Nurses Association of Ontario (RNAO)[6]	2021	Do not use peripheral catheters for continuous vesicant therapy.[6]	<900 mOsm/L	Consider the infusate characteristics (e.g., irritant, vesicant or osmolarity) in conjunction with the anticipated duration of infusion therapy and availability of peripheral vascular access sites.[6]	Consultation with a pharmacist may be required for high risk or vesicant medications.[6]
Safe vascular access 2016 The Association of Anaesthetists of Great Britain & Ireland[7]	2016	Peripheral insertion is inappropriate for infusion of fluid with low (< 5) or high pH (> 9) or intravenous access for more than 2 weeks Correction issued following publication: For some fluids and drugs, peripheral insertion is inappropriate	Peripheral insertion is inappropriate for infusion of [some fluids and drugs*] <500 mOsm/L for more than 2 weeks[6, 7] *Correction issued in 2016		Peripheral insertion is inappropriate for some fluids and drugs e.g. high osmolality >500 mOsm. potent vasopressors or intravenous access for more than 2 weeks. Check local or national guidance* *Correction issued in 2016
Management of Peripheral Intravenous Catheters Clinical Care Standard[8]	2021	Not cited	Not cited	Only insert a PIVC for medicines and fluids suitable for peripheral administration. If all other routes of administration have been excluded and IV access is needed, assess whether peripheral or central venous access is appropriate by considering • Patient's medical history, age, clinical and vascular condition • Likelihood of repeated or prolonged administration of vesicants or irritants such as vancomycin, flucloxacillin, potassium or certain types of chemotherapy • Patient's history of infusion therapy and whether there were complications associated with its use – for example, difficulty locating suitable veins[8]	

Anticipated duration of therapy and device selection for peripherally compatible infusates[2]

Duration	Device	Therapy
<4 days	PIVC	Peripherally compatible
5-15 days	Midline, possibly long PIVC	Peripherally compatible
>15 days	CVAD, possibly long PIVC	Peripherally compatible

Terms to know when using the Infusate Consideration Companion (ICC)

Peripherally compatible[4]	Short to medium term infusion of peripherally compatible solutions[4] • solutions with pH 5–9 • drugs with osmolarity <600 mOsm/L • parenteral nutrition with osmolarity <800–850 mOsm/L • any drug or solution not associated with potential endothelial damage
Non-peripherally compatible[1, 4]	Do not use a PVADs [including] Short Peripheral Catheter (SPC), Long Peripheral Catheter (LPC), or Midline Catheter (MC) for repeated or prolonged administration of solutions that are not peripherally compatible (chemical irritants, vesicant drugs, parenteral nutrition with osmolality >850 mOsm/L, etc.)[4]. Irritants or vesicants including parenteral nutrition and chemotherapy[1]
Phlebitis[2,3]	Inflammation of the vein; may be accompanied by pain/tenderness, erythema, purulence, and/or palpable venous cord; rated by a standard scale or definition
Thrombophlebitis[2, 3, 9]	Inflammation of the vein in conjunction with formation of a blood clot (thrombus), inflammatory process that causes a blood clot to form and block one or more veins near the surface of your skin (superficial thrombophlebitis)
Thrombosis[2, 3, 9]	The formation, development, or existence of a blood clot within the vascular system; forms in one or more of the deep veins in your body, blood clots in your veins can break loose, travel through your bloodstream and get stuck in your lungs, blocking blood flow (pulmonary embolism)
Erythema[2, 3, 10]	Redness of the skin in a specified area or more generalized
Extravasation[2, 3]	Inadvertent infiltration of vesicant solution or medication into surrounding tissue; rated by standard tool or definition
Necrosis[11]	A form of cell injury which results in the premature death of a portion of tissue differentially affected by local injury (as loss of blood supply, corrosion, burning or the local lesion of a disease)
Irritant[2, 3]	An agent capable of producing discomfort (eg, burning, stinging) or pain as a result of irritation to the internal lumen of the vein with or without immediate external signs of vein inflammation
Vesicant[2, 3]	A vesicant is an agent capable of causing tissue damage when it escapes from the intended vascular pathway into surrounding tissue

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- Other

Antibiotic

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
ampicillin[1, 2]	8.0-10.0		●						●		◆
ampicillin/sublactam[1, 3]	8.0-10.0	●	●			●			●		◆
azithromycin[1, 4]	NR*					●					◆
aztreonam[1, 5]	4.5-7.5	●	●			●	●		●		
capreomycin[1, 6, 7]	4.5-7.5					●					
cefazolin[1, 8]	4.5 or 7.0	●	●			●					
cefepime[1, 9]	4.0-6.0	●	●			●	●				
cefiderocol sulfate tosylate[1, 10, 11]	5.2-5.8	●				●	●				
cefotaxime sodium[1, 12, 13]	5.0-7.5	●	●		●	●	●		●		
cefotetan disodium[1, 14]	4.5-6.5	●	●			●			●		◆
cefoxitin[1, 15]	4.2-7.0	●	●						●		
ceftaroline fosamil[1, 16]	4.8-6.5	●									
ceftazidime[1, 17]	5.0-8.0	●				●					
ceftolozane/tazobactam[1, 18, 19]	5.0-7.0				●						●
ceftriaxone[1, 20]	6.6-6.7		●			●	●				
cefuroxime[1, 21]	5.0-8.5		●			●			●		●
chloramphenicol sodium succinate[1, 22]	6.4-7.0										

*NR-Not reported

Generic Drug name	Brand Name	Additional Consideration
ampicillin[1, 2]	Omnipen, Totalcillin-N	Inactivated in solution with aminoglycosides (e.g., amikacin, gentamicin). Do not mix in the same solution. Appropriate spacing and/or separate sites required.[1]
ampicillin/sublactam[1, 3]	Unasyn	Frequently used concomitantly with aminoglycosides (e.g., gentamicin), but these drugs must never be mixed in the same infusion (mutual inactivation). If given concurrently, administer at separate sites.[1]
azithromycin[1, 4]	Zithromax	Manufacturer states, "Other IV substances, additives, or medications should not be added to azithromycin, or infused simultaneously through the same IV line." Flush IV line with a compatible IV fluid before and after administration.[1] Note: "phlebitis" not used, local inflammation is used; must be infused over at least 1 hour.[1] Local IV site reactions have been reported with the intravenous administration of azithromycin. All volunteers who received infusate concentrations above 2.0 mg/mL experienced local IV site reactions and, therefore, higher concentrations should be avoided.[4]
aztreonam[1, 5]	Azactam	
capreomycin[1, 6, 7]	Capastat	
cefazolin[1, 8]	Ancef, Kefzol	
cefepime[1, 9]	Maxipime	
cefiderocol sulfate tosylate[1, 10, 11]	Fetroja	
cefotaxime sodium[1, 12, 13]	Claforan	
cefotetan disodium[1, 14]	Cefotan	Solutions of cefotetan must not be admixed with solutions containing aminoglycosides. If Cefotan and aminoglycosides are to administered to the same patient, they must be administered separately and not as a mixed injection[13]
cefoxitin[1, 15]	Mefoxin	
ceftaroline fosamil[1, 16]	Teflaro	
ceftazidime[1, 17]	Fortaz, Tazicef	
ceftolozane/ tazobactam[1, 18, 19]	Zerbaxa	General disorders and administration site conditions: infusion site reactions. Zerbaxa (ceftolozane/tazobactam) should not be infused simultaneously with other medications via the same intravenous line[18]
ceftriaxone[1, 20]	Rocephin	
cefuroxime[1, 21]	Zinacef	May be used concomitantly with aminoglycosides (e.g., amikacin, gentamicin), but these drugs must never be mixed in the same infusion (mutual inactivation). If given concurrently, administer separately and flush the IV line before and after administration[1]
chloramphenicol sodium succinate[1, 22]	Chloromycetin	

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Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
ciprofloxacin[1, 2]	3.5-4.6		●				●				
clindamycin[1, 3]	5.5-7.0		●			●					
daptomycin[1, 4, 5]	6.8										
delafloxacin meglumine[1, 6]	NR*	●		●	●	●	●				◆
doripenem[1, 7]	4.5-5.5	●				●			●		
doxycycline hyclate[1, 8]	1.8-3.3	●	●					●			
eravacycline[1, 9, 10]	5.5-7.0	●	●	●	●	●	●	●			◆
ertapenem[1, 11]	7.5	●	●			●	●		●		◆
erythromicin[1, 12]	6.5-7.7					●	●				◆
gentamicin sulfate[1, 13]	3.0-5.5										◆
imipenem-cilastatin[1, 14]	6.5-8.5	●	●			●	●		●		●
levofloxacin[1, 15, 16]	3.8-5.8	●				●	●				●
lincomycin hydrochloride[1, 17, 18]	3.0-5.5		●			●					
linezolid[1, 19]	4.8										◆
meropenem[1, 20]	7.3-8.3	●	●	●		●	●				
metronidazole hydrochloride[1, 21]	4.5-7.0		●								◆
minocycline hydrochloride[1, 22]	4.5-6.0		●	●		●	●	●			

*NR-Not reported

Generic Drug name	Brand Name	Additional Consideration
ciprofloxacin[1, 2]	Cipro IV	
clindamycin[1, 3]	Cleocin	
daptomycin[1, 4, 5]	Cubicin, Cubicin RF	
delafloxacin meglumine[1, 6]	Baxdela	Do NOT administer delafloxacin through the same IV line with any solution containing multivalent cations (e.g., calcium and magnesium). Do NOT co-infuse delafloxacin with other medications. May be given through a y-tube or three way stopcock of infusion set. Temporarily discontinue other solutions infusing at the same site, and flush tubing before and after the delafloxacin. Monitor infusion site for inflammation and/or extravasation.[1] Do NOT administer Baxdela for injection with any solution containing multivalent cations, e.g.,calcium and magnesium, through the same intravenous line. Do NOT co-infuse Baxdela for Injection with other medications. If a common intravenous line is being used to administer other drugs in addition to Baxdela the line should be flushed before and after each Baxdela infusion with 0.9% Sodium Chloride Injection or D5W. infusion site extravasation. infusion related reactions. Baxdela should not be co-administered with any solution containing multivalent cations, e.g., magnesium, through the same intravenous line.[6]
doripenem[1, 7]	Doribax	
doxycycline hyclate[1, 8]	Vibramycin monohydrate, Doxy 100, Doxy 200	
eravacycline[1, 9, 10]	Xerava, tetracycline drugs	Eravacycline should not be mixed with other drugs or added to solutions containing other drugs; May be administered through a dedicated line or through a Y-site. If the same IV line is used for sequential infusion of several drugts, the line should be flushed with normal saline before and after the infusion.[1] Xerava may be administered intravenously through a dedicated line or through a Y-site. If the same intravenous line is used for sequential infusion of several drugs, the line should be flushed before and after infusion of Xerava with 0.9%.[10]
ertapenem[1, 11]	Invanz	Do not mix or co-infuse ertapenem with other medications. Do not use diluents containing dextrose. "Infusion site reactions"[1] IV infusion over 30 minutes. May also administer IV push over 5 minutes. Infused vein complication (7%), infusion-site pain (infants, children, and adolescents: 7%),erythema at injection site (infants, children, and adolescents: 4%). induration at injection site. Injection site irritation.[11]
erythromicin[1, 12]	Erythrocin	Must be diluted. Specific compatibilities dependent on concentration and manufacturer; consult w pharmacist. A slow infusion rate is recommended to reduce pain along the injection site. Continuous infusion preferred. Mild local venous discomfort.[1] Occasional venous irritation has been encountered, but if the infusion is given slowly, in dilute solution, preferably by continuous intravenous infusion or intermittent infusion in no less than 20 to 60 minutes, pain and vessel trauma are minimized.[12]
gentamicin sulfate[1, 13]		Do not physically premix with other drugs. Inactivated in solution with beta-lactam antibiotics and vancomycin. Appropriate spacing required because of incompatibilities.[1]
imipenem-cilastatin[1, 14]	Imipemide, Primaxin	
levofloxacin[1, 15, 16]	Levaquin	
lincomycin hydrochloride[1, 17, 18]	Lincocin	Manufacturer lists as incompatible at the Y-site with amphotericin B (conventional), ceftriaxone (Rocephin), chlorpromazine (Thorazine), diazepam (Valium), erythromycin (Erythrocin), pentamidine, phenytoin (Dilantin), and sulfamethoxazole/trimethoprim.[1]
linezolid[1, 19]	Zyvox	
meropenem[1, 20]	Merrem IV	
metronidazole hydrochloride[1, 21]	Flagyl, Metro IV	Administer separately, discontinue the primary IV during administration and do not introduce additives into the solution.[1] Local reactions: Thrombophlebitis after intravenous infusion. This reaction can be minimized. Administered by slow intravenous drip infusion only, either as a continuous or intermittent infusion or avoided by avoiding prolonged use of indwelling intravenous catheters. If used with a primary intravenous fluid system, the primary solution should be discontinued during metronidazole infusion.[21]
minocycline hydrochloride[1, 22]	Minocin	

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Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
moxifloxacin hydrochloride[1, 2, 3]	4.1-4.6	●	◆	●		●					●
nafcillin sodium[1, 4, 5]	6.0-8.5	●	●	●		●		●	◆	●	
omadacycline[1, 6]	NR*		●	●		●	●	●			
oritavancin[1, 7, 8]	3.1-4.3	●		●			●	●			◆
oxacillin[1, 9, 10]	6.0-8.5	●	●	●		●	●	●			●
penicillin G aqueous[1, 11]	5.5-8.0	●	●						◆		●
piperacillin-tazobactam[1, 12]	5.5-6.8	●	●				●		●		●
rifampim[1, 13]	7.8-8.8	●		●		●	●	●	●		
sulfamethoxazole -trimethoprim[1, 14]	9.5-10.5	●	●	●		●		●	●		
telavancin[1, 15]	4.5-5.0					●	●				
ticarcillin and clavulanate[1, 16]	5.5-7.5	●	●			●	●		●		◆
tigecycline[1, 17]	7.8	●	●			●	●				
tobramycin[1, 18]	3.0-6.5										◆
vancomycin[1, 19, 20, 21]	2.5-5.5	●	●	●	●	●	●	●	●	◆	◆

*NR-Not reported

Generic Drug name	Brand Name	Additional Consideration
moxifloxacin hydrochloride[1, 2, 3]	Avelox	Local side effects include; Common (1%-10%): Injection site reactions, infusion site reactions Uncommon (0.1%-1%): Infusion site extravasation, infusion site thrombophlebitis/phlebitis
nafcillin sodium[1, 4, 5]	Nallpen, Unipen, Nafcil	May cause thrombophlebitis, especially in the elderly or with too-rapid injection. Limit peripheral IV treatment to 24 to 48 hours when possible. Change to oral therapy as soon as practical.[1]
omadacycline[1, 6]	Nuzyra	Do not infuse omadacycline solutions simultaneously through the same IV line with any solution containing multivalent cations (e.g., calcium, magnesium)[5]
oritavancin[1, 7, 8]	Orbactiv	
oxacillin[1, 9, 10]	Bactocill	
penicillin G aqueous[1, 11]	Penicillin G Potassium, Penicillin G Sodium, Pfizerpen	May cause thrombophlebitis; observe carefully and rotate infusion sites.[1]
piperacillin-tazobactam[1]	Zosyn	
rifampim[1, 13]	Rifadin	
sulfamethoxazole -trimethoprim[1, 14]	SMZ-TMP, TMP-SMZ, Bactrim	
telavancin[1, 15]	Vibativ	
ticarcillin and clavulanate[1, 16]	Timentin	May be inactivated in solution with aminoglycosides (e.g., amikacin, gentamicin). Do not mix in the same solution. Appropriate spacing and/or separate sites required. Manufacturer recommends temporarily discontinuing the administration of other solutions at the same site during intermittent infusion and lists as incompatible with sodium bicarbonate.[1]
tigecycline[1, 17]	Tygacil	
tobramycin[1, 18]	Nebcin	Manufacturer states, "Do not physically premix with other drugs; administer separately." Inactivated in solution with beta-lactam antibiotics (e.g., cephalosporins, penicillins) and vancomycin; do not mix in the same solution. Appropriate spacing required because of physical incompatibilities[1]
vancomycin[1, 19, 20, 21]	Vancocin HCl	Recommend using a central catheter for vancomycin infusion at concentrations higher than 5mg/ml to avoid phlebitis or other complications. Current recommendations fail to include long-term vancomycin infusion therapy and studies have shown that phlebitis usually occurs after 24 h of treatment.[1, 20]

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Nutrition/Electrolyte Replacement

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
calcium chloride 10% [1, 2]	5.5-7.5			●		●		●		●	
calcium gluconate[1, 3, 4]	6.0-8.2			●		●	●	●			
dextrose <10% (less than 10%)[5]	4.3										
dextrose ≥10% (equal to or greater than 10%)[1, 6, 7, 8]	3.2-6.5	●		●	●	●	●	●		●	
dextrose 50%[1, 9, 10]	3.2-6.5	●		●	●					◆	
fat emulsion, intravenous (10% or less)[1, 11, 12]	6.0-8.9		●				●			◆	
fat emulsion, intravenous (greater than 10%)[1, 11, 13, 14]	6.0-8.9		●				●		●	◆	
magnesium sulfate[1, 15]	3.5-7.0										
potassium chloride 10mEq[1, 16]	4.0-8.0	●		●	●	●	●	●			
potassium chloride 20mEq[1, 16]	4.0-8.0	●	●	●	●	●	●	●		◆	
potassium chloride 40mEq[1, 16, 17]	4.0-8.0	●	●	●	●	●	●	●		●	
potassium phosphate[1, 18, 19]	2.2-2.4	●	●	●	●	●	●	●		●	
sodium bicarbonate (greater than 8%)[1, 20, 21, 22]	7.0-8.5	●		●				●			
sodium chloride 3-5%[1, 23]	4.5-7.0	●		●	●	●		●		●	
tromethamine[24, 25]	NR*	●		●	●			●			

*NR-Not reported

Generic Drug name	Brand Name	Additional Consideration
calcium chloride 10%[1, 2]		Calcium salts not generally mixed with carbonates, phosphates, sulfates, or tartrates.[1] Take great care to avoid extravasation or accidental injection into perivascular tissues.[2]
calcium gluconate[1, 3, 4]		
dextrose <10% **(less than 10%)**[5]		
dextrose ≥10% **(equal to or greater than 10%)**[1, 6, 7, 8, 10]	Glucose	Dextrose is considered a vesicant if the concentration is 10% or greater, extra care has to be taken during administration of this medication.[10]
dextrose 50%[1, 9, 10]		Significant extravasation of D50%W can lead to complications, including skin and soft tissue injury, loss of limb, or death.[10]
fat emulsion, intravenous **(10% or less)**[1, 11, 12]	Liposyn (lipids, 10%)	Monitor catheter site.[1] Isotonic; may be administered by a peripheral vein or central venous infusion; when administered with dextrose and amino acids, choice of peripheral or central vein is based on osmolarity of the final infusate.[1]
fat emulsion, intravenous **(greater than 10%)**[1, 11, 13, 14]	Clinolipid 20%, Itralipid 20% & 30%, Omegaven	Solutions with osmolarity of 900 mOsm/L or greater must be infused through a central vein[12]
magnesium sulfate[1, 15]	Magnesium Sulfate heptahydrate	
potassium chloride 10mEq[1, 16]	PROAMP	
potassium chloride 20mEq[1, 16]	PROAMP	Because pain associated with peripheral infusion of potassium has been reported, administration via a central route is recommended whenever possible. Higher concentrations (40 mEq/100 mL) should be exclusively administered via a central line.[1]
potassium chloride 40mEq[1, 16, 17]		
potassium phosphate[1, 18, 19]		
sodium bicarbonate **(greater than 8%)**[1, 20, 21, 22]		
sodium chloride 3-5%[1, 23]		
tromethamine[24, 25]	THAM	Extreme care should be taken to avoid perivascular infiltration. Local tissue damage and subsequent sloughing may occur if extravasation occurs. Chemical phlebitis and venospasm have been reported.[24]

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Antifungal/Antiviral

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
acyclovir[1, 2]	11	●	●	●					●		
amphotericin B[1, 3] **(generic/conventional)**	5.0-7.0	●	●			●	●				●
caspofungin acetate[1, 4]	6.6	●				●	●				
pentamidine isethionate[1, 5, 6]	4.1-5.4	●	●	●		●	●			●	◆
posoconazole[1, 7, 8]	2.6		●			●	●			●	
remdesivir[9-12]	3.0-4.0	●		●				●			●
voriconazole[1, 13]	NR*										●

*NR-Not reported

Generic Drug name	Brand Name	Additional Consideration
acyclovir[1, 2]	Zovirax	
amphotericin B[1, 3]	generic/conventional	
caspofungin acetate[1, 4]	Cancidas	
pentamidine isethionate[1, 5, 6]	Nebupent	Will form a precipitate with NS; do not use for dilution or infusion. Manufacturer states, "Do not mix pentamidine solutions with any other drugs."[1]
posoconazole[1, 7, 8]	Noxafil	
remdesivir[9-12]	Veklury	
voriconazole[1, 13]	Vfend IV	

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Cardiac/Hemodynamic

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
amiodarone[1, 2]	4.08	●	●	●	●	●	●			●	●
conivaptan hydrochloride[1, 3]	3.4-3.8	●				●	●				●
diltiazem[1, 4]	3.7-4.1										●
dobutamine hydrochloride[1, 5]	2.5-5.5	●		●							
dopamine HCL[1, 6]	2.5-5.0			●		●	●			●	
ephedrine sulfate[1, 7]	4.5-7.0										
epinephrine[1, 8]	2.5-5.0			●				●	●	●	
esmolol hydrochloride[1, 9]	4.5-5.5		●	●			●	●		●	◆
isoproterenol hydrochloride[1, 10]	3.5-4.5										
lidocaine hydrochloride[1, 11]	3.0-7.0		●	●							●
metoprolol tartrate[1, 12]	7.5										
milrinone lactate[1, 13]	3.2-4.0						●				
nitroglycerine injection[1, 14]	3.0-6.5										●
nitroprusside[1, 15, 16]	3.5-6.0			◆		●					●
norepinephrine bitartrate[1, 17, 18]	3.0-4.5			●		●		●		●	◆
phenylephrine[1, 19]	3.0-6.5			●				●		●	
vasopressin[1, 20]	2.5-4.5			●	●			●		●	

Generic Drug name	Brand Name	Additional Consideration
amiodarone[1, 2]	Nexterone	
conivaptan hydrochloride[1, 3]	Vaprisol, Arginine vasopressin antagonist	
diltiazem[1, 4]	Cardizem	
dobutamine hydrochloride[1, 5]	Dobutamine	
dopamine HCL[1, 6]	Dopamine HCL or Intropin	
ephedrine sulfate[1, 7]	Akovaz, Corphedra	
epinephrine[1, 8]	Adrenalin Injection	
esmolol hydrochloride[1, 9]	Breviblock	Incompatible with bicarbonate and furosemide. Do not add additional medications to the bag. Infusion site reactions, including irritation, inflammation, and severe reaction (e.g., thrombophlebitis, necrosis, and blistering), have occurred; avoid infusion in to small veins or through a butterfly catheter. Well tolerated if adminstered through a central vein. Monitor for infusion site reaction and prevent extravasation. Restart at an alternate infusion site.[1] Infusion into small veins or through a butterfly catheter should be avoided (can cause thrombophlebitis). Vesicant; ensure proper needle or catheter placement prior to and during infusion; avoid extravasation.[9]
isoproterenol hydrochloride[1, 10]	Isuprel	
lidocaine hydrochloride[1, 11]	Lidocaine PF, Xylocaine PF, Xylocard	
metoprolol tartrate[1, 12]	Lopressor	
milrinone lactate[1, 13]	Primacor	
nitroglycerine injection[1, 14]		
nitroprusside[1, 15, 16]	Nipride RTU, Nitropress	Determine patency of vein; avoid extravasation[1]
norepinephrine bitartrate[1, 17, 18]	Levarterenol Bitartrate, Levophed	Consult pharmacist; may be inactivated by solutions with a pH above 6. Incompatible with whole blood; administer through Y-site or a separate IV line. Avoid contact with iron salts, alkalis, or oxidizing agents. Large vessel is preferred.[17]
phenylephrine[1, 19]	Neo-synephrine, Vazculep	
vasopressin[1, 20]	Vasostrict	Use of a central line is recommended. Other sources suggest specific compatibilities dependent on concentration and manufacturer; consult a pharmacist.[1,20]

Cardiac/Hemodynamic

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Analgesic/Opioid/Anesthetic/CNS

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
etomidate[1, 2]	4.0-7.0		●	●	●	●		●			
fentanyl citrate[1, 3]	4.0-7.5										
hydromorphone hydrochloride[1, 4, 5]	3.5-5.5, 4.5-6.5					●					
ketamine[1, 6]	3.5-5.5					●	●				
lorazepam[1, 7, 8]	6.4		●	●		●	●	●			
midazolam hydrochloride[1, 9, 10]	3.0	●	●	●	●	●	●	●			
morphine sulfate[1, 11]	2.5-6.5										
propofol[1, 12]	7.0-8.5	◆		◆	◆	●					
thiopental[13, 14, 15]	10.0-11.0	●		●	●	●				◆	

Generic Drug name	Brand Name	Additional Consideration
etomidate[1, 2]	Amidate	
fentanyl citrate[1, 3]	Fentanyl, Fentanyl Citrate PF	
hydromorphone hydrochloride[1, 4, 5]	Dilaudid; Dilaudid HP	
ketamine[1, 6]	Ketalar	
lorazepam[1, 7, 8]	Ativan, Lorazepam PF	
midazolam hydrochloride[1, 9, 10]	Versed, Midazolam HCl PF	
morphine sulfate[1, 11]	Astramorph PF, Duramorph PF, Morphine Injection	
propofol[1, 12]	Diprivan, Propoven	Pain at the injection site occurs in up to 70% of patients following peripheral IV administration. Thrombosis or phlebitis reported rarely. Local pain, swelling, blisters, and/or tissue necrosis reported rarely following inadvertent extravasation. To minimize pain at the injection site, use larger veins of the forearm or antecubital fossa rather than hand veins.[12]
thiopental[13, 14, 15]	Pentothal	*Consideration for Ph may direct clinician to use a central line.

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Antihypertensive

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
clevidipine butyrate[1, 2, 3]	6.0-8.0										●
enalaprilat[1, 4]	6.5-7.5										
hydralazine hydrochloride[1, 5]	3.4-4.0										
labetalol hydrochloride[1, 6]	3.0-4.5										
nicardipine hydrochloride[1, 7, 8]	3.5-4.7	●	●	●	●	●		●	●	●	●

Generic Drug name	Brand Name	Additional Consideration
clevidipine butyrate[1, 2, 3]	Cleviprex	Do not administer in the same IV line as other drugs. Should not be administered in the same line as other medications.
enalaprilat[1, 4]	Enalaprilat Injection	
hydralazine hydrochloride[1, 5]		
labetalol hydrochloride[1, 6]	Trandate, Normodyne	
nicardipine hydrochloride[1, 7, 8]	Cardene IV	

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Anticonvulsant

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
acetazolamide[1, 2]	9.2										
levetiracetam injection[1, 3]	5.5										
phenobarbital sodium injection[1, 4]	8.5-10.5	●		●	●	●	●	●			
phenytoin[1, 5]	12.0			●		●	●	●		●	●
valproate[1, 6]	7.6					●	●				

Generic Drug name	Brand Name	Additional Consideration
acetazolamide[1, 2]	Diamox	
levetiracetam injection[1, 3]	Keppra	
phenobarbital sodium injection[1, 4]	Luminal Sodium	
phenytoin[1, 5]	Dilantin	
valproate[1, 6]	Depacon	

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Other

Drug	pH	Phlebitis	Thrombo-phlebitis	Potential for damage from extravasation	Thrombosis of vessel	Patient pain on infusion	Redness at injection site	Absolute vein patency needed	Rotation of peripheral infusion sites recommended	Central line preferred	No simultaneous infusion/ dedicated lumen
aminophylline[1, 2]	8.6-9.0										
arginine hydrochloride[1, 3]	5.0-6.5			◆				●			
dantrolene[1, 4]	9.5 and 10.3		●	●			●	●			
dexamethasone[1, 5]	7.0-8.5										
dexmedetomidine[1, 6]	4.5-7.0					●					
diazepam[1, 7]	6.2-6.9	●		●	●						●
epoprostenol sodium[1, 8]	10.2-13						●			●	●
furosemide[1, 9]	8.0-9.3		●								
infliximab[1, 10]	6.0-7.0										●
mannitol (10% or greater)[1, 11, 12]	4.5-7.0	●	●	●		●	●			●	
mycophenolate mofetil[1, 13, 14]	2.4-4.1	◆			◆						●
ondansetron[1, 15]	3.0-4.0					●	●				
pantoprazole[1, 16]	9.0-10.5		●				●				●
promethazine[1, 17, 18]	4.0-5.5	●	●	●	●	●	●	●			
tacrolimus[1, 19]	NR*										◆

Other *NR-Not reported

Generic Drug name	Family	Brand Name	Additional Consideration
aminophylline[1, 2]	Respiratory/ Bronchodilator	Aminophylline	
arginine hydrochloride[1, 3]	Diagnostic Agent	R-Gene 10	
dantrolene[1, 4]	Skeletal Muscle Relaxant	Dantrium, Revonto, Ryanodex	
dexamethasone[1, 5]	Corticosteroids	Decadron	
dexmedetomidine[1, 6]	Sedative	Precedex	Sedative for nonintubated patients; compatibility with other drugs not established. Separate lumen or adequate flushing necessary to prevent incompatibility[1,6]
diazepam[1, 7]	Benzodiazepine, sedative, anticonvulsant	Valium	
epoprostenol sodium[1, 8]	Pulmonary antihyper-tensive, vasodilator	Flolan, Velitri	
furosemide[1, 9]	Diuretic	Lasix	
infliximab[1, 10]	Antirheumatic	Remicaide, Inflectra, Renflexis, Ixifi, Avsol	
mannitol (10% or greater)[1, 11, 12]	Diuretic	Osmitrol	
mycophenolate mofetil[1, 13, 14]	Immunoglobulin/ Immunotherapy	CellCept, Myfortic	Mycophenolate mofetil for injection must be administered by slow intravenous infusion over a period of no less than 2 hours by either peripheral or central vein, as rapid infusion increases the risk of local adverse reactions such as phlebitis and thrombosis[15]
ondansetron[1, 15]	Antiemetic	Ondansetron HCl PF, Zofran, Zofran PF	
pantoprazole[1, 16]	Proton Pump Inhibitor	Protonix IV	
promethazine[1, 17, 18]	Antiemetic	Phenergan	
tacrolimus[1, 19]	Immunoglobulin/ Immunotherapy	Prograf	

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