

A GUIDE ON INTRAVENOUS DRUG COMPATIBILITIES BASED ON THEIR pH

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ABSTRACT

Hospital pharmacies in many countries include a mix of both European and FDA approved medications in their Formulary. Mixing incompatible medications is a major intravenous (IV) medication error especially when data on compatibility is not available in commonly used references. The pH of IV medications is very important to consider when tackling compatibility of solutions. Developing a guide reporting the pH of medications, in addition to compatible solutions and light sensitivity, can serve as a unique tool during the preparation of special admixture for a specific patient.

Keywords: pH solution, compatibility, intravenous, light sensitivity.

INTRODUCTION

Hospital pharmacies in many non European or U.S. countries have a mix of both European and FDA approved medications in their Formulary. Developing a guide on intravenous (IV) medications compatibility for the commonly used medications in these countries can provide the pharmacists and nurses with a quick information tool, especially when additional information (such as pH data on medications) are required during special admixture preparation.

Medication errors are causing substantial global public health concern, as many result in harm to patients and increased costs to health-care providers.⁶ Studies have shown that the second most frequent type of medication errors was related to the medication administration.⁴ Medication errors include prescribing errors, dispensing errors, medication administration errors and patient compliance errors.² The pharmacist has a major role in ensuring safe administration and appropriate utilization of medications in patients. One of the medication administration errors is incompatibility which is defined as the reaction of IV medications when mixed together resulting in solutions that are no longer optimal for the patient. The stability is altered by physico-chemical reactions leading to decreased effectiveness of the drug or an increased micro-particles load leading ultimately to therapeutic failure, catheter occlusion or embolism.⁸

MIXING INCOMPATIBLE MEDICATIONS AND IV MEDICATION ERROR

Mixing incompatible medications is a major IV medication error. Patients in the intensive care units (ICU) setting are more prone to medication errors as they typically receive a greater number of medications, which are being administered in a more pressured environment.⁵ Although

critically ill patients usually have multiple central IV lines, several medications have to be infused simultaneously through the same lines. Investigations have shown that mixing an IV drug with the wrong diluents can occur in up to 80% of the cases. This is alarming especially in the ICU where 25% of the IV incompatibilities are highly significant and 26% are life-threatening.⁸ On the other hand, delivering continuous infusions are more complex and may be more prone to errors than intermittent dosing. This includes medications with higher likelihood of harmful effect such as vasoactive substances (e.g. dopamine or epinephrine), sedatives, and narcotics.⁵ This high incidence led investigators to find ways in order to decrease IV incompatibilities & their associated complications.

Nemc K 2008 showed that standardization of infusion solutions allowed compatibility testing with a number of medications combinations and served as a measure to reduce the high risk of ward-based IV medication preparation.⁸ The pH of solution was one of the compatibility measure used in the establishment of standard concentrations of medications commonly given by continuous infusion and prepared at the bedside.⁸ This also allowed grouping medications that can be infused simultaneously through the same IV line or through the same lumen of a multi-lumen central-venous catheter in case of severe critical illness in order to simplify the administration technique.⁸

The pH of an IV solution is very important to consider when tackling compatibility of solutions. It is critical that infusion of parenteral solutions does not alter the body's pH, as well as to prevent stinging, burning, pain, irritation or tissue damage. Medications admixture into a solution could alter the pH to acidic or basic depending on the solution buffer capacity. Normal Saline (NS) and Dextrose 5% in water (D5W) solutions have low buffer capacity, so that the solution will turn acidic with the admixture of an acidic medication, and it will turn basic with the admixture

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of a basic medication. Lactated Ringer's (LR) solution has a high buffer capacity, so that when adding an acidic medication, the solution will either remain neutral or the pH will drop to a lesser extent than that observed with NS or D5W solution.⁹

INTRAVENOUS DRUG COMPATIBILITIES BASED ON THEIR pH¹⁰⁻¹⁸

Drug	pH	Commonly used diluent	Administration	Light Sensitivity
Acetazolamide sodium	9.2 - 9.6	D5W, 0.9% NaCl	Direct IV injection	
Acyclovir sodium	11 (10.5 - 11.6)	D5W, 0.9% NaCl	Slow IV infusion	
Alentuzumab	†	D5W, 0.9% NaCl	IV infusion	
Alfacalcidol	†	NA	IV injection over 30 seconds	Yes*
Alprostadil	†	D5W, 0.9% NaCl	Continuous IV infusion Intra-arterial in neonates	
Alteplase	7.3	D5W, 0.9% NaCl	IV infusion, directly after reconstitution to a 1mg/ml concentration or dilution with an equal volume of diluent to a 0.5 mg/ml	Yes
Amikacin	4.5 (3.5 - 5.5)	D5W, 0.9% NaCl	IM injection IV infusion	
Aminophylline	8.6 - 9	D5W, D5W in 0.9% NaCl	IV infusion Slow direct IV injection	
Amiodarone HCl	4.08	D5W, 0.9% NaCl	IV infusion after dilution	Yes
Amoxicillin sodium	8 - 10	0.9% NaCl	IM injection Direct IV injection Intermittent IV	Store in airtight container
Amoxicillin/clavulanic acid	6.5	0.9% NaCl	IV injection IV infusion	
Amphotericin B	5.7 (Amphotericin B in D5W)	D5W	Slow IV infusion over 2 hours Intra-arterial Intrathecal	
Amphotericin B liposomal	†	D5W	IV infusion over 30-120 min	
Ampicillin sodium	8 - 10 (10mg/ml Ampicillin sodium)	0.9% NaCl	IM injection Direct IV injection IV infusion	
Anti-D (rh) immunoglobulin	†	NA	IV injection IM injection	The liquid and freeze-dried preparations should be stored, protected from light, The freeze-dried preparation should be stored in an airtight container
Ascorbic acid	5.5 - 7	D5W, 0.9% NaCl, 0.45% NaCl, D10W	SC injection IV injection But IM injection is preferred Note: For IV, it should be diluted with a large volume and infused slowly	Yes
Asparaginase	7.4 (6.5 - 8)	D5W, 0.9% NaCl	IV injection IM injection	
Atosiban acetate	†	NA	IV bolus followed by IV infusion	
Atropine sulfate	4.5 - 6.2 (2% aqueous solution)	D5W, 0.9% NaCl	SC injection IM injection Direct rapid IV injection	Yes*
Azathioprine	9.6	D5W, 0.9% NaCl, 0.45% NaCl	IV injection Intermittent infusion over 30-60 min	Yes
Aztreonam	4.5 - 7.5	D5W, 0.9% NaCl	IV bolus Deep IM injection IV infusion	
Betamethasone sodium phosphate	8.5	NA	IV injection IM injection Intra-articular	Yes*
Bleomycin sulfate	4.5 - 6	0.9% NaCl	IM injection SC injection IV injection Intrapleural	
Botulinum toxin A (Dysport)	†	No dilution needed	IM injection Intradermal depending on indication Note: Given as a complex usually with haemagglutinin by local injection	

Buflomedil hydrochloride	5 - 6.5 (5% aqueous solution)	NA	IM injection IV infusion Slow IV injection	
Caffeine citrate	4.7	D5W	Slow IV injection	
Carmustine	5.6 - 6	D5W	IV infusion	Yes*
Caspofungin	†	NA	Slow intravenous infusion over about 1 hour	
Cefazolin sodium	4.5 - 6 4.5 - 7 (Frozen premixed solution)	D5W, 0.9% NaCl	Deep IM injection Direct IV injection Intermittent IV infusion Continuous IV infusion	Yes*
Cefepime HCl	4 - 6	D5W, 0.9% NaCl	Deep IM injection Intermittent IV infusion	Yes*
Cefotaxime	5 - 7.5	D5W, 0.9% NaCl, 0.45%NaCl D10W,	Deep IM injection Continuous IV infusion Intermittent IV infusion	No
Ceftazidime	5 - 8	D5W, 0.9% NaCl, 0.45%NaCl	Deep IM injection Intermittent IV infusion	No
Ceftizoxime	6 - 8	D5W, 0.9% NaCl	Deep IM injection Intermittent IV infusion Continuous IV infusion	
Ceftriaxone sodium	6.7 (6 - 8)	D5W, 0.9% NaCl	Deep IM injection Intermittent IV infusion	Yes
Cefuroxime	(6 - 8.5) (Reconstituted vials) 5 - 7.5 (Frozen premixed solutions)	D5W, 0.9% NaCl	Deep IM injection Direct IV injection Continuous IV infusion Intermittent IV infusion	Yes
Chlorpromazine HCl	3 - 5	0.9% NaCl	Slow deep IM injection Direct IV injection	Yes
Cisatracurium besylate	3.25 - 3.65	D5W, 0.9% NaCl	IV bolus Continuous IV infusion	
Cisplatin	3.5 - 4.5	0.9% NaCl	IV infusion with hydration with mannitol	No
Clarithromycin	7.5 - 10	D5W, 0.9% NaCl	IV infusion only	Yes
Clindamycin phosphate	5.5 - 7 usually 6 - 6.3	D5W, 0.9% NaCl	IM injection Intermittent IV infusion diluted	No
Clomipramine HCl	3.5 - 10 (Solution having a concentration of 100mg/L)	NA	IM injection IV infusion	No
Clonidine HCl	5 - 7	0.9% NaCl	Continuous epidural infusion	Yes ^s
Cyanocobalamin	4.5 - 7	D5W, 0.9% NaCl	IM injection Deep SC injection	
Cyclophosphamide	3 - 9	D5W, 0.45% NaCl, D5W in 0.9% NaCl	IM injection Intraperitoneal Intrapleural Direct IV injection Continuous IV infusion Intermittent IV infusion	No
Cytarabine	4 - 6 (Reconstituted lyophilized powder) 7.4 (Injection pH)	D5W, 0.9% NaCl	SC injection Intrathecal Direct IV injection Continuous IV Intermittent IV IM injection	Yes
Dacarbazine	3 - 4	D5W, 0.9% NaCl	Direct IV injection IV infusion	Yes
Daclizumab	†	0.9% NaCl	IV injection over 15 min Central IV infusion Peripheral IV infusion	
Dantrolene sodium	†	NA	IV injection	Yes*
Daunorubicin HCl	4.5 - 6.5	D5W, 0.9% NaCl	IV injection only	Yes
Deferoxamine	†	D5W, 0.9% NaCl	IM injection Slow IV after dilution at a rate not exceeding 15mg/kg/hr, SC via a portable infusion control device	
Desmopressin acetate	†	NA	Slow IV infusion over 15-30 min IM injection SC injection	Yes ^s
Dexamethasone sodium phosphate	7 - 8.5	D5W, 0.9% NaCl	24 mg/ml by direct injection slowly, Continuous or intermittent IV infusion 4 mg/ml by IM, Intra-arterial, intrasynovial 10 mg/ml by IM injection, IV injection only	

Diazepam	6.2 - 6.9	Incompatible with 0.9% NaCl (precipitate) & D5W (cloudiness & precipitate)	Direct IV injection	Yes
Digoxin	6.8 - 7.2	D5W, 0.9% NaCl	Direct IV injection diluted or undiluted	Yes
Dipyridamole	†	NA	IV injection in stress testing	Yes*
Dobutamine	2.5 - 5.5	D5W, 0.9% NaCl	IV infusion after dilution	No
Docetaxel	3 - 5	D5W, 0.9% NaCl	IV infusion	Yes
Dopamine HCl	3.3 (2.5 - 5)	D5W, 0.9% NaCl	IV infusion	Yes
Drotrecogin alpha (activated)	†	NA	IV infusion	
Enoxaparin sodium	5.5 - 7.5	0.9% NaCl	Deep SC injection	
Ephedrine sulfate	4.5 - 7	0.9% NaCl	SC injection IM injection Slow IV injection	Yes
Epinephrine	2.2 - 5	D5W, 0.9% NaCl	SC injection IM injection IV injection Intra-cardiac	Yes
Epirubicin HCl	3	D5W, 0.9% NaCl	IV infusion Note: Not given IM, SC	
Epoetin alpha	6.6 - 7.2 (Single-use vials) 5.8 - 6.4 (Multiple-dose vials)	Bacteriostatic 0.9% NaCl	IV injection SC injection	Yes
Esmolol	3.5 - 5.5 (Concentrate) 4.5 - 5.5 (Ready-to-use)	D5W, 0.9% NaCl, 0.45% NaCl	IV infusion at a concentration of 10 mg/ml	Yes (IV bag must be shielding against light)
Esomeprazole	9 - 10	D5W, 0.9% NaCl	IV injection (≥3 min) IV infusion (10-30 min)	
Etamsylate	4.5 - 5.6 (10% aqueous solution)	NA	IM injection IV injection	Yes*
Etomidate	†	No dilution needed	IV injection over 30-60 seconds	
Etoposide	3 - 4	D5W, 0.9% NaCl	Slow IV injection Continuous IV infusion	No
Factor VII a or Eptacog alpha (activated)	†	NA	IV bolus over 2-5 min	
Factor VIII	†	NA	IV injection	Yes
Fluconazole	4 - 8 (In NaCl diluents) 3.5 - 6.5 (In D5W diluents)	NA	Intermittent IV Note: Do not administer direct IV injection	No
Fludarabine phosphate	7.2 - 8.2	D5W, 0.9% NaCl	IV infusion diluted Rapid IV injection Continuous IV infusion	No
Flumazenil	4	D5W, 0.9% NaCl	IV through a running IV infusion line into a large vein	
Fluorouracil	9.2 (8.6 - 9.4)	D5W, 0.9% NaCl	IV injection	Yes
Flupenthixol	2 - 3	NA	IM injection only	
Folate de calcium	6.5 - 8.5	D5W, 0.9% NaCl	IM injection IV injection IV infusion	
Furosemide	8 - 9.3	D5W, 0.9% NaCl	IM injection Direct IV injection IV infusion	Yes
Ganciclovir sodium	11	D5W, 0.9% NaCl	IV infusion	No
Gemcitabine	2.7 - 3.3	0.9% NaCl	IV infusion	
Gentamicin sulfate	3 - 5.5 4 - 4.5 (Premixed Gentamicin in 0.9% NaCl)	D5W, 0.9% NaCl	IM injection Intermittent IV	No
Glucagon hydrochloride	†	NA	IV injection IM injection SC injection	Yes
Glyceryl trinitrate	†	NA	Transdermal IV infusion	Yes
Glycopyrrolate	2 - 3	D5W, 0.9% NaCl	IV injection IM injection without dilution or via a running IV infusion	No
Granisetron HCl	4.7 - 7.3 (Single-use vials) 4 - 6 (Multiple-dose vials)	D5W, 0.9% NaCl	IV injection undiluted IV infusion after dilution	

Haloperidol lactate	3 - 3.8	D5W	IM injection	Yes
Heparin	5 - 8 (Heparin sodium injection) 5 - 7.5 (Heparin lock flush solution)	D5W, 0.9% NaCl	Deep SC injection Intermittent IV undiluted or diluted Continuous IV infusion	No
Hepatitis B surface antigen (HBsAg)	†	NA	IM injection	Yes [‡]
Hepatitis B virus surface antigen recombinant	†	NA	IM injection SC injection	Yes [‡]
Hexoprenaline sulfate	†	D5W, 0.9% NaCl	IV infusion preceded by slow IV injection in the management of premature labor	
Hydralazine	3.4 - 4.4	Note: Not recommended to add to infusion solutions	IM injection Rapid IV injection	
Hydrocortisone	5 - 7	NA	IV injection	Yes
Hydroxocobalamin	8 - 10 (2% aqueous solution)	NA	IM injection	
Hydroxyprogesterone caproate	†	NA	IM injection	Yes
Hyoscine butylbromide	3 - 6.5	D5W, 0.9% NaCl	IM injection SC injection Slow IV injection	No
Idarubicin HCl	3.5	D5W, 0.9% NaCl	IM injection SC injection Slow IV injection	Yes
Ifosfamide	6	D5W, 0.9% NaCl	Slow IV infusion Continuous IV infusion	No
Immune Globulin IV	4 - 4.5 (Gamimune N®) 6.4 - 6.8 (Sandoglobulin®)	Gamimune N® diluted in D5W Sandoglobulin® diluted in D5W, 0.9%NaCl, or sterile water for injection	Slow IV infusion initially then the rate is gradually increased according to patient tolerance	Yes for Privigen®
Infliximab	†	NA	IV infusion over at least 2 hours	No
Insulin regular	7 - 7.8 (Neutral)	0.9% NaCl	SC injection IM injection IV infusion	Yes
Interferon alpha-2a	-	NA	IM injection SC injection	Yes*
Interferon alpha-2b	6.9 - 7.5 (Reconstituted powder for injection)	0.9% NaCl for IV infusion admixtures	IV infusion for reconstituted dry powder products IM injection or SC injection for the solution products	
Iohexol	6.8 - 7.7	NA	IV injection Intra-arterial Intrathecal (except for Omnipac® 350mg) Intra-articular	
Irinotecan HCl	3 - 3.8	D5W, 0.9% NaCl	IV infusion	No
Iron sucrose	10.5 - 11	0.9% NaCl	IV infusion	Yes [‡]
Isoproterenol HCl	2.5 - 4.5	D5W, 0.9% NaCl	IV infusion Direct IV injection IM injection SC injection	Yes
Isosorbide dinitrate	†	D5W, 0.9% NaCl	IV infusion Intracoronary bolus during PTCA	Yes [§]
Ketamine HCl	3.5 - 5.5	D5W, 0.9% NaCl	IM injection Slow IV injection	
Ketoprofen	6.5	NA	IV injection IM injection	Yes [§]
Ketorolac tromethamine	6.9 - 7.9	D5W, 0.9% NaCl	Slow deep IM injection IV injection	Yes
Labetalol HCl	3 - 4	0.9% NaCl	Direct IV injection Continuous IV infusion	Yes
Lidocaine	6.5 (5-7) (Injection pH) 3 - 7 (Premixed infusion solutions in D5W)	D5W, 0.9% NaCl, 0.45% NaCl	Direct IV injection Continuous IV infusion Note: Products containing 40, 100 or 200 mg/ml should not be given by direct IV without prior dilution; products containing preservatives should not be given IV	No

Lincomycin	3 - 5.5	D5W, 0.9% NaCl	Deep IM injection Slow IV infusion	No
Mesna	7.5 - 8.5	D5W, 0.9% NaCl	IV injection IV infusion	No
Methotrexate sodium	8.5 (7.5 - 9)	D5W, 0.9% NaCl	IM injection Intra-arterial Intrathecal Direct IV injection Intermittent IV infusion Continuous IV infusion	Yes
Methylergometrine maleate	4.4 - 5.2 (0.5% solution) 4.4 - 5.2 (0.02% aqueous solution)	NA	IM injection Slow IV over at least 1 min in case of emergency	
Methylergonovine Maleate	2.7 - 3.5	0.9% NaCl	IM injection Slow IV injection	
Methylprednisolone	7 - 8	D5W, 0.9% NaCl	IM injection Direct IV injection Intermittent IV Continuous IV infusion	No
Methylprednisolone acetate	3.5 - 7	NA	IM injection Intra-articular Intrasyovial without dilution Note: Must not be administered IV	
Methylprednisolone sodium succinate	7 - 8	D5W, 0.9% NaCl	Deep IM injection Direct IV injection Continuous IV infusion Intermittent IV infusion	
Methylthioninium chloride	-	NA	IV over several minutes Dye in diagnostic procedures	Yes
Metoclopramide	2.5 - 6.5	D5W, 0.9% NaCl	IM injection Direct IV injection undiluted slowly Intermittent IV infusion	
Metoclopramide HCl	2.5 - 6.5	D5W, 0.9% NaCl	IM injection Direct IV injection undiluted Intermittent IV infusion diluted	
Metoclopramide hydrochloride	3 - 6.5	D5W, D5W in 0.45% NaCl	IM injection Direct IV injection undiluted slowly over 1-2 min for 10 mg dose Intermittent IV infusion over 15 min diluted for larger doses	Yes
Metronidazole	0.5 - 2 (After reconstitution) 6 - 7 (On further dilution and subsequent neutralization)	D5W, 0.9% NaCl	Continuous IV Intermittent IV infusion over 1 h Note: MTZ must be diluted to 8mg/ml or less and neutralized prior to administration. Because of the very low pH of the reconstituted solution, it cannot be given by direct IV injection	Yes
Micafungin sodium	†	NA	IV infusion	
Midazolam	2.9 - 3.7	D5W, 0.9% NaCl	IM injection Slow IV injection IV infusion diluted	Yes
Milrinone	3.2 - 4	D5W, 0.9% NaCl, 0.45% NaCl	IV continuous infusion	
Mitoxantrone HCl	3 - 4.5	D5W, 0.9% NaCl	Slow IV infusion after dilution Continuous IV	No
Molsidomine	5.5-7.5 (1% solution in water)	0.9% NaCl	IV single dose IV infusion at a rate of 3mg/hr	
Morphine sulfate	2.5 - 6.5	D5W	SC injection IM injection Slow IV injection Slow continuous SC or IV infusion	Yes
Naloxone HCl	3 - 4	D5W, 0.9% NaCl	SC injection IM injection Continuous IV infusion	Yes
Nandrolone decanoate	†	NA	Oily IM injection	Yes*
Neostigmine methylsulfate	5 - 6.5	0.9% NaCl	IM injection SC injection Slow IV injection	Yes
Nicardipine HCl	3.5	D5W, 0.9% NaCl	Diluted before slow continuous IV infusion	

Nimodipine	†	D5W, 0.9% NaCl, LR	IV infusion Intracisternal Note: Should not be added to an infusion bag or bottle. It's drawn into a syringe and connected to a 3-way stopcock and polyethylene tube	Yes
Nitroglycerine	3 - 6.5 (Concentrate for injection) 4 (3 - 5) (Baxter premixed infusion solution)	D5W, 0.9% NaCl	IV infusion after dilution	No
Noradrenaline tartrate	3 - 4.5	Note: Not administer Noradrenaline in NaCl 0.9% because of lack of oxidative protection	IV infusion diluted in base & D5W with or without NaCl	Yes
Octreotide acetate	3.9 - 4.5	D5W, 0.9% NaCl	SC injection IV injection IV infusion	
Olanzapine	†	NA	IM injection Deep IM injection	Yes
Omeprazole	11	D5W, 0.9% NaCl	IV infusion IV injection	
Ondansetron HCl	3.3 - 4	D5W, 0.9% NaCl	IV infusion	
Oxacillin	6 - 8.5	D5W, 0.9% NaCl	Deep IM injection Direct IV injection Continuous IV infusion Intermittent IV infusion	No
Oxytocin	3 - 5	D5W, 0.9% NaCl	IV infusion IM injection	
Paclitaxel	4.4 - 5.6	D5W, 0.9% NaCl	IV infusion	Yes
Pamidronate	8.3 (1% aqueous solution)	D5W, 0.9% NaCl	Intermittent IV IV infusion	
Pancuronium bromide	3.8 - 4.2	D5W, 0.9% NaCl	IV injection	No
Papaverine HCl	≥ 3	D5W, 0.9% NaCl	IM injection Slow IV injection	Yes
Pemetrexed	4.5	Preservative-free 0.9% NaCl ONLY	IV injection	
Penicillin G potassium	6 - 8.5	D5W, 0.9% NaCl	IM injection Continuous IV infusion Intermittent IV infusion	No
Penicillin G sodium	5 - 7.5	0.9% NaCl	IM injection Continuous IV infusion Intermittent IV infusion	No
Pentoxifylline	†	D5W, 0.9% NaCl	Slow IV injection IV infusion after dilution	Yes
Pethidine	3.5 - 6	D5W, 0.9% NaCl	Intermittent SC IM injection Direct IV injection Intermittent IV IV infusion Note: IM for repeated doses and SC for occasional use	
Phenobarbital sodium	9.2 - 10.2	D5W, 0.9% NaCl, 0.45%NaCl	IM injection Slow IV injection	No
Phenylephrine HCl	3 - 6.5	D5W, 0.9% NaCl	SC injection IM injection Direct slow IV IV infusion	Yes*
Phenytoin sodium	10 - 12.3	Injected into a running 0.9% NaCl infusion	Direct IV in a running infusion	Yes for extended capsules
Phloroglucinol/ trimethylphloroglucinol	4 - 6 (1% aqueous solution)	NA	IV injection IM injection	Yes
Phytonadione	3.5 - 7 5 - 7 (Phytonadione Merck)	D5W, 0.9% NaCl	SC injection IM injection preferred Direct IV injection IV infusion	Yes
Piperacillin/Tazobactam	4.5 - 6.8	D5W, 0.9% NaCl	IV infusion after dilution Infusion via infusion pumps	No
Piracetam	-	NA	IM injection Slow IV infusion, as a drop IV	
Pneumococcal vaccine (23-valent)	4.5 - 7.4	NA	IM injection SC injection	Yes‡
Pralidoxime methyl sulfate	3.5 - 4.4	NA	Slow IV injection over 5 to 10 minutes IV infusion over 15 to 30 minutes SC injection IM injection	
Promethazine HCl	4 - 5.5	D5W, 0.9% NaCl	Deep IM injection IV injection	Yes

Propofol	4.5 - 6.6	D5W	Undiluted or diluted IV injection/infusion	No
Propranolol HCl	2.8 - 4	D5W, 0.9% NaCl	IV injection	Yes
Protamine sulfate	6 - 7	D5W, 0.9% NaCl	Slow IV undiluted as 10 mg/ml IV infusion after dilution	No
Quinine hydrochloride	6 - 6.8 (1% aqueous solution)	0.9% NaCl	IM injection IV infusion	
Ranitidine HCl	6.7 - 7.3	D5W, 0.9% NaCl	IM undiluted Slow IV after dilution Intermittent IV infusion Continuous IV infusion Direct IV injection	Yes ^s
Risperidone	-	NA	IM injection	
Rituximab	6.5	D5W, 0.9% NaCl	IV infusion Note: Do not give direct IV injection	Yes
Rocuronium bromide	4	D5W, 0.9% NaCl	Rapid IV injection IV infusion when admixed in IV infusion solution	
Scopolamine hydrobromide	3.5 - 6.5	NA	SC injection IM injection Direct IV injection after dilution	Yes
Sodium Bicarbonate	7 - 8.5	D5W, 0.9% NaCl	IV injection undiluted or diluted SC injection if diluted to isotonicity (1.5%)	No
Streptokinase	pH of the reconstituted solution is dependent on the diluent used	D5W, 0.9% NaCl but 0.9% NaCl is the preferred diluent	IV injection Intra-arterial Intracoronary infusion after dilution	
Streptomycin sulfate	5 - 8	D5W, 0.9% NaCl	Deep IM injection	Yes
Sufentanil citrate	3.5 - 6	D5W, 0.9% NaCl	Slow IV injection IV infusion IM injection	Yes
Suxamethonium chloride	4 - 5 (0.5% aqueous solution)	NA	IV injection IV infusion IM injection	
Teichoplanin	†	D5W, 0.9% NaCl	IM injection after reconstitution Direct IV bolus IV infusion after dilution of the reconstituted solution	
Tenecteplase	†	NA	IV bolus	
Tenoxicam	†	Addition to infusion solutions is not recommended	IM injection IV bolus	
Tetanus Immunoglobulins	†	NA	IM injection IV infusion	Yes
Tetracosactide acetate	†	NA	IV injection IM injection	Yes
Thiopental sodium	10.2 - 11.2	D5W, 0.9% NaCl	Slow IV infusion only	No
Tirofiban	5.5 - 6.5	D5W, 0.9% NaCl	IV infusion	No
TMP-SMX	10	D5W	IV injection only after dilution	Yes
Tramadol HCl	†	D5W, 0.9% NaCl	IM injection Direct IV injection slowly IV infusion after dilution	Yes
Tranexamic acid	6.5 - 8	D5W, 0.9% NaCl	IV infusion	
Triamcinolone acetonide	†	NA	IM injection Intra-articular	
Triptorelin acetate	†	NA	Daily SC injection IM or SC depot preparation	
Tropisetron HCl	5	D5W, 0.9% NaCl	Slow IV injection IV infusion	
Urapidil HCl	†	NA	IV injection	Yes (Wrapped in aluminum)
Valproate sodium	7.6	D5W, 0.9% NaCl	IV infusion over 60 min at a rate that does not exceed 20mg/min diluted in at least 50 ml of a compatible infusion solution	No
Vancomycin HCl	3.9 (Vancomycin in 0.9% NaCl) 2.5 - 4.5 (Vancomycin in D5W) 3 - 5 (Premixed Vancomycin)	D5W, 0.9% NaCl	Intermittent IV infusion Continuous IV infusion	No

Vecuronium bromide	4	D5W, 0.9% NaCl	Rapid IV injection IV infusion	Yes
Verapamil	4 - 6.5 (target 4.9)	D5W, 0.9% NaCl	Slow IV injection Direct IV injection IV infusion	Yes
Vinblastine sulfate	3.5 - 5 (Reconstituted lyophilized)	0.9% NaCl	IV injection only	Yes
Vincristine sulfate	3.5 - 5.5	D5W, 0.9% NaCl	Continuous IV infusion Intermittent IV infusion	Yes
Vinorelbine tartrate	3.5	D5W, 0.9% NaCl	IV injection after dilution only	Yes
Zoledronic acid	†	D5W, 0.9% NaCl Note: not to be mixed with LR or solutions containing divalent cations	IV infusion over not less than 15 min	
Zuclopenthixol acetate	†	NA	Deep IM injection	Yes

†: no data on pH, §: tablets are light sensitive, *: store in airtight container, ||: no data on light sensitivity, ‡: do not freeze, NA: not available

CONCLUSION

Given the importance of compatibility of IV medications admixture, we decided to formulate the following table on parenteral medications, their pH, their administration techniques, compatible diluents, and light sensitivity, to serve as a guide for hospital practitioners. This table will serve as a unique tool in helping decrease hospital related IV incompatibilities and stability errors, especially when PH levels of medications to be mixed together in dextrose in water or normal saline solutions are needed during special admixture preparation. Its uniqueness resides in the combination of commonly used FDA and European approved medications. Tertiary references used include

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