F. A. Davis Company

Always at your side...

IV Therapy Notes

Nurse's Clinical Pocket Guide

Lynn D. Phillips

Waterproof and Reusable

Includes...

- ✔ Wipe-Free Forms
- ✔ Administering IV Meds
- ✔ IV Piggyback Setup
- ✔ IV Compatibilities with Potassium
- ✔ Flushing IV Catheters
- ✔ Starting IVs
- ✔ Essentials of Fluid & Electrolytes
- ✔ Calculating IV Fluid Rates
- ✔ Nutritional Assessment
- ✔ Peripheral and Central Lines

and more!

Contacts • Phone/E-Mail	
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:
Name Ph:	e-mail:

IV Therapy Notes

Nurse's Pharmacology Pocket Guide

Lynn D. Phillips

Purchase additional copies of this book at your health science bookstore or directly from F. A. Davis by shopping online at www.fadavis.com or by calling 800-323-3555 (US) or 800-665-1148 (CAN)

A Davis's Notes Book

F. A. Davis Company • Philadelphia

F. A. Davis Company
1915 Arch Street
Philadelphia, PA 19103
www.fadavis.com

Printed in China by Imago

Last digit indicates print number: 10 9 8 7 6 5 4 3 2 1

Publisher, Nursing: Joanne Patzek DaCunha, RN, MSN
Project Editor: Ilysa H. Richman
Design Manager: Joan Wendt

Place $2\frac{7}{8} \times 2\frac{7}{8}$ **Sticky Notes** here
for a convenient and refillable note pad

✓ **HIPAA Compliant**
✓ **OSHA Compliant**

Waterproof and Reusable Wipe-Free Pages

Write directly onto any page of *IV Therapy Notes* with a ballpoint pen. Wipe old entries off with an alcohol pad and reuse.

Look for our other Davis's Notes titles

Available Now!

RNotes™: *Nurse's Clinical Pocket Guide*
ISBN: 0-8036-1060-2

LPN Notes: *Nurse's Clinical Pocket Guide*
ISBN: 0-8036-1132-3

MedNotes: *Nurse's Pocket Pharmacology Guide*
ISBN: 0-8036-1109-9

MedSurg Notes: *Nurse's Clinical Pocket Guide*
ISBN: 0-8036-1115-3

NutriNotes: *Nutrition and Diet Therapy Pocket Guide*
ISBN: 0-8036-1114-5

Coming Soon

LabNotes: *Guide to Lab & Diagnostic Tests*
ISBN: 0-8036-1265-6

PsychNotes: *Clinical Pocket Guide*
ISBN: 0-8036-1265-6

ECG Notes: *Interpretation and Management Pocket Guide*
ISBN: 0-8036-1265-6

OrthoNotes: *A Clinical Examination Pocket Guide*
ISBN: 0-8036-1350-4

MA Notes: *Medical Assistant's Pocket Guide*
ISBN: 0-8036-1281-8

Also by Lynn Diane Phillips

Manual of I.V. Therapeutics, 4th Edition
ISBN: 0-8036-1187-0

1

Contents: BASICS

Common Formulas

Syringe (Amount to be drawn up)	$\times$ (Drug) $= \dfrac{\text{Desired amount} \times \text{Total volume}}{\text{Total amount of drug on hand}}$
mL/hr— Infusion rate	$\times \dfrac{\text{drops}}{\text{min}} = \dfrac{\text{Desired amount} \times \text{drop factor of tubing}}{\text{Time in minutes}}$
Programming Pump Units/Hour	$\dfrac{D \times Q \text{ Method}}{A} \times \text{mL} = \dfrac{\text{Desired} \times \text{mL of fluid}}{\text{Available}}$
Micrograms/ Kilogram/ Minute	$\times$ mL/h = Ordered μg /min $\times$ pt. $\dfrac{\text{Weight in kg} \times 60 \text{ min}/1 \text{ hr}}{\text{Medication concentration (No. of } \mu\text{g/mL)}}$

To calculate volume/hour

Total Volume $\div$ Administration time = mL (volume)/hour

To calculate drops/minute

$\times$ gtt/min = Hourly Volume $\times$ gtt factor of tubing

$\dfrac{\text{(i.e. 125 mL) (i.e. 15 gtt/mL drop factor)}}{\text{Time in minutes (60)}}$

Body Surface Area (BSA)

Using cm & kg: $\sqrt{\dfrac{\text{Ht (cm)} \times \text{Wt (kg)}}{3600}}$	Using inches & lb: $\sqrt{\dfrac{\text{Ht (in)} \times \text{Wt (lbs)}}{3131}}$

3

Pediatric Formulas

Key Points

- Child's weight in kilograms
- What is the safe recommended dosage or range?
- Is the order safe?
- How many milligrams will you administer?

Milligram/kilogram/hour

$$X \text{ mL} = \text{mg} \times \text{kg wt} \times 24 \text{ hours}$$

Body Surface Area (BSA)
Dose based on BSA (use West nomogram)

$$\text{BSA in } m^2 \times \text{Recommended adult dose} = \text{Child dose}$$
$$\text{BSA of adult (1.7)}$$

Clark's Rule:
Dose based on child's weight

$$\frac{\text{Weight (lb)} \times \text{Average adult dose}}{\text{Average adult weight}} = \frac{\text{Child dose}}{150 \text{ lbs}}$$

Pediatric IV Solutions

Key Points

- Pediatric formulas are not different from those of adults; however, the difference is the amount of volume of solution used.
- Pediatric patients require a smaller volume of IV solutions.
- Accurate calculation of drug to volume of solution is important to prevent vein irritation.

Pediatric IV Medications by Pump

$$X \text{ mL/hour} = \frac{\text{Total volume to be infused (in mL)}}{\textbf{Total amount of time for infusion (in hours)}}$$

If to be infused by Volume Control Set by gravity

$$X \text{ gtt/min} = \frac{\text{Total volume to be infused (in mL)} \times \text{gtt factor}}{\textbf{Total amount of time for infused (in minutes)}}$$

Example: An 18-month-old child has Ancef 450 mg q 4 h IVPB over 15 minutes. The child weighs 19 kg. The maximum recommended infusion concentration is 50 mg/mL. The vial is Ancef 250 mg/mL. How many mL of medication will be provided in 450 mg? How many mL of IV solution needs to be added to equal the recommended final concentration? What should the IV pump be programmed for?

- Calculate volume of medication to be withdrawn from vial
  250 mg: 1 mL :: 450 : X mL
  $250 \times = 450$

  $$X = \frac{450}{250}$$

  $X = 1.8$ mL

- Calculate the volume of IV solution

  $$\frac{\text{Ordered dose X 1 mL}}{\text{Recommended concentration}} = \text{X mL}$$

  $$\frac{450 \text{ mg} \times 1 \text{ mL}}{50 \text{ mg}} = 9 \text{ mL}$$

  Therefore: to the 1.8 mL of Ancef, the nurse must add enough IV solution to give a TOTAL of 9 mL
  9 mL – 1.8 mL = 7.2 mL
  Add 7.2 mL of compatible IV fluid to volume control chamber, then add 1.8 mL of Ancef to make a total volume of 9 mL
  Final concentration: 50 mg/mL

- Calculate the mL/h to program the pump

  $$\frac{9 \text{ mL}}{0.25 \text{ hr}} = \textbf{36 mL/hr}$$

Universal Formula for Calculating Drip Rates and Drug Amounts

Image rights unavailable.

IV Fluid Rates in Drops per Minute

Order—mL/hr	10 Drops/mL	15 Drops/mL	20 Drops/mL	60 Drops/mL
10	2	3	3	10
15	3	4	5	15
20	3	5	7	20
30	5	8	10	30
50	8	13	17	50
75	13	19	25	N/A
80	13	20	27	N/A
100	17	25	33	N/A
120	20	30	40	N/A
125	21	31	42	N/A
150	25	38	50	N/A
166	27	42	55	N/A
175	29	44	58	N/A
200	33	50	67	N/A
250	42	63	83	N/A
300	50	75	100	N/A

Note: Microdrip tubing is not appropriate for rates over 50 mL/hr.

Basic Formula

$$X \text{ gtt/min} = \frac{\text{mL per hour} \times \text{Drop factor minute}}{\text{60 minutes}}$$

Use this page to calculate your drop rates (gtt/hour) for gravity infusions

Drip rate _____ = (Hourly volume) _____ / (Time) × (Drop factor tubing) _____

Drip rate _____ = (Hourly volume) _____ / (Time) × (Drop factor tubing) _____

Drip rate _____ = (Hourly volume) _____ / (Time) × (Drop factor tubing) _____

Drip rate _____ = (Hourly volume) _____ / (Time) × (Drop factor tubing) _____

Drip rate _____ = (Hourly volume) _____ / (Time) × (Drop factor tubing) _____

Note: When using an EID that is mL/hr, the drip rate is the same as for 60 gtt tubing (hourly volume = drip rate); e.g., 75 mL/hr would be 75 mL/hr.

General Dilution Chart (g to mg)

	Amount of Diluent						
Amount of Drug in Grams	**1000 mL**	**500 mL**	**250 mL**	**125 mL**	**100 mL**	**50 mL**	**25 mL**
Grams	*mg/mL*	*mg/mL*	*mg/mL*	*mg/mL*	*mg/mL*	*mg/mL*	*mg/mL*
0.25	0.25	0.5	1	2	2.5	5	10
0.5	0.5	1	2	4	5	10	20
1	1	2	4	8	10	20	40
1.5	1.5	3	6	12	15	30	60
2	2	4	8	16	20	40	80
2.5	2.5	5	10	20	25	50	100
3	3	6	12	24	30	60	120
3.5	3.5	7	14	28	35	70	140
4	4	8	16	32	40	80	160
4.5	4.5	9	18	36	45	90	180
5	5	10	20	40	50	100	200
6	6	12	24	48	60	120	240
7	7	14	28	56	70	140	280
8	8	16	32	64	80	160	320
9	9	18	36	72	90	180	360
10	10	20	40	80	100	200	400

To Use Chart

- Find mg/mL desired; track to amount of diluent desired and amount of drug in g required.
- Find amount of drug in g required; track to diluent desired and/or mg/mL desired.
- Find amount of diluent required; track to amount of drug in g and/or mg/mL desired.

Formula:

X g diluted in X amount = X mg/mL (Example: 1 g in 1000 mL = 1 mg/mL)

General Dilution Chart (mg to μg)

Amount of Drug in mg	Amount of Diluent						
	1000 mL	500 mL	250 mL	125 mL	100 mL	50 mL	25 mL
Milligrams	*μg/mL*	*μg/mL*	*μg/mL*	*μg/mL*	*μg/mL*	*μg/mL*	*μg/mL*
0.25	0.25	0.5	1	2	2.5	5	10
0.5	0.5	1	2	4	5	10	20
1	1	2	4	8	10	20	40
1.5	1.5	3	6	12	15	30	60
2	2	4	8	16	20	40	80
2.5	2.5	5	10	20	25	50	100
3	3	6	12	24	30	60	120
3.5	3.5	7	14	28	35	70	140
4	4	8	16	32	40	80	160
4.5	45	9	18	36	45	90	180
5	5	10	20	40	50	100	200
6	6	12	24	48	60	120	240
7	7	14	28	56	70	140	280
8	8	16	32	64	80	160	320
9	9	18	36	72	90	180	360
10	10	20	40	80	100	200	400

To Use Chart

- Find μg/mL desired, track to amount of diluent desired and amount of drug in mg required.
- Find amount of drug in mg required; track to diluent desired and/or μg/mL desired.
- Find amount of diluent required; track to amount of drug in mg and/or μg /mL desired.

Formula:

X mg diluted in X mL of solution = X μg/mL (1 mg in 1000 mL = 1 μg/mL)

Notes

11

Contents: F & E

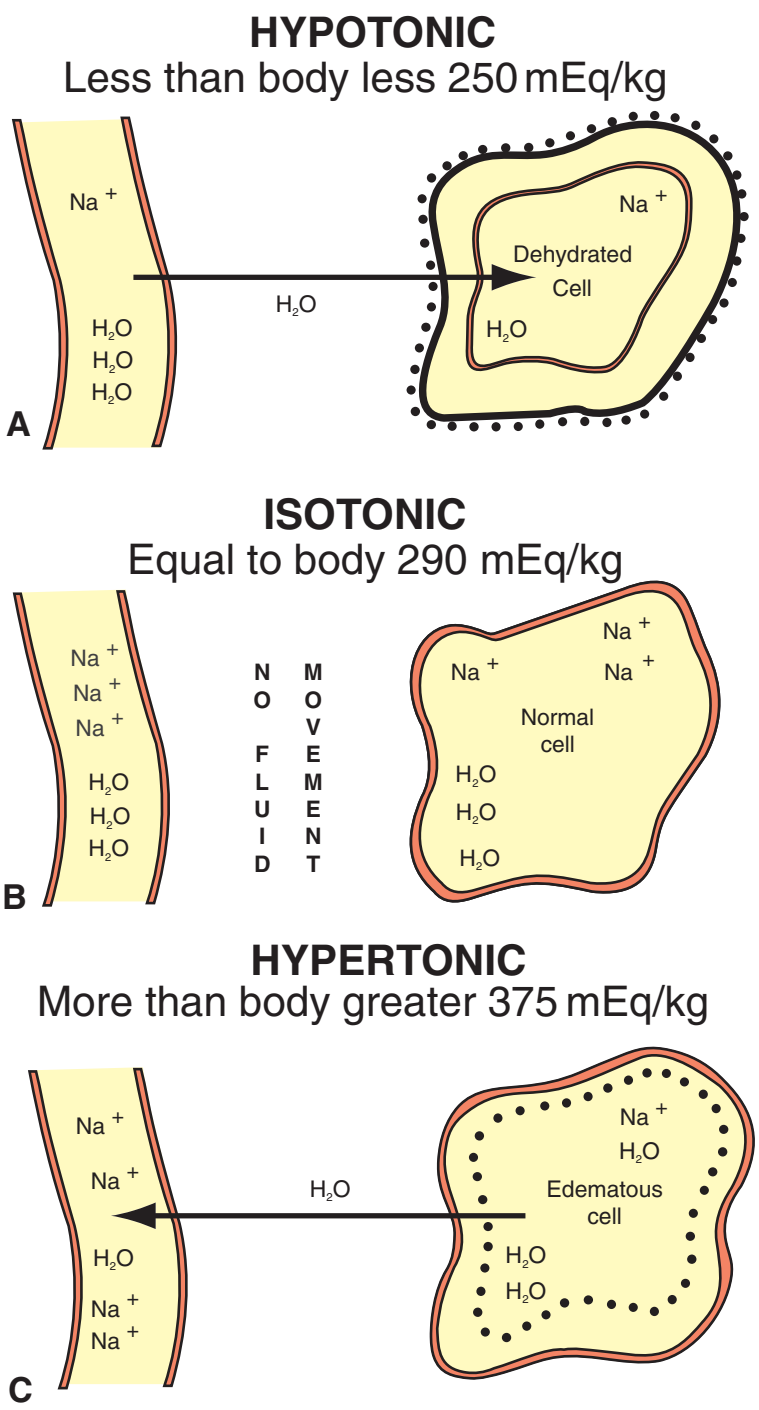
Percentage of Total Body Fluid in Relation to Age and Gender

Age	% of Water = Body Weight
Full-term newborn	70 to 80
Infant to 1 year	64
Puberty to 39 years	Men: 60 Women: 55
40–60 years	Men: 55 Women 47
Over 60 years	Men: 52 Women: 46

Osmolarity of Fluids

Normal body fluids	280–295 mOsm/L
Isotonic fluids	250–375 mOsm/L
Hypotonic fluids	Below 250 mOsm/L
Hypertonic fluids	Above 375 mOsm/L

Effects of Fluid Shifts in Isotonic, Hypotonic, and Hypertonic States



Fluid Imbalances

Sodium: Normal value 135–145 mEq/L

	Cause	Signs/Symptoms	Treatment
Fluid Volume Deficit	Acute weight loss, changes in mental status, posture, hypotension, dizziness, syncope, vertigo, distention of neck vein, decreased central venous pressure, weak pulse, nausea, vomiting and anorexia, increased thirst, decreased urine output, poor skin turgor over sternum and forehead, dry skin and mucous membrane, sunken eyes	**Serum** Hematocrit: Increased Hemoglobin: Increased Proteins: Increased Osmolarity: Normal **Urine** Sodium: <50 mEg/L Osmolarity: >500 mOsm/L Specific gravity: Above 1.030	Restore fluid and electrolyte balance using isotonic sodium chloride solutions. Treat underlying cause.
Fluid Volume Excess	Weight gain; edema occurs when 2–4 kg of fluid is retained; altered respiratory and cardiovascular function: hypertension, tachycardia; altered LOC, skeletal muscle weakness, and increased bowel sounds	**Serum** Hematocrit: Normal to low Hemoglobin: Normal to low Proteins: Normal to low Osmolarity: Normal BUN: Normal to low **Urine** Sodium: Reduced Osmolarity <500 mOsm/L Specific gravity: 1.010	Reduce fluid retention by salt and fluid restriction. Diuretics to increase fluid excretion. Treat underlying cause.

Sodium Imbalances

Sodium: Normal value 135–145 mEq/L

	Cause	Signs/Symptoms	Treatment
Sodium Deficit *Hyponatremia* *Serum Na+ <135*	Abnormal loss of GI secretions (vomiting, diarrhea); losses from skin; hormonal—SIADH Oxytocin Adrenal insufficiency	Na+<115: affects CNS cells Headache Sensation of taste impaired Anorexia Feeling exhausted, muscle cramps Focal weakness (hemiparesis, ataxia)	Replace sodium and fluid losses. Restore normal ECF volume. Correct any other electrolyte losses.
Sodium Excess *Hypernatremia* *Serum Na+ >145*	Person who cannot respond to thirst Hypertonic tube feeding Administration of sodium-containing solutions Drowning in seawater Heat stroke	Marked thirst Temperature Swollen tongue Red, dry, sticky membranes Disorientation Irritability Hyperactivity	Infuse hypotonic saline solution or 5%D/W Use diuretics

Potassium Imbalances

Normal value 3.5–5.5 mEq/L

	Cause	Signs/Symptoms	Treatment
Potassium Deficit *Hypokalemia* *Serum K+ <3.5*	Prolonged gastric losses Laxative overuse Potassium-wasting diuretic therapy Drugs such as sodium penicillin, carbenicillin, glucocorticoids Sweat losses	Neuromuscular changes Fatigue, muscle weakness, diminished deep tendon reflexes Anorexia, nausea ECG changes Increased sensitivity to digitalis	Mild: Dietary potassium supplements Potassium replacement by IV (See guidelines for administration of potassium)
Potassium Excess *Hyperkalemia* *Serum K+ >5.5*	Increase in potassium intake, oral or IV Decreased urinary excretion of potassium Shift of K+ out of cells	Changes to ECG Vague muscle weakness Anxiety, nausea, cramping, diarrhea	Restrict dietary K+ Administer regular insulin (10–25 U) in hypertonic dextrose to shift K+ Sodium polystyrene sulfonate Peritoneal dialysis

Critical Guidelines for Administration of Potassium

- **NEVER give potassium IV push (FATAL).**
- Do not give more than 120 mEq/24 hours without ICU monitoring.
- Potassium chloride (KCl) is compatible with most IV solutions.
- Never administer concentrated potassium without first diluting.
- Potassium solutions in commonly used strengths (20 or 40 mEq/L) are available in premixed form from manufacturers.
- KCl preparations greater than 60 mEq/L **should not** be given in peripheral vein.
- Make sure KCl mixes with the solution thoroughly—invert and agitate the container to ensure mixing.
- Do not add KCl to a hanging container!
- Administer potassium at a rate not to exceed 10 to 20 mEq/hr.
- For extreme hypokalemia, rates should be no more than 40 mEq/h while ECG is monitored.
- KCl administered into the subcutaneous tissue (infiltrated) is extremely irritating and can cause tissue damage. Use extravasation protocol.
- Use infusion pump to control flow rate.
- Use extreme caution for hourly replacement of potassium by secondary infusion.
- Potassium is primarily excreted through the kidneys—check kidney function!

IV Potassium Compatibilities

Medications Compatible with IV Potassium Chloride

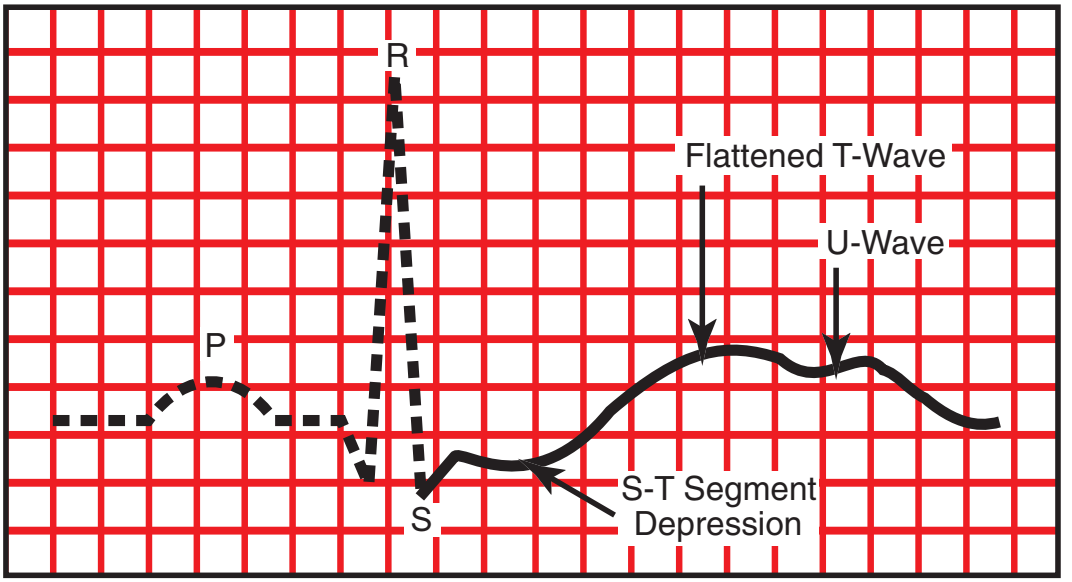
acyclovir
alatrovafloxacin
aldesleukin
allopurinol
amifostine
aminophylline
amiodarone
ampicillin
amrinone
atropine
aztreonam
betamethasone
calcium gluconate
chlordiazepoxide
chlorpromazine
cimetidine
ciprofloxacin
cisatracurium
cladribine
cyanocobalamin
dexamethasone
digoxin
diltiazem
diphenhydramine
dobutamine
docetaxel
dopamine
doxorubicin liposome
droperidol
droperidol/fentanyl
edrophonium
enalaprilat
epinephrine
esmolol
conjugated estrogens
ethacrynate sodium
etoposide
famotidine
fentanyl
filgrastim
fludarabine
fluorouracil
furosemide
gatifloxacin
gemcitabine
granisetron
heparin
hydralazine
idarubicin potassium
indomethacin
insulin
isoproterenol
kanamycin
labetalol
lidocaine
linezolid
lorazepam
magnesium sulfate

Medications Compatible with IV Potassium Chloride *(Cont'd)*

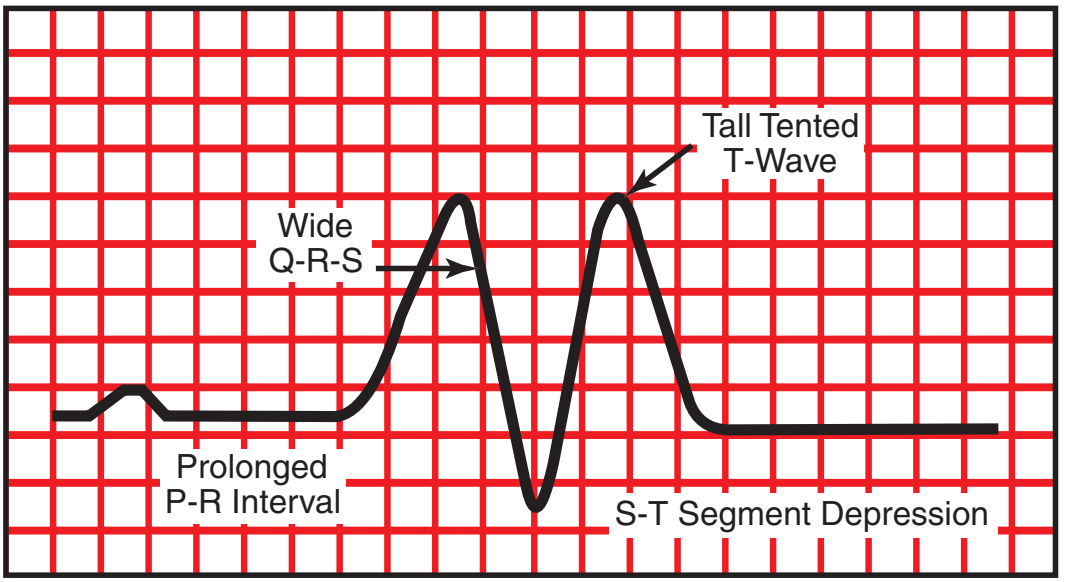
melphalan
menadiol
meperidine
methoxamine
methylergonovine
midazolam
minocycline
morphine
neostigmine
norepinephrine
ondansetron
oxacillin
oxytocin
paclitaxel
penicillin G potassium
pentazocine
phytonadione
piperacillin/tazobactam
procainamide
prochlorperazine edisylate
propofol
propranolol
pyridostigmine
ranitidine
remifentanil
sargramostim
scopolamine
sodium bicarbonate
succinylcholine
tacrolimus
teniposide
theophylline
thiotepa
tirofiban
trimethaphan
trimethobenzamide
vinorelbine
warfarin
zidovudine

Medications Incompatible with IV Potassium

adrenaline HCl
amphotericin B cholesteryl sulfate complex
atropine sulphate
cephalothin sodium
chloramphenicol sodium succinate
chlorpromazine HCl
diazepam
ergotamine tartrate
methicillin sodium
phenytoin
phenytoin sodium
sulphadiazine sodium
suxamethonium chloride
thiopentone sodium



Hypokalemia—ECG tracing has ST-segment depression, flattened T-wave, and a U-wave.

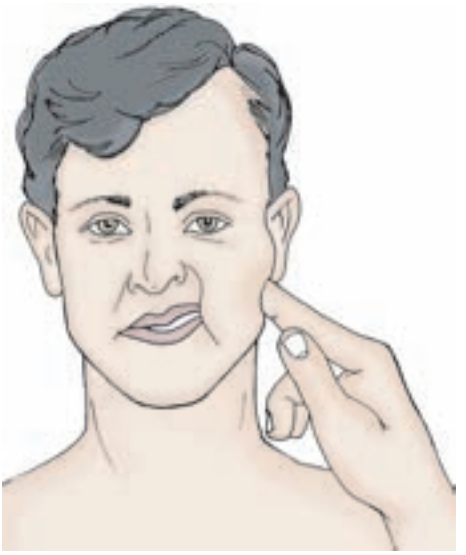


Hyperkalemia—ECG tracing has tall, thin T-waves; prolonged PR intervals; ST-segment depression; widened QRS; loss of P-wave.

Calcium Imbalance

	Cause	Signs/Symptoms	Treatment
Calcium Deficit *Hypocalcemia* *Serum level <8.5 mg/dL*	Inadequate secretion of PTH caused by primary hypoparathyroidism or surgically induced hypoparathyroidism; also results from calcium loss through diarrhea, wound exudate, acute pancreatitis, hyperphosphatemia associated with renal failure. Prolonged NG suctioning. Infusion of citrated blood.	Neuromuscular symptoms (numbness of fingers, cramps in muscles), hyperactive deep tendon reflexes, and positive Trousseau's sign and Chvostek's sign. Irritability, memory impairment, delusions, seizures (late), prolonged QT interval, and altered CV hemodynamics. Laryngospams and tetany-like contractions.	Alleviate underlying cause. Administration of calcium gluconate (orally or IV). IV 10–20 mL of a 10% solution in 5% D/W for 20 minutes.
Calcium Excess *Hypercalcemia* *Serum calcium >10.5* *Symptoms occur when 12 mg/dL or higher*	Excessive release of calcium from bone. Hyperparathyroidism, multiple fractures, overuse of calcium-containing antacids. Patients with solid tumors that have metastasized or hematologic tumors. Drugs that can increase calcium levels include mega-doses of vitamins A or D, diuretics, androgens, estrogens, IV lipids, lithium, and tamoxifen.	Neuromuscular symptoms such as muscle weakness, incoordination, lethargy, deep bone pain, flank pain, pathologic fractures. Constipation, anorexia, nausea, vomiting, polyuria, and renal colic. Patients taking digitalis must take calcium with extreme caution.	Administer calcitonin. Occasionally, plicamycin administered, which inhibits bone reabsorption and lowers serum calcium.

Positive Trousseau's Sign
Carpopedal attitude of the hand when blood pressure cuff is placed on the arm and inflated above systolic pressure for 3 minutes. Positive reaction is the development of carpal spasm.



Positive Chvostek's Sign
Occurs after tapping the facial nerve approximately 2 cm anterior to the earlobe.

Magnesium Imbalance

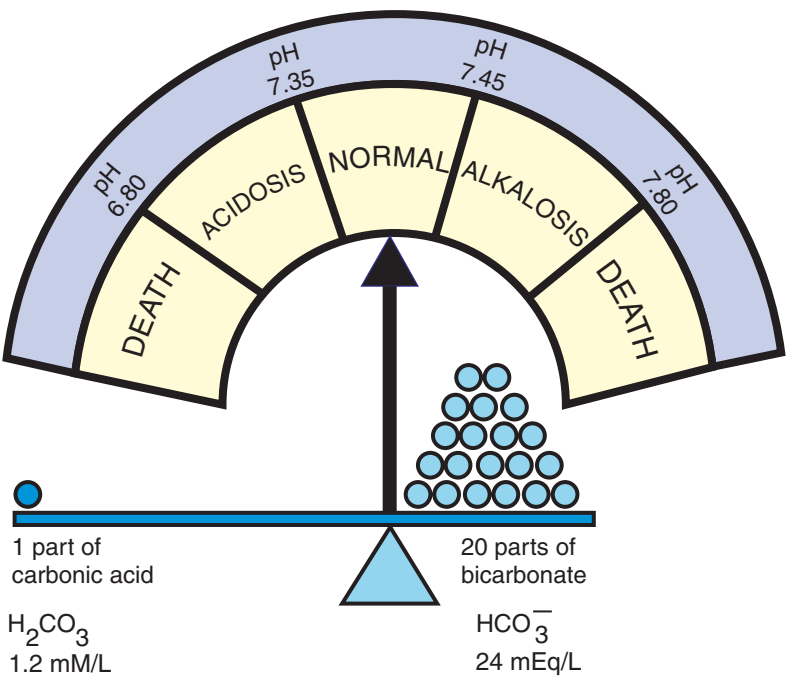
Normal Value: 1.5 to 2.5 mEq/L

	Cause	Signs/Symptoms	Treatment
Magnesium Deficit Hypomagnesemia Serum value <1.0 mEq/L	Chronic alcoholism; malabsorption syndrome, prolonged malnutrition or starvation; prolonged diarrhea; acute pancreatitis, prolonged NG suctioning. Administration of magnesium-free IV solutions past 1 week.	Neuromuscular symptoms, hyperactive reflexes, coarse tremors, muscle cramps, positive Chvostek's and Trousseau's signs, seizures, paresthesia of feet and legs, painfully cold hands and feet, disorientation, tachycardia, and increased potential for digitalis toxicity	Administer oral magnesium salts. Administer 40 mEq (5 g) magnesium sulfate added to 1 L of 5% D/W. Administer 1 to 2 g of 10% solution of magnesium sulfate by direct IV push at rate of 1.5 mL/min.
Magnesium Excess Hypermagnesemia Serum value >2.5 mEq/L	Renal failure Hyperparathyroidism; hyperthyroidism; excessive magnesium administration during treatment of patients with eclampsia.	Neuromuscular symptoms such as flushing and sense of skin warmth, lethargy, sedation, hypoactive deep tendon reflexes, depressed respirations, and weak or absent cry in newborn. Hypotension, sinus bradycardia, heart block, cardiac arrest (>15 mEq/L), nausea, vomiting, and seizures	Administer calcium gluconate to antagonize the action of magnesium. Support respiratory function. Peritoneal or hemodialysis.

Chloride Imbalance

	Cause	Signs/ Symptoms	Treatment
Chloride Deficit Hypochloremia Serum Chloride >95 mEq/L	GI losses Acute infection and use of chlorothiazide diuretics **Note:** Serious acid-base imbalances occur with chloride imbalances	Neuromuscular symptoms such as tetany and hypertonic reflexes. Depressed respirations and excessive loss of chlorides result in alkalosis Increase in HCO_3 levels	Treat underlying cause (alkalosis) Administer sodium chloride solutions

Acid-Base Scale



The Body's Reaction to Acid-Base Imbalance

Condition	pH	$Paco_2$	HCO_3	How the Body Compensates
Respiratory acidosis	↓	↑ or normal	↑	Kidneys conserve HCO_3 and eliminate H^+ to increase pH
With compensation	Slightly ↓ or normal	↑	↑	
Respiratory alkalosis	↑	↓ or normal	↓	Kidneys eliminate HCO_3 and conserve H^+ to decrease pH
With compensation	Slightly ↓ or normal	↓	↓	
Metabolic acidosis	↓	↓	↓ or normal	Hyperventilation to blow off excess CO_2 and conserve HCO_3
With compensation	Slightly ↓ or normal	↓	↓	
Metabolic alkalosis	↑	↑	↑ or normal	Hypoventilation to ↑ CO_2; kidneys keep H^+ and excrete HCO_3
With compensation	Slightly ↓ or normal	↑	↑	

Common Causes of Acid-Base Imbalance

Respiratory acidosis	Asphyxia, respiratory depression, CNS depression
Respiratory alkalosis	Hyperventilation, anxiety, PE (causing hyperventilation)
Metabolic acidosis	Diarrhea, renal failure, salicylate overdose such as ASA (aspirin)
Metabolic alkalosis	Hypercalcemia, overdose on an alkaline substance such as antacid

Summary of Acute Acid-Base Imbalances

Acid–Base Imbalance	pH	$Paco_2$	HCO_3	Signs & Symptoms	Causes
Acute Metabolic Acidosis	⇓	N* *⇓	⇓*	Tachypnea; Kussmaul's respirations; hypotension; cold, clammy skin; coma; dysrhythmias	Shock, arrest, ketoacidosis, starvation, acute renal failure, ingestion of acids
Metabolic Alkalosis	⇑	N *⇑	⇑*	Muscular weakness, hyporeflexia, dysrhythmias, apathy, confusion	Volume depletion, gastric drainage, vomiting, diuretic use, aldosteronism, severe potassium depletion
Respiratory Acidosis	⇓	⇑	No change ⇑*	Tachycardia, tachypnea, diaphoresis, headache, restlessness, coma, cyanosis, dysrhythmias, hypotension	Acute respiratory failure, drug overdose, chest wall trauma, asphyxiation, CNS trauma, impaired muscle of respiration
Respiratory Alkalosis	⇑	⇓	No change ⇓*	Paresthesia (fingers), dizziness, lethargy, confusion	Hyperventilation, salicylate poisoning, hypoxia with pneumonia, pulmonary edema, gram-negative sepsis, CNS lesion, inappropriate mechanical ventilation

*Compensatory response

27

Parenteral Solutions—Fast Facts

Dextrose Solutions

- 1600 calories needed daily for an adult at bed rest, which does not allow for fever or other increased metabolism needs.
- 5% dextrose in water = 5 g dextrose in 100 mL
- 1 L of 5% dextrose = 50 g of dextrose
- Provided as 2.5%, 5%, 10%, 20%, 30%, 50%, and 70%
- Hypotonic dextrose solutions hydrate the intracellular compartment
- Hypertonic dextrose solutions pull water from the intracellular compartment, decreasing swelling
- Before any medication is added to a dextrose solution, compatibility information should be checked

Sodium Chloride Solutions

- Provide for ECF replacement
- Available in 0.25%, 0.33%, 0.45%, 0.9%, 3%, and 5%
- During times of stress, the body retains sodium, adding to hypernatremia
- Hypotonic saline is 0.45% or less; can be used to supply normal daily salt and water requirements safely
- 0.9% sodium chloride is the only solution to be used with blood components
- Hypertonic sodium chloride (3% and 5%) can be dangerous when administered incorrectly

Hydrating Solutions

- Combination of dextrose and hypnotic sodium chloride
- Hydrates patients in dehydrated states
- Promotes diuresis—used for fluid challenge, check kidney function
- Potassium free

Multiple Electrolyte Solutions
Lactated Ringer's

- Solution that most parallels the body's extracellular electrolyte content
- Used to replace fluid loss from burns, bile, and diarrhea
- Contains bicarbonate precursor to assist in prevention of acidosis
- Should not be used in patients with impaired lactate metabolism

Alkalizing Solutions

- 1/6 molar sodium lactate and 5% sodium bicarbonate injection
- Used for metabolic acidosis

Acidifying Solutions

- Ammonium chloride
- Treat metabolic alkalosis
- Use with caution in patients with severe hepatic disease

Colloid Solutions

Dextran

- Polysaccharide
- Low molecular weight Dextran (Dextran 40) and high molecular weight Dextran (Dextran 70)
- Substitute for plasma expansion
- Contraindicated for severe bleeding disorders

Albumin

- Available as 5% or 25%
- 5% is osmotically and oncotically equal to plasma
- 25% equal to 500 mL of plasma
- Used for maintenance of blood volume

Mannitol

- Sugar alcohol substance
- Available from 5% to 25%
- Promotes diuresis
- Reduces intracranial pressure and cerebral edema

Hetastarch

- Hydroxyethyl glucose; synthetic colloid made from starch
- Hespan 6% or 10%
- Does not interfere with blood typing and cross-matching as do other colloidal solutions
- Possibility of allergic reaction
- Use cautiously in patient whose conditions cause fluid retention

Intravenous Solutions Chart

Solutions	Osmolarity	Indications	Precautions
Dextrose *2.5%* *5%* *10%, 20%, 50%, 70%*	Hypnotic Isotonic Hypertonic	Spares body protein Provides calories Provides free water Acts as a diluent for IV drugs Treats dehydration Treats hyperkalemia	Possible compromise of glucose tolerance Does not provide any electrolytes May cause vein irritation, water intoxication Hypertonic solutions may cause hyperglycemia, osmotic diuresis
Sodium Choride *0.25%* *0.45% half-strength* *0.9% full strength 3%* *5%*	Hypotonic Isotonic Hypertonic	Replaces ECF and electrolytes Replaces sodium and chloride Treats hyperosmolar diabetes Acts as diluent for IV drugs Used to initiate blood products Replaces severe sodium and chloride deficits Irrigant for intraavascular devices	Hyponatremia; calorie depletion; hypernatremia or hyperchloremia; circulatory overload; deficit of other electrolyte Can induce hyperchloremic acidosis due to loss of bicarbonate ions Does not provide free water or calories

(Continued on the following page)

Intravenous Solutions Chart *(Continued)*

Solutions	Osmolarity	Indications	Precautions
Hydrating Solutions *5% D/0.25% NaCl 5%* *D/0.45% NaCl 5%* *D/0.9% NaCl*	Isotonic Hypertonic	Assess kidney function Hydrate cells Promote diuresis Supply some calories Reduce nitrogen depletion Used as plasma expander	Use with caution in patients with edema and those with cardiac, renal, or liver disease. Do not use in patients allergic to corn.
Multiple Electrolyte *Lactated Ringer's* *5% D/LR*	Isotonic Hypertonic	Treats mild metabolic acidosis Replaces fluid losses from burns and trauma Replaces fluid losses from alimentary tract Rehydrates in all types of dehydration	Contraindicated in patients with lactic acidosis Circulatory overload
Plasma Expanders *Dextran 70 (6%) in water* *Dextran 40 (10%) in water*	Isotonic	Provides plasma expansion Treats shock Prevents venous thrombosis during surgery	Hypersensitivity reactions Increased risk of bleeding *Do not add any medications to dextran solutions

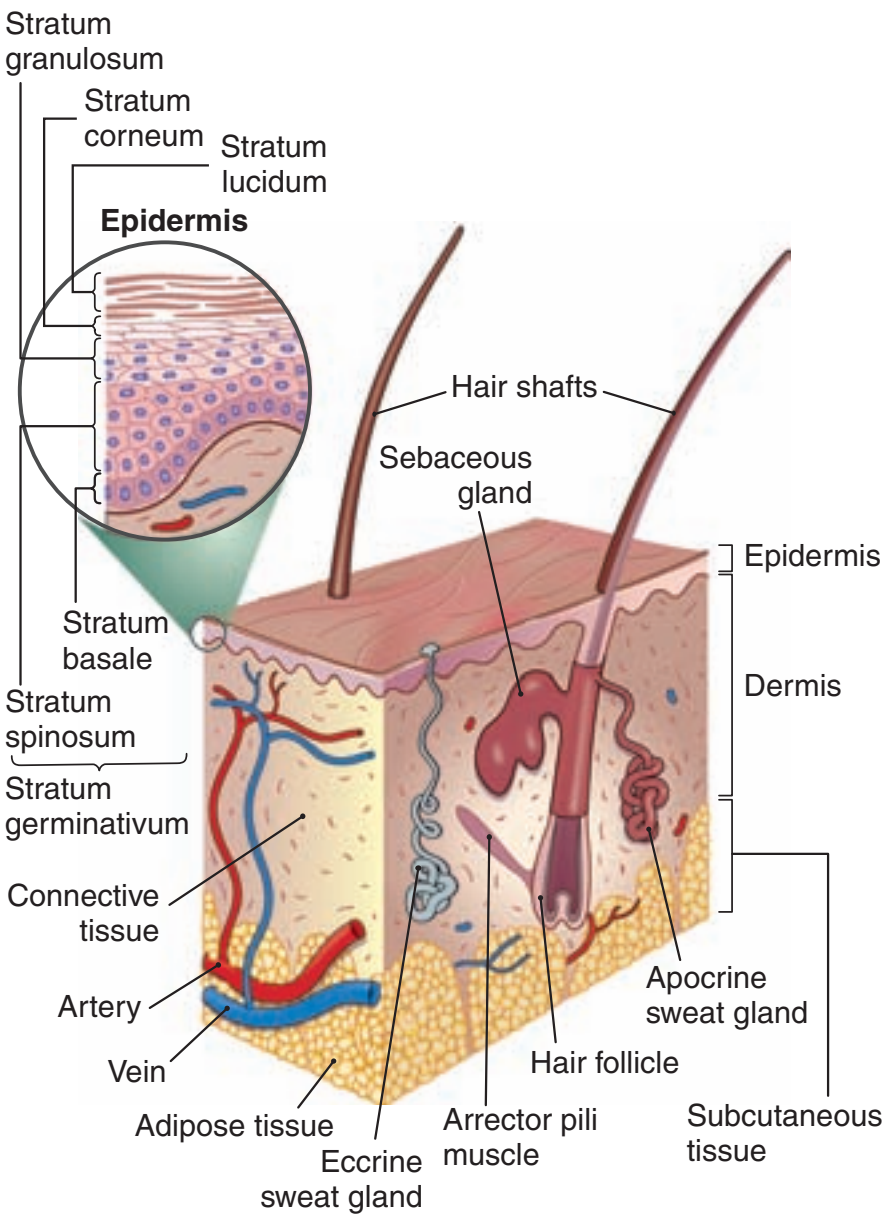
Intravenous Solutions Chart

Solutions	Osmolarity	Indications	Precautions
10% Mannitol *20% Mannitol*	Hypertonic	Reduces introcular pressure, reduces cerebral edema Promotes diuresis of toxic substances	Hypervolemia Extravasation Skin irritation Tissue necrosis Interferes with laboratory testing
5% Albumin *25% Albumin*		Restores circulatory dynamics Counteracts shock Provides protein Treats hyperbilirubinemia	Allergic reactions Circulatory overload Alteration in laboratory tests Due to heat during preparation, viral disease transmission is eliminated

Notes

Contents: PERIPHERAL

Skin



The skin consists of two main layers, the epidermis and dermis

- Epidermis composed of squamous cells: normally 5–7 cells thick as age decreases layers of cells and thins
- Dermis: thicker layer consists of blood vessels, hair follicles, sweat glands, small muscles, and nerves

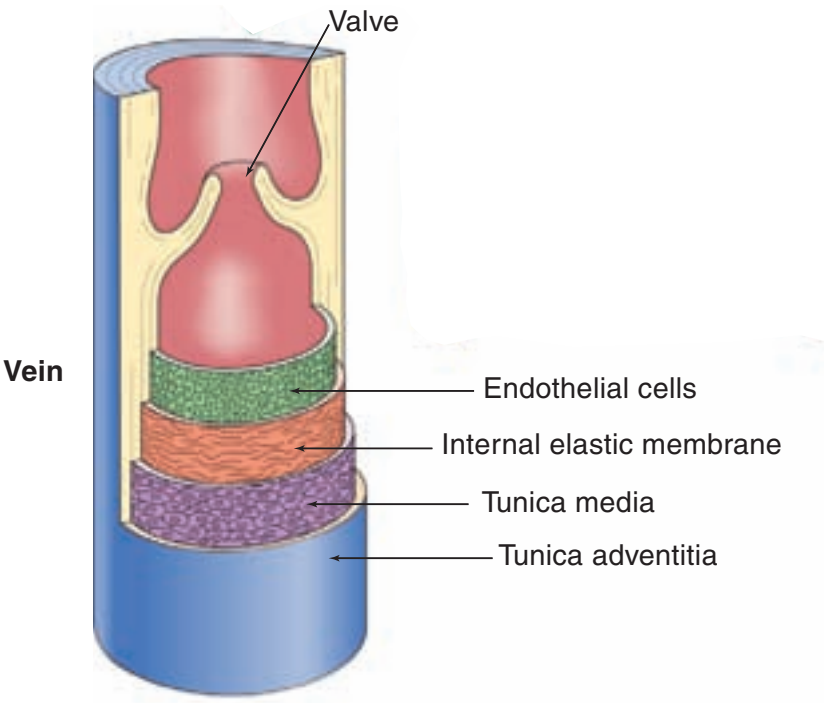
- Dermis reacts quickly to painful stimuli, temperature changes, and pressure sensation. Most painful layer during venipuncture!
- Sensory receptors are located in dermis
  - Mechanoreceptors—process skin tactile sensations (vein palpation)
  - Thermoreceptors—process cold, warmth, and pain (application of heat and cold)
  - Nociceptors—process pain (insertion of catheter)

Venous System

Venous blood flows slower in periphery and increases in turbulence in the larger veins of the thorax

Cephalic and basilic veins: 45–90 mL/min
Subclavian vein: 150–300 mL/min
Superior vena cava: 2000 mL/min

Anatomy of a Vein



Key Points

Tunica Adventitia

- Outermost layer
- Supports and surrounds a vessel
- Blood supply of this layer called vasa vasorum—in IV therapy when you get a small amount of blood flow but cannot thread the catheter, you are in this layer of the vein!

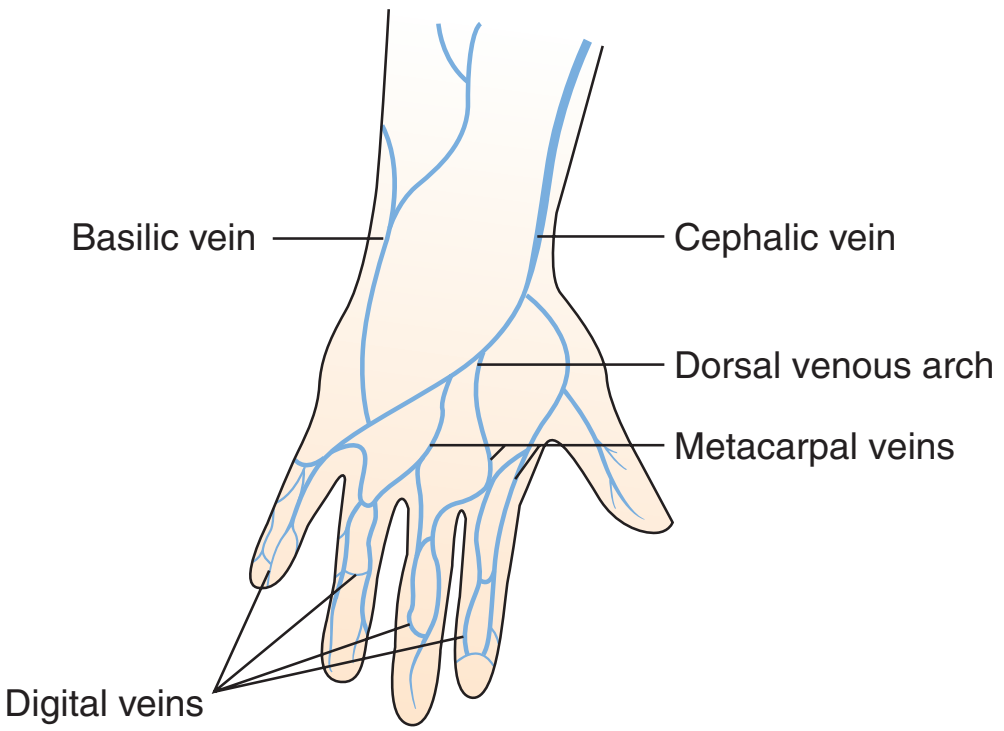
Tunica Media

- Middle layer composed of muscular and elastic tissue
- Contains nerve fibers for vasoconstriction and vasodilation
- Collapses or distends as pressure decreases or increases

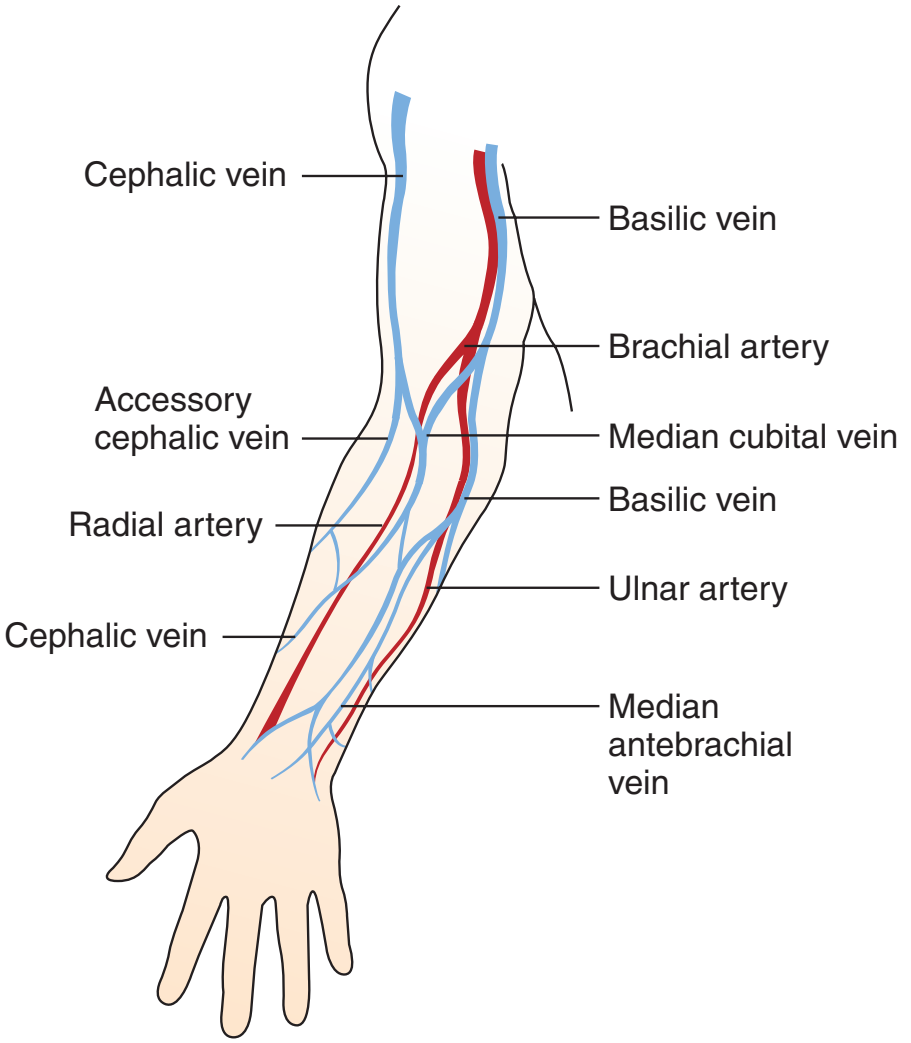
Tunica Intima

- Innermost layer
- Has one thin layer of cells—endothelial lining
- Any roughening of this layer fosters the process of thrombosis formation

Anatomy of the Peripheral Vasculature



Superficial Vessels of the Forearm



Selection of Gauge of Catheter and Insertion Site

Vein Location	Size of Catheter	Considerations
Digital: Lateral and dorsal portions of fingers	Small gauge: 20–22 g	Use only solutions that are isotonic Use a padded tongue blade to splint the catheter

Selection of Gauge of Catheter and Insertion Site		
Vein Location	**Size of Catheter**	**Considerations**
Metacarpal: Dorsum of hand	20–22 g; 3/4–1 inch in length	Good site to begin therapy Easy to visualize Avoid if infusing antibiotics, potassium chloride, or chemotherapeutic agents!
Cephalic: Radial portion of lower arm along radial bone of forearm	18–22 g	Large vein, easy to access Useful for infusing blood and chemically irritating medications
Basilic: Ulnar aspect of lower arm, runs up ulnar bone	18–22 g	Difficult to access Large vein, easily palpated but moves easily; stabilizes with traction Vein dilates with multiple tourniquet technique
Upper cephalic: Radial aspect of upper arm above elbow	16–20 g	Difficult to visualize Excellent site for confused patients
Median antecubital veins: In the bend of the elbow; three veins *Median basilic* *Median cubital* *Median cephalic*	16–20 g	Should be reserved for blood draws Uncomfortable placement site owing to arm extending in an unnatural position Area difficult to splint with armboard If used in an emergency situation, change site within 24 hours

Phillips 15-Step Venipuncture Method

Pre-Catheterization

1. Check physician's order
2. Hand hygiene procedures
3. Prepare equipment and inspect for integrity
4. Patient assessment and psychological preparation
5. Site selection and vein dilation

Catheterization

6. Needle selection
7. Glove
8. Prepare site
9. Insertion of catheter into vein
10. Catheter stabilization and dressing management

Post-Catheterization

11. Label solution, tubing, and catheter site
12. Disposal of equipment
13. Patient education
14. Rate calculation
15. Documentation

Step 1: Check Physician's Order

A physician's order is necessary to initiate IV therapy. The physician's order should include:

- Type of solution
- Route of administration
- Amount to be infused either hourly or 24-hour volume
- Rate of infusion
- Duration of infusion
- Physician's signature

Step 2: Hand Hygiene Procedures

Indications for handwashing and hand antisepsis

- When hands are visibly dirty or contaminated with blood or other body fluids, wash hands with either a nonantimicrobial soap and water or an antimicrobial soap and water.

- If hands are not visibly soiled, use an alcohol-based hand rub to avoid routinely contaminating hands in all other clinical situations.
- Decontaminate hands before having direct contact with patients
- Do not wear artificial fingernails or extenders when having direct contact with patients at high risk

(CDC, 2002)

Step 3: Equipment Preparation

- Inspect solution container for integrity
  Glass—Hold up to light to look for cracks, clarity, particulate contamination, and expiration date
  Plastic—Squeeze to check for pinholes, clarity, particulate contamination, and expiration date
- Inspect administration set
  Choose the appropriate set: vented or nonvented
- Gather venipuncture and dressing supplies
  Catheter (22 g, 20 g, or 28 g most common)
  Dressing (gauze or TSM)
  Tape: 1-inch paper
  Prepping solution
  Gloves
  2×2 gauze

Step 4: Patient Assessment and Psychological Preparation

- Provide privacy
- Evaluate the patient preparedness for IV procedure by talking with patient before assessing veins

Things to know

- Patient's medical diagnosis.
- History of chronic disease that places patient at risk for complications.
- History of vasovagal reactions during venipuncture or when blood is seen.
- Has the patient had vascular access devices?
- Will the patient be going home with the catheter?

- If cultural barrier exists, take more time; speak slowly and distinctly but not louder. Use pictures. Keep messages simple, and use interpreter to improve communication.
- Assess both arms and hand prior to choosing appropriate vein.
- Choose the lowest best site for size catheter being inserted and type of therapy the patient will receive.

Step 5: Site Selection and Vein Dilation
Factors to consider before venipunctures:

- **Type of solution** to be infused—Hypertonic solutions and medications are irritating to vein.
- **Condition of vein**—Use soft, straight, bouncy vein; if you run your finger down the vein and it feels like a cat's tail—avoid! Avoid veins near previously infected areas.
- **Duration of therapy**—Choose a vein that can support IV therapy for 72–96 hours.
- **Catheter size**—Hemodilution is important. The gauge of the catheter should be as small as possible.
- **Patient age**—Elderly and children need additional time for assessment and management of insertion.
- **Patient activity**—Ambulatory patients using crutches or walker need catheter placement above the wrist.
- **Presence of disease or previous surgery**—Patients with vascular disease or dehydration may have limited venous access. If a patient has a condition causing poor vascular return (mastectomy, stroke), the affected side **must be avoided**.
- Presence of shunts or graft—Do **not** use the arm or hand that has a patent graft or shunt for dialysis.
- **Patient receiving anticoagulation therapy**
  Patients receiving anticoagulant therapy have a propensity to bleed.
  Local ecchymoses and major hemorrhagic complications can be avoided if the nurse is aware of the anticoagulant therapy.
  Precautions: Minimal tourniquet pressure; use the smallest catheter that is appropriate for therapy; use care in removing dressing.

- Patient with allergies
  - Identify allergies
  - Iodine—avoid povidone-iodine as skin preparation
  - Latex—set up latex allergy cart
  - Question regarding allergies to medications, foods, animals, and environmental substances

Vein dilation techniques

- **Tourniquet**—Latex or nonlatex used most frequently. Placed 6–8 inches above the venipucture site. If BP high, move farther from venipuncture site. If BP low, move as close as possible without risking site contamination.
- **Gravity**—Position the extremity lower than the heart.
- **Fist clenching**—Instruct patient to open and close his/her fist.
- **Tapping vein**—Using thumb and second finger, flick the vein; this releases histamines beneath the skin and causes dilation (do not slap vein).
- **Warm compresses**—10 minutes maximum. *Do not use microwave!*
- **Blood pressure cuff**—Inflate to 300 mm Hg; great for fragile veins
- **Multiple tourniquet technique**—Use 2 to 3 latex tourniquets; apply one high on arm and leave for 2 minutes; apply second at midarm below antecubital fossa; collateral veins should appear; apply third if needed.

Tips for selecting veins

- Suitable vein should feel relatively smooth and pliable, with valves well spaced
- Start with distal veins and work proximally
- Veins that feel bumpy (like running your finger over a cat's tail) are usually thrombosed or extremely valvular
- Veins will be difficult to stabilize in a patient who has recently lost weight
- Sclerotic veins are common among narcotic addicts
- Dialysis patients usually know which veins are good for venipunctures

Step 6: Needle Selection
Recommended gauges

- 16–18 g: Trauma
- 18–20 g: Infusion of hypertonic or isotonic solutions
- 18–20 g: Blood administration (18 g preferred)
- 22–24 g: Pediatric patients
- 22 g: Fragile veins in elderly person (if unable to place 20 g)
  - The tip of the catheter should be inspected for integrity prior to venipuncture
  - Only two attempts at venipuncture are recommended

Step 7: Gloving

Standard precautions require gloves to be worn during placement of an IV catheter.

Step 8: Site Preparation
Key points

- Do not shave site—Remove hair with scissors or clippers only
- Depilatories not recommended—Potential for allergic reaction
- Cleanse insertion site with one of the following solutions:
  - 2% Chlorhexidine gluconate (preferred)
  - Iodophor (povidone-iodine)
  - 70% Isopropyl alcohol
  - Tincture of iodine 2%

Standard of practice

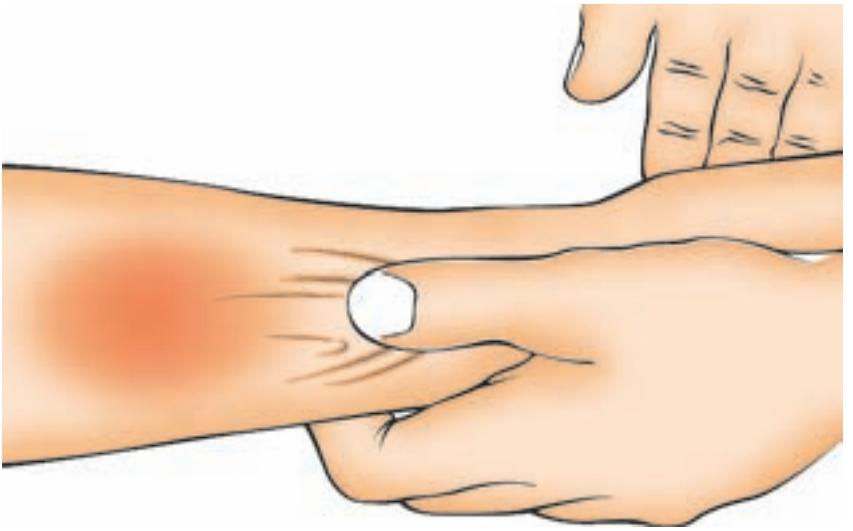
Do not apply 70% isopropyl alcohol after povidone-iodine preparation. Alcohol negates the effect of povidone-iodine (INS 2000, 47).

Technique: Apply antimicrobial solution, working from center outward in a circular motion for 2–3 inches for 20 seconds, using friction.

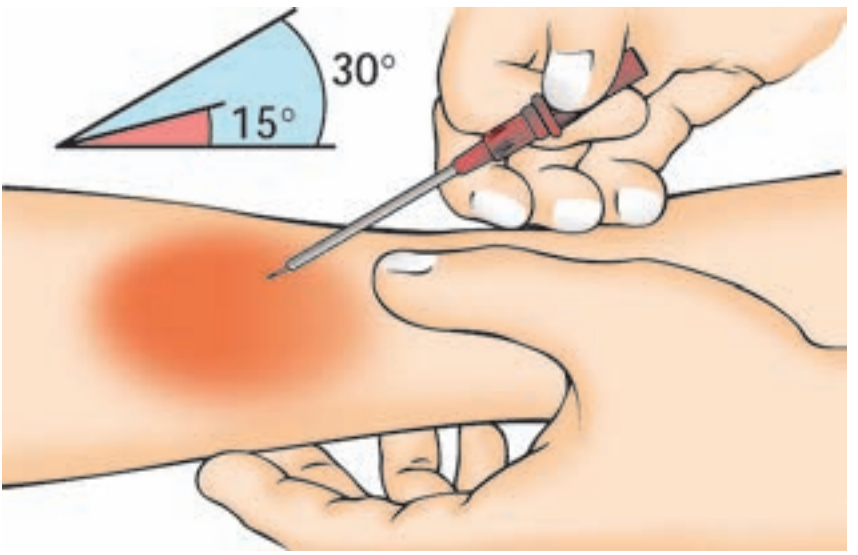
Step 9: Vein Entry
Two methods of venipuncture

- Direct method
- Indirect method

Step a—Pull skin below puncture site to stabilize the skin and prevent the vein rolling



Step b—Grasp flashback chamber on catheter
Step c—Insert needle **bevel up** at 30–45 degree angle



Step d—Insert catheter by direct or indirect method with steady motion

Direct: One-Step Method

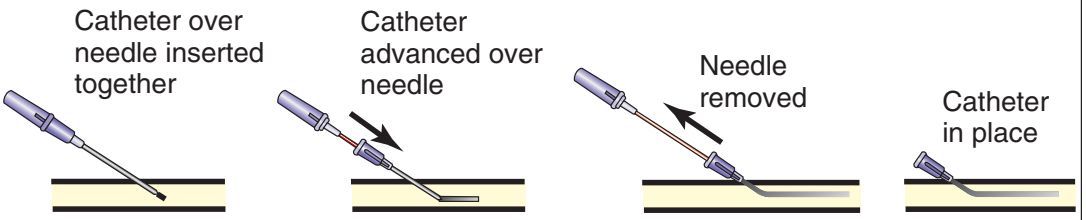
Insert catheter directly over vein

Penetrate all layers of vein in one motion

Indirect: Two-Step Method

Insert catheter at a 30-45 degree angle to skin alongside vein; gently insert catheter distal to point at which needle will enter vein; maintain parallel alignment and advance through the subcutaneous tissue

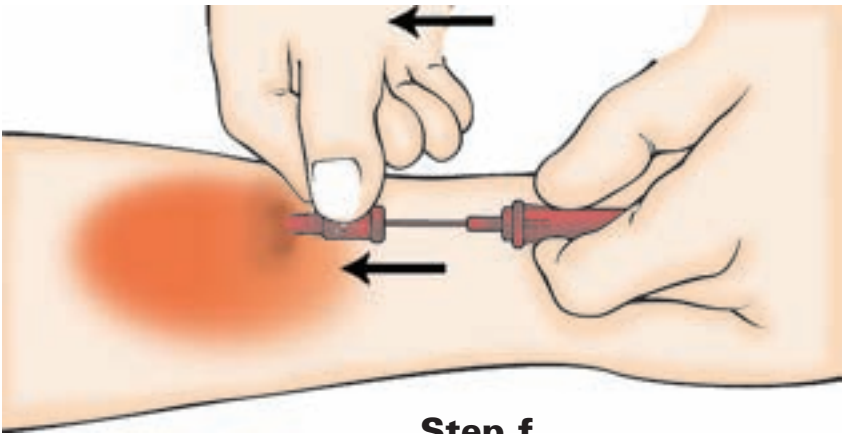
Relocate the vein and decrease the angle as the catheter stylet enters vein



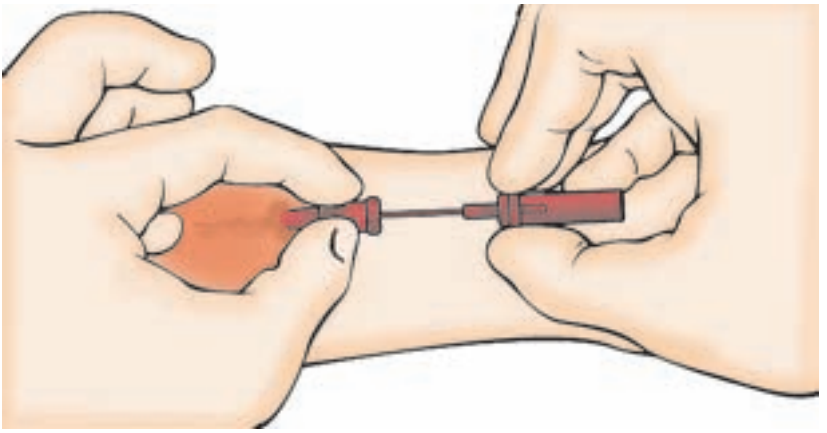
Step e—After bevel enters vein and blood flashback occurs, lower angle of catheter and stylet as one unit and advance into vein

Note: A steady backflow of blood indicates successful entry.

Step f—After vein is entered, cautiously advance catheter into vein lumen. Hold catheter hub with your thumb and middle finger and use your index finger to advance catheter, maintaining skin traction. A one-handed technique is recommended to advance catheter off the stylet.



Step f



Step h

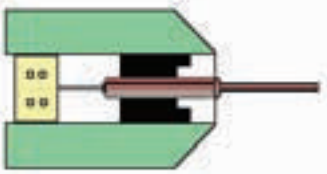
Step g—While stylet is still partially inside catheter, release tourniquet.
Step h—Remove stylet
Step i—Connect adaptor on administration set or PRN device to catheter hub

Step 10: Catheterization
Catheter stabilization and dressing management
Catheter Stabilization
Key Points

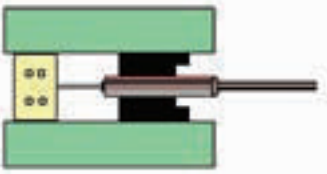
- Catheter should be stabilized in a manner that does not interfere with visualization.
- Methods appropriate for stabilization of catheter hub
  - U method
  - H method
  - Chevron method

STABILIZING THE CATHETER*

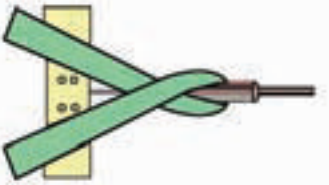
U Method



H Method



Chevron Method



Use for Winged Set	Use for Winged Set	Use for Winged Set
1. Cut three strips of $^1/_2$-in tape. With sticky side up, place one strip under tubing. 2. Bring each side of the tape up, folding it over the wings of the needle. Press it down, parallel with the tubing. 3. Loop the tubing and secure it with a piece of 1-in tape.	1. Cut three strips of 1-in tape. 2. Place one strip of tape over each wing, keeping the tape parallel with the needle. 3. Place another strip of tape perpendicular to the first two. Place over the wings to stabilize wings and hub.	1. Cover the venipuncture with transparent dressing or 2 × 2 gauze dressing. 2. Cut a long 5- to 6-in strip of $^1/_2$-in tape. Place one strip of tape, sticky side under hub, parallel with the dressing. 3. Cross the end of the tape over the opposite side of the needle so that the tape sticks to the patient's skin. 4. Apply a piece of 1-in tape across the wings of the chevron. Loop the tubing and secure it with another piece of 1-in tape.

*For all methods, include on the last piece of tape the date, time of insertion, size of gauge, length of needle or catheter, and your initials.

Dressing management

Types of dressings acceptable for peripheral catheter

- Gauze dressing with tape
- Transparent semipermeable dressing (TSM)

Standards of practice

- Gauze dressings should be changed every 48 hours on peripheral sites (INS 2000, 50)
- The use of nonocclusive-type adhesive bandage strip in place of dressing not recommended
- TSM dressing can be changed when catheter is changed (72–96 hr)

Step 11: Post-Catheterization

Labeling

Insertion site

The venipuncture site should be labeled:

- Date and time
- Type and length of catheter
- Nurse's initials

Administration set

- Label according to agency policy: label should have date on which administration set must be changed

Solution container

- Place a time strip on all parenteral solutions
- Any additives must have a clear label applied to bag

Step 12: Equipment Disposal

Standard of practice

Needles and stylets shall be disposed of in nonpermeable, tamper-proof containers (INS, 2000, 31)

Dispose of all paper and plastic equipment in a biohazard container

Step 13: Patient Education

Patient must receive information on all aspects of their care.

After catheter is stabilized, dressing is applied, and labeling complete:

- Inform regarding any limitations of movement or mobility
- Explain all alarms if EID is used
- Instruct to call for assistance if venipuncture site becomes tender or sore or if redness or swelling develops
- Advise that site will be checked every shift by the nurse

Home care

Comprehensive education to patient and caregiver includes the behavioral domains of cognitive, affective, and psychomotor along with written set of instructions on treatment.

Step 14: Rate Calculation

Refer to section in Basics for rate calculation information.

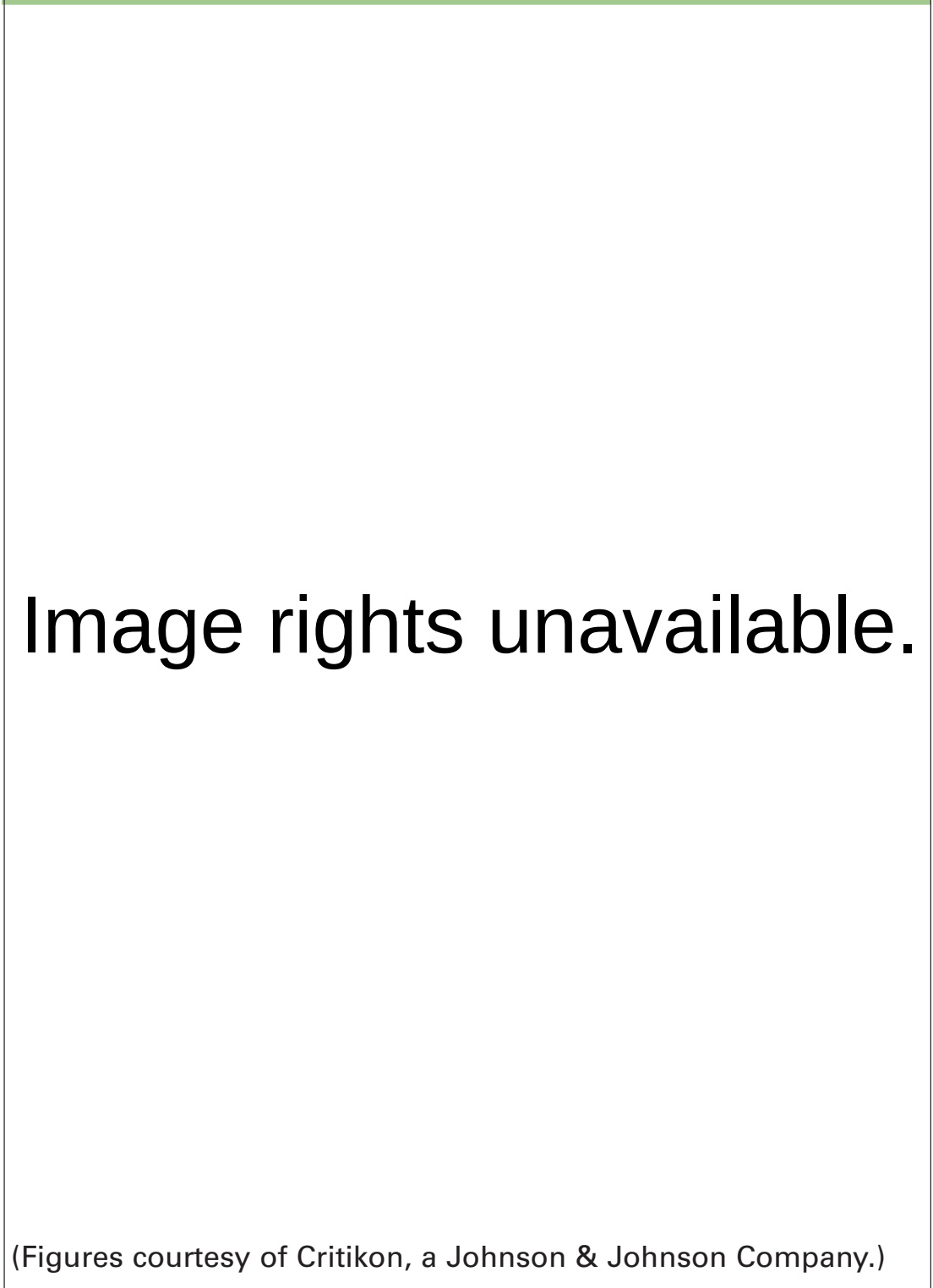
Do not leave patient care environment until rate is calculated and adjusted.

Step 15: Documentation

Documentation of IV therapy procedures include:

- Date and time of insertion
- Manufacturer's brand name and style of device
- The gauge and length of the device
- Specific name and location of the accessed vein
- Number of attempts for a successful IV start
- Infusing by gravity or EID
- Any add-on devices
- The patient's specific comments related to the procedure
- Signature

Applying a Dressing



(Figures courtesy of Critikon, a Johnson & Johnson Company.)

Procedure: Administration of Piggyback Secondary Infusion

Equipment: **Gloves, medication bag, secondary administration set, alcohol swabs**

- Verify physician order
- Educate patient regarding purpose of medication
- Follow hand hygiene procedures
- Observe standard precautions
- Check compatibility of medication with IV solution, and check expiration date
- Add drug to secondary IV infusion solution if appropriate, or remove piggyback medication prepared in pharmacy from refrigerator 10–15 minutes prior to infusion
- Secure secondary administration set onto piggyback solution container. Prime the set.
- Confirm patient's identity and verify allergy status
- Don gloves
- Swab injection port (port closest to drip chamber) with alcohol
- Hang secondary piggyback set container
- Insert needleless tip from secondary line into injection port. (Most systems have Luer lock device that secures the secondary administration set to the primary set port)
- Lower primary bag with the extension hook that is contained in the secondary administration box (primary set must hang lower than secondary)
- Open clamp and adjust drip rate
- Document procedure and medication administration

Note: As secondary infusion begins, the back check valve in the primary administration set will close from pressure, stopping the primary infusion.

Flushing Intermittent Infusion Devices

Intermittent infusion devices referred to as PRN devices, locking devices, heparin locks, saline locks. All use a resealable device!
Two methods of maintaining patency of locking devices: sodium chloride (saline flush) and heparin lock flush.

Procedure: Saline Flush—Use With Peripheral Devices

Flushing Supplies: Gloves, antiseptic solution swabs, preservative-free 0.9% sodium chloride (saline), syringes (3 mL or 5 mL)

- Follow hand hygiene procedures
- Don gloves
- Observe standard precautions
- Cleanse port with appropriate antiseptic solution
- Insert saline-filled syringe to catheter via insertion into locking device
- Slowly aspirate until positive blood return is obtained to confirm patency
- Slowly inject flush (1 mL)
- Disconnect syringe and attach medication syringe
- Adminster medication slowly
- Disconnect medication syringe; attach saline syringe
- Flush with saline, maintaining postive pressure
- Disconnect syringe from access port
- Document in patient record

Note: Most peripheral lines are maintained with sodium chloride flush

Flushing IV Catheters

Catheter Type	Solution	Strength	Frequency
Peripheral Catheters (Open Ended)			
Peripheral IV catheter	Normal saline	n/a	3 mL daily and PRN
Midline catheter (each lumen if multiple)	Heparin	10 units/mL	5 mL daily and PRN
Central Venous Catheters (CVC)			
Valved-tip catheters (Groshong)	Normal saline	n/a	5 mL per lumen weekly and PRN
Open-ended PICC lines	Heparin	10 units/mL	5 mL per lumen daily and PRN
Tunneled catheters (Hickman, Broviac)	Heparin	100 units/mL	5 mL per lumen daily and PRN
Implanted Port Catheters			
Groshong Port-a-Cath (when accessed)	Heparin	100 units/mL	5 mL daily and PRN

Solution Used to Flush a Catheter

Valved-tip catheters require only saline flushes; however, the use of heparin is not contraindicated. All other central lines require heparin flushes to minimize fibrin collection and clot formation.

Syringe Selection

The smaller the syringe size, the greater the pressure in PSI. Greater PSI pressure increases potential for catheter damage. Therefore, a syringe size of **10 mL** or greater is recommended for central-line flushes.

Positive-Pressure Flushing of Valved-Tip Catheters

Important: To reduce potential for blood backflow into the catheter tip, which promotes clot formation and catheter occlusion, always remove needles or needleless caps slowly while injecting the last 0.5 mL of saline.

"SAS" Technique: Flush with **S**aline, **A**dminister Med, Flush with **S**aline

Procedure: Heparin Lock Flush

Used most frequently with central venous access devices (CVADs)
SASH Method (*S*aline, *A*dministration, *S*aline, *H*eparin)
Flushing Supplies: Antiseptic solution swabs, preservative-free 0.9% sodium chloride injection, heparin 10 U, 100-μ/mL vials, syringes (10 mL), gloves, and sharps container

- Follow hand hygiene procedures
- Don gloves
- Observe standard precautions
- Cleanse injection port with appropriate antiseptic solution
- Connect saline-filled syringe to injection port
- Slowly aspirate until positive blood obtained, confirming catheter patency
- Flush with saline
- Cleanse port with appropriate antiseptic solution
- Connect medication to injection port
- Administer medication
- Disconnect medication from port
- Cleanse injection/access port with antiseptic solution
- Connect second saline-filled syringe to injection port
- Flush with saline
- Disinfect port with antiseptic solution
- Connect heparin-filled syringe to injection port and slowly aspirate to reconfirm positive blood aspirate
- Slowly inject flush, maintaining positive pressure
- Document heparin flush in patient record

Local Anesthesia

Anesthesia is used to provide a localized effect during vascular access. A physician's verbal or written order is required, and organization policy must be followed.
Types of local anesthetics:

- Transdermal analgesic cream

- Iontophoresis of lidocaine hydrochloride 2% with epinephrine 1:1000,000 topical solution
- Intradermal injection of lidocaine hydrochloride 1%

Procedure: Transdermal (Topical) Analgesic Cream

Equipment: Transdermal cream, occlusive dressing, single-use alcohol swabs

- Follow hand hygiene procedures
- Don gloves
- Observe standard precautions
- Follow manufacturer's guidelines
- Assess and select intended venipuncture site
- Cleanse site with antiseptic solution (usually alcohol)
- Cover with transparent semipermeable membrane (TSM) dressing for manufacturer's recommended time (30–60 min)
- Remove dressing and remaining cream
- Cleanse site with antiseptic solution, and begin venipuncture procedure
- Include use of transdermal cream in documentation

Procedure: Intradermal Anesthetic—Lidocaine 1%

Equipment: Gloves, intradermal anesthetics (lidocaine 1%), single-use alcohol swabs, gauze pads, tuberculin 1-mL syringe, sharps container

- Follow hand hygiene procedures
- Don gloves
- Observe standard precautions
- Cleanse site with alcohol and allow to dry
- Draw 0.3 mL of lidocaine 1% into tuberculin syringe
- With needle bevel up, gently insert needle intradermally above intended venipuncture site
- Inject 0.3-cc anesthetic to form wheal
- Remove needle and discard syringe in sharps container
- Include use of lidocaine in documentation procedure

IV Piggyback (IVPB) Setup

- The piggyback bag must be higher than the IV.
- To do this, use an **extension hook**.
- Use the most proximal access port on primary line.
- Adjust piggyback stopcock to desired rate.
- After infusion is complete, the primary IV bag will begin to drip again. Ensure primary drip rate.

Procedure: Medication Administration—Direct IV Push

Equipment: Gloves, three 3-cc syringes, one for medication, two for sodium chloride flush; medication; and filter needle if appropriate

- Verify physician order
- Educate patient regarding purpose of medication
- Follow hand hygiene procedures

- Observe standard precautions
- Check compatibility of medication with IV solution, and check expiration date
- Dilute opioid analgesics, and follow manufacturer's recommendation for administration
- Don gloves
- Cleanse lowest Y port, if using primary line, or resealable lock on locking device with antiseptic solution. Check for patency. If drug is incompatible with primary solution, flush catheter with 0.9% sodium chloride before and after administration of medication (INS, 2000, 73)
- Insert syringe into medication port
- Pinch tubing to primary solution if using primary line
- Inject one-fourth of medication into patient over a 15- to 20-second period
- Watch patient for any adverse effects
- Repeat above steps, delivering one-fourth of drug each time for three more times
- When the entire desired drug is delivered, remove syringe from port
- Flush catheter, following saline lock flush guidelines
- Document procedure and how patient tolerated medication administration

Discontinuation of IV Catheter

Equipment: Gloves, 70% isopropyl alcohol swabs, 2 x 2 inch sterile gauze, tape, Band-Aids, sharps container

- Verify physician order
- Check patient identification
- Explain procedure to patient
- Follow hand hygiene procedures
- Observe standard precautions
- Clamp infusion adminstration set and turn off EID
- Don gloves

- Remove all tape and carefully loosen skin from edges of TSM dressing over the IV site (use stretch method or alcohol over TSM dressing to loosen material)
- Place 2 x 2 inch sterile gauze over the IV insertion site and slowly withdraw catheter in one motion; do not apply pressure over catheter while removing; once catheter is removed, place on paper towel next to bed
- Apply firm pressure over venipuncture site once catheter has been removed
- Examine catheter for integrity and intactness
- Dispose of catheter in sharps container
- Once any signs of bleeding have stopped, apply Band-Aid or sterile 2 x 2 gauze and tape over site
- Assess site for signs of redness, swelling, or purulent drainage
- If patient is being discharged, educate about site care
- Document site assessment and catheter integrity

Local Complications of Peripheral IV Therapy

Complication	Signs & Symptoms	Treatment	Prevention
Hematoma	Ecchymoses Swelling Inability to advance catheter Resistance during flushing	Remove catheter Apply pressure with 2 × 2 Elevate extremity	Use indirect method of venipuncture Apply tourniquet just before venipuncture
Thrombosis	Slowed or stopped infusion Fever/malaise Inability to flush catheter	Discontinue catheter Apply cold compresses to site Assess for circulatory impairment	Use pumps Choose micro-drip sets with gravity flow if rate is below 50 mL/hr Avoid flexion areas
Phlebitis	Redness at site Site warm to touch Local swelling Pain Palpable cord Sluggish infusion rate	Use phlebitis scale for documentation Discontinue catheter Apply cold compresses initially; then warm Consult physician if 3+	Use larger veins for hypertonic solutions Choose smallest catheter appropriate Good hand hygiene Add buffer to irritating solutions Change solutions containers every 24 hr Rotate infusion sites every 72–96 hr

(Continued on the following page)

Local Complications of Peripheral IV Therapy *(Continued)*

Complication	Signs & Symptoms	Treatment	Prevention
Infiltration (extravasation)	Coolness of skin at site Taut skin Dependent edema Backflow of blood absent Infusion rate slowing	Use infiltration scale Discontinue catheter Apply cool compresses Elevate extremity slightly Follow extravasation guidelines Have antidote available	Stabilize catheter Place catheter in appropriate site Avoid antecubital fossa
Local infection	Redness and swelling at site Possible exudate Increase WBC count Elevated T lymphocytes	Discontinue catheter and culture site and catheter Apply sterile dressing over site Administer antibiotics if ordered	Inspect all solutions Good technique during venipuncture and site maintenance
Venous spasm	Sharp pain at site Slowing of infusion	Apply warm compress to site Restart infusion only if spasm continues	Thorough history Verify allergies Proper patient identification Warm solutions with appropriate warming device if appropriate

Systemic Complications of Peripheral IV Therapy

Complication	Signs & Symptoms	Treatment	Prevention
Septicemia	Fluctuating temperature Profuse sweating Nausea/vomiting Diarrhea Abdominal pain Tachycardia Hypotension Altered mental status	Restart new IV system Obtain cultures Notify physician Initiate antimicrobial therapy as ordered Monitor patient closely	Good hand hygiene Careful inspection of fluids Use Luer locks Cover infusion sites with appropriate dressings Follow standards of practice related to rotation of sites/hang time of infusions Use appropriate preparation solutions
Fluid overload	Weight gain Puffy eyelids Edema Hypertension Changes in I&0 Rise in CVP Shortness of breath Crackles in lungs Distended neck veins	Decrease IV flow rate Place patient in high Fowler's position Keep patient warm Monitor vital signs Administer oxygen Consider changing to microdrip set	Monitor infusion Maintain flow at prescribed rate Monitor I&0 Know patient's cardiovascular history Do not "catch up" infusion—recalibrate

(Continued on the following page)

Systemic Complications of Peripheral IV Therapy *(Continued)*			
Complication	**Signs & Symptoms**	**Treatment**	**Prevention**
Air embolism	Lightheadedness Dyspnea, cyanosis, tachypnea, expiratory wheezes, cough Mill wheel murmur, chest pain, hypotension Changes in mental status Coma	Call for help! Place patient in Trendelenburg position Administer oxygen Monitor vital signs Notify physician	Remove all air from administration sets Use Luer locks Attach piggyback to appropriate port
Speed shock	Dizziness Facial flushing Headache Tightness in chest Hypotension Irregular pulse Progression of shock	Call for help! Give antidote or resuscitation medications	Reduce the size of drops by using microdrip set Use EID Monitor infusion sites Dilute IV push mediations if possible; give slowly
Catheter embolism	Sharp sudden pain at IV site Rough, uneven catheter noted on removal Chest pain Tachycardia	Apply tourniquet above elbow Contact physician Start new IV Measure remainder of catheter	Use radiopaque catheters! Do not apply pressure over site. Avoid joint flexions. Never reinsert stylet that has been removed from sheath.

Phlebitis Scale

Text rights unavailable.

Source: Revised Standards of Practice (2000). Infusion Nurses Society, with permission.

Calculation of Phlebitis Rates

The peripheral phlebitis incidence rate should be calculated according to a standard formula:

$$\frac{\text{Number of phlebitis incidents}}{\text{Total number of IV peripheral lines}} \times 100 = \%\ \text{of Peripheral phlebitis}$$

Infiltration Scale

Text rights unavailable.

Source: Revised Standards of Practice (2000). Infusion Nurses Society, with permission.

Factors in Flow Rate Control

Patient Related	Vein Related
Patient or family manipulation Patient blood pressure	Infiltration Phlebitis
Venous spasm	

Administration Set Related	Clot Formation
"Cold flow" of plastic set Drop formation rate Final in-line filters Kinked or pinched set Rate of fluid flow Slipping of roller clamp–gravity set EID malfunction	Needle or catheter position **Other** Height of IV standard Bed position

Complications of Starting/Maintaining IVs

Infiltration	Phlebitis
Assessment: Swelling; tenderness; decreased or no infusion rate; blanching of skin; site is cool to touch.	**Assessment:** Classic sign is red line along course of vein; other signs include redness, heat, swelling, and tenderness.
Interventions: D/C IV, and restart in a new site. Apply warm compress to affected area.	**Interventions:** D/C IV, and restart in a new site. Apply warm compress to affected area.

Extravasation Antidote Chart

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Adrenergic Agents	amrinone (Inocor) dobutamine (Dobutrex) dopamine (Intropin) epinephrine (Adrenalin) isoproterenol (Isuprel) metaraminol (Aramine) methoxamine (Vasoxyl) norepinephrine (Levophed) phenylephrine (NeoSynephrine)	Usually sloughing and tissue necrosis with extravasation	5–10 mg phentolamine mesylate into extravasated area	Discontinue infusion Aspirate any remaining drug with a syringe Apply cold compresses Slightly elevate extremity only if elevation does not cause pain Inject drug into extravasated area, using small intradermal needle (27–25 g)

(Continued on the following page)

Extravasation Antidote Chart *(Continued)*

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Alkalinizing Agents	sodium bicarbonate tromethamine (Tham-E)	Usually causes ulceration, sloughing, cellulites, and tissue necrosis	Inject 1% procaine to reduce venous spasm Inject 5 to 10 mg phento-lamine mesylate into extravasated area **Or** Inject hyaluronidase (Wydase) 150 U/mL	Discontinue infusion Use small intradermal needle (27–25 g) Apply cold compresses Elevate slightly*

Extravasation Antidote Chart *(Continued)*

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Alkylating Agents	carmustine (BCNU) irritant streptozocin (Zancosar) mechlorethamine (nitrogen mustard) vesicant	Usually causes sloughing and tissue necrosis	Inject long-acting dexamethasone or other corticosteroid dimethylsulfoxide (DSM) applied topically **OR** sodium thiosulfate	Discontinue infusion Apply cold compresses or ice pack (20 min/hr) Elevate slightly* Apply every 3, 4, 6, or 8 hours for 7–14 days. Use ice compresses for 20 min/hr until inflammation

(Continued on the following page)

Extravasation Antidote Chart *(Continued)*				
Drug Class	**Medication**	**Extravasation Symptoms**	**Antidote & Dose**	**Nursing Tip**
Antihypertensive Agents	nitroprusside sodium (Nipride)		sodium thiosulfate	Discontinue infusion Dilute 4 mL with 6 mL of sterile water; inject 1 to 4 mL through existing catheter; give 1 mL for each milliliter extravasated Use cool compress Elevate slightly*

Extravasation Antidote Chart

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Antineoplastic agents (RNA/DNA inhibitors or mitotic inhibitors)	dacarbazine (DTIC) vesicant etoposide (VePeside) irritant vinblastine (Velban) vesicant vincristine (Oncovin) vesicant vindesine (Eldisine) vesicant	Usually causes severe tissue sloughing and necrosis	Inject long-acting dexamethasone or other corticosteroid **OR** hyaluronidase (Wydase) 150 U/mL	Discontinue infusion Aspirate any remaining drug Apply warm compress Use 27–25 g needle Elevate slightly*

(Continued on the following page)

Extravasation Antidote Chart *(Continued)*

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Antibiotic antineoplastic agents	dactinomycin (Actinomycin D) vesicant daunorubicin (Daunomycin) vesicant doxorubicin (Adriamycin) vesicant idarubicin (Idamycin) vesicant mitomycin C (Mutamycin) vesicant plicamycin (Mithramycin) vesicant	Generally, cause stinging, burning, severe cellulitis, and tissue necrosis	Flush the extravasated area with 0.9% sodium chloride Inject long-acting corticosteroid Inject hyaluronidase (Wydase) (150 U/mL 0.2 mL × 5 SQ throughout the area) Flush with 0.9% sodium chloride Inject long-acting dexamethasone **OR** Inject hyaluronidase (Wydase) 150 U/mL 0.2 mL × 5 SQ Inject long-acting dexamethasone	Discontinue infusion Aspirate any remaining drug Use small-gauge (27–25g) needle Apply cold compresses Elevate slightly* Discontinue infusion after sodium bicarbonate (neutralizing agent is instilled into catheter) Apply cool compresses

Extravasation Antidote Chart

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Electrolyte Solutions	Calcium carbonate Calcium chloride Calcium gluconate Calcium lactate Calcium gluceptate Potassium solutions	Vein irritation that generally causes necrosis, sloughing, cellulitis, and tissue necrosis	Inject hyaluronidase (Wydase) through administration set 150 U/mL 0.2 mL × 5 SQ	Discontinue infusion Apply cool compresses Elevate slightly*
Penicillins	nafcillin (Nafcil; Unipen) ampicillin sodium (Unasyn) azlocillin sodium (Azlin)	Sterile abscesses, thrombophlebitis, and severe pain	Inject hyaluronidase (Wydase) 150 U/mL 0.2 mL	Stop the infusion Aspirate any remaining drug Administer antidote throughout the area to dilute extravasated drug. Use 27–25 g needle subcutaneously

(Continued on the following page)

Extravasation Antidote Chart *(Continued)*

Drug Class	Medication	Extravasation Symptoms	Antidote & Dose	Nursing Tip
Hypertonic (>10% Solutions)	Dextrose solutions		Inject hyaluronidase (Wydase) 150 U/mL through administration set 150 U/mL 0.2 mL × 5 SQ	Discontinue infusion Apply cool compresses Elevate slightly†

* Research on small quantities of infiltrated IV solutions followed by magnetic resonance imaging found that hypotonic solutions decreased in volume and hypertonic solutions increased in volume with elevation.

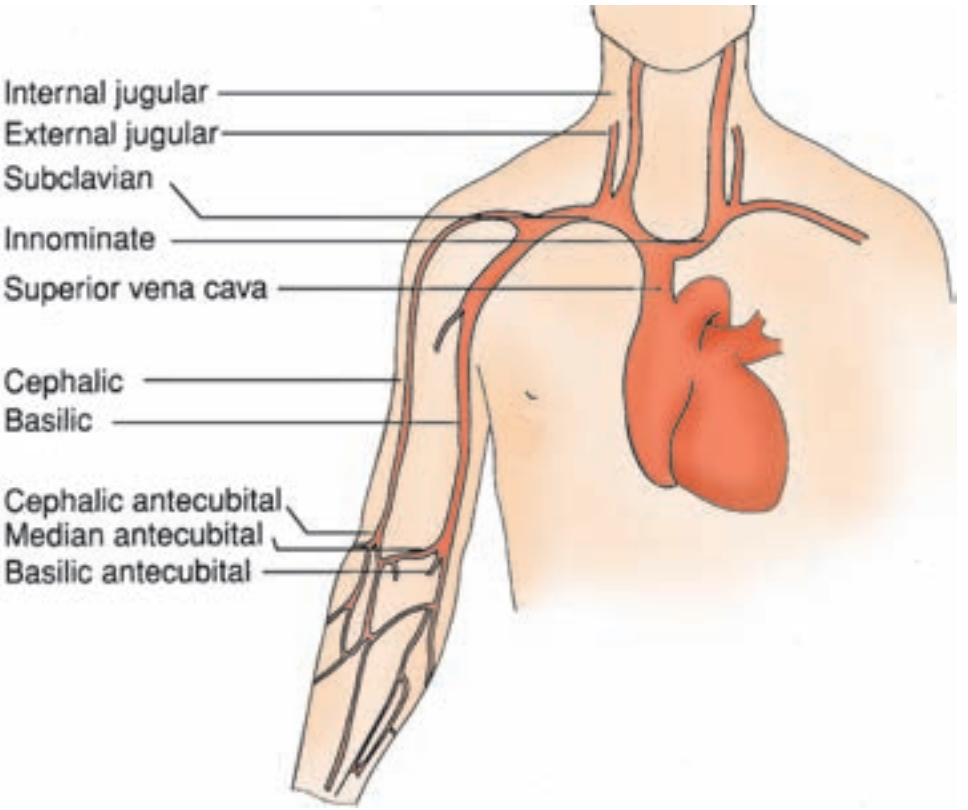
† A 4-inch elevation of the extremity made no difference in the rate of fluid reabsorption. Elevating the arm may be uncomfortable for some patients.

Notes

Notes

Contents: CENTRAL

Anatomy and Physiology Related to IV Practice



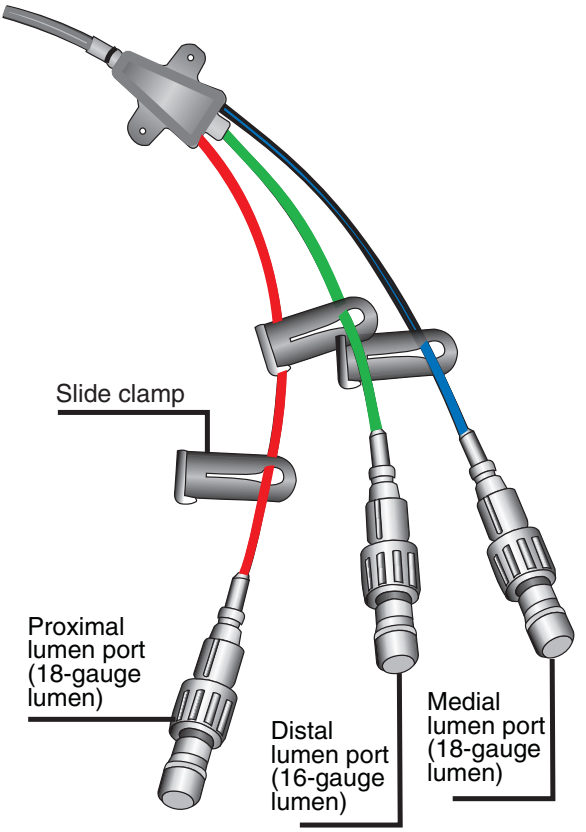
Anthropometric Measurements of Venous Anatomy

Vein	Length, cm	Diameter, mm
Cephalic	38	6
Basilic	24	8
Axillary	13	16
Subclavian	6	19
Right brachiocephalic	2.5	19
Superior vena cava	7	20

Key Terms

CVAD—central vascular access device
CVC—central venous catheter
CVTC—central venous tunneled catheter
PICC—peripherally inserted central catheter

Injection Ports of Triple-Lumen Catheter



- Distal port: CVP monitoring and high-volume or viscous fluids, colloids, or medications
- Proximal port: Blood sampling, medications, or blood components administration
- Medial port: Reserved exclusively for TPN
- Fourth port: Infusion of fluids or medications

Comparison of CVC			
Type & Use	**Features**	**Advantages**	**Disadvantages**
Percutaneous use: Intended for days to several weeks	Material: Polyurethane silicone Multiple lumens available	Inserted at beside Cost-effective Easy to remove	Placement time limited to 7 days Requires sterile dressing changes; daily heparin flushes; catheter may break; requires activity restrictions
PICC use: Up to several months	Material: silicone Lumen: double Groshong valve available	Inserted at bedside by specially trained RN Insertion trays, spare needles, spare catheters, and repair kits available; cost-effective; easy to remove	Requires sterile dressing changes; requires routine heparin flushes except with Groshong valve in place Catheter may break; requires activity restrictions
CVTC use: Long-term: 3 years +	Material: silicone Length: 55–90 cm Gauge: 2.7–19.2 Fr Lumen: multiple Groshong valves available	Long-term access device Requires aseptic dressing changes; clean when site is healed; can be repaired externally; self-care	May require routine heparin flushes, except with Groshong valve; catheter may break; daily to weekly site care; may be difficult to remove

Comparison of CVC

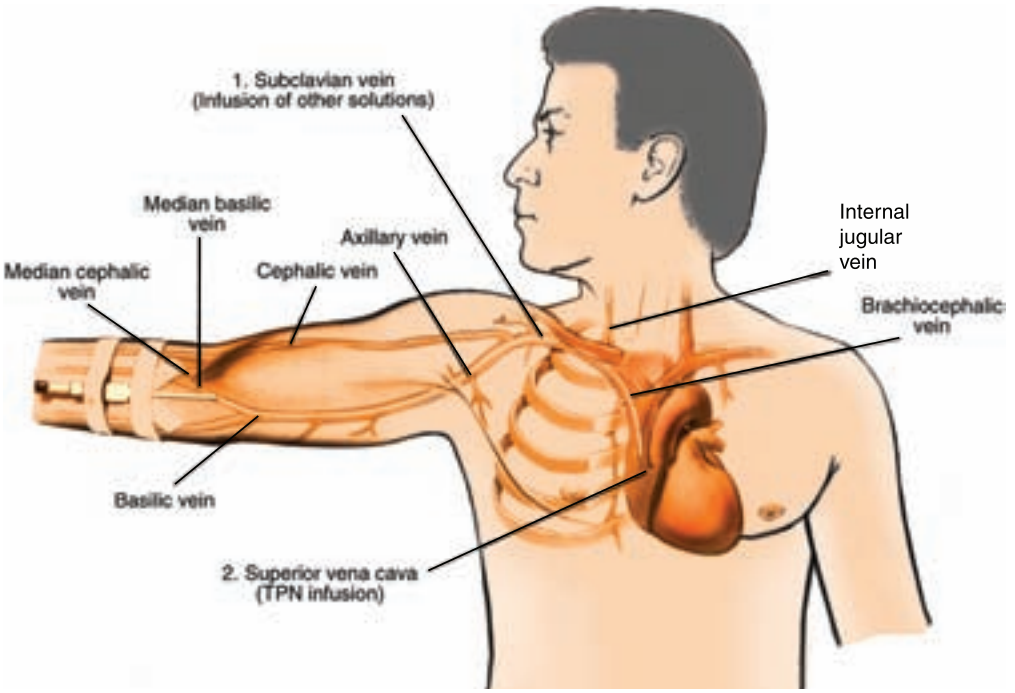
Type & Use	Features	Advantages	Disadvantages
Implanted Port Use: Long-term: 3 years +	Material: silicone Port: Titanium, stainless steel, plastic Height: 9.8–17.0 mm Width of base: 24–50 mm Lumen: Dual Groshong valve available	Can access dome port from any angle Preattached catheter on port or two-piece system Several catheter port locking devices available No dressing changes; monthly heparin flushes; no activity restrictions	Requires non-coring needle to access; expensive; requires minor surgery to remove

Percutaneous Catheters

Key Points

- Inserted at bedside
- Stay in place for 7 days
- Most common site for insertion is infraclavicular approach to subclavian vein
- Patient placed in Trendelenberg position
- Placement must be confirmed by chest x-ray prior to infusion of solutions
- Dressing management: TSM or gauze
- Flush with heparin solution—twice the volume of the catheter

PICC



Key Points

- Placement of PICC by RN with specialty training
- Chest radiograph needed to verify placement of PICC tip
- Inserted at bedside
- Stays in place weeks to months
- Sterile procedure (approximately 45 minutes)
- Final placement is in superior vena cava
- Placement must be confirmed by chest x-ray prior to infusion of solutions
- Access through antecubital fossa (basilic, cephalic, median cephalic, and median basilic veins)
- Dressing management: first 24 hours 2 x 2 gauze. After 24 hours change orginal dressing to gauze or TSM dressing according to organizational policy
- Use 4 Fr or larger for blood administration through PICC
- PICC lines are used successfully with infusion pumps. With 3.0 Fr and smaller PICCs, infusion pumps may be necessary to maintain infusion and patency
- Dual lumen PICCs cannot be repaired

Irrigating PICC

- Whenever the line needs to be locked
- After every blood draw
- After intermittent medication administration
- After blood or blood component administration
- After TPN

Frequency of flushing procedure depends on organizational policy and patient condition.

Recommendations are:

- Every 4–6 hours for 2 Fr or smaller or after each use
- Every 8–12 hours for larger sizes or after use

Pulsatile (Push-Pause) Flushing

A rapid succession of pulsatile *push-pause-push-pause* movements exerted on the plunger of the syringe barrel creates a turbulence within the catheter lumen that causes a swirling effect to move residues of fibrin, medication, lipids, or other adherents attached to the catheter lumen.

Procedure: Irrigating PICC

Equipment: 10-mL syringe, preservative-free 0.9% sodium chloride, gloves, sharps container, antiseptic solution, heparin 10 U–100 U/mL vials, 5 mL (or custom-made kits)

- Verify physician order
- Educate patient on purpose of procedure and site observation after discontinuation
- Follow hand hygiene procedures
- Observe standard precautions
- Follow manufacturer's guidelines for flushing certain CVADs.
- Identify patient
- Don gloves
- Cleanse the central venous catheter injection cap (port) with 70% isopropyl alcohol. Allow to air dry. **Note:** Additional 2% chlorexidine or povidone-iodine preparation necessary with blunt needle access
- Attach syringe containing 0.9% sodium chloride to the injection port via needleless system
- Aspirate to check patency
- Instruct patient to perform Valsalva maneuver and open the CVC if hub-to-syringe connection
- Irrigate the line with 0.9% sodium chloride using *push-pause* method
- Attach the syringe with the heparinized saline to the injection port (if indicated). Most CVCs require heparin unless closed-end valve such as Groshong or pressure-activated safety valve (PASV)
- Instruct patient to perform Valsalva maneuver and open the CVC clamp if hub to syringe
- Irrigate the line with heparinized saline solution using *push-pause* method
- Document procedure on patient record

Procedure: Discontinuation of PICC

Performed by a qualified RN

Equipment: 10-mL syringe, sodium chloride, gloves, suture removal set if appropriate, sterile dressing

- Verify physician order
- Educate patient on purpose of procedure and site observation after discontinuation
- Follow hand hygiene procedures
- Observe standard precautions
- Position patient in dorsal recumbent position and abduct the patient's arm
- Don gloves
- Flush the catheter with 0.9% sodium chloride using a 10-mL syringe
- Remove the dressing
- Remove suture if necessary
- Remove any other securement devices if in place
- Withdraw catheter with smooth, gentle pressure in small increments (DO NOT STRETCH CATHETER)
- Cover site with sterile 2 x 2 gauze pressure dressing
- Leave pressure dressing in place for 24 hours
- Measure length of catheter and compare with length recorded before insertion
- Document procedure

Algorithm for a "stuck" PICC

Resistance met during catheter removal

⇓

Cover catheter with sterile dressing: attempt after 20–30 minutes

⇓

Unsuccessful attempt at removal

⇓

Apply sterile occlusive dressing and intermittent warm compresses 12–24 hours

⇓

Unsuccessful attempt at removal

⇓

Obtain x-ray study to rule out mechanical problem

⇓

Mechanical problem detected

⇓

Consult interventional radiologist

⇓

No mechanical problem detected

Apply sterile occlusive dressing and intermittent warm compresses for 12–14 hours

⇓

Assist with relaxation exercises to hand or wrist

⇓

Unsuccessful attempt at removal

⇓

Repeat for 3–5 days

⇓

Unsuccessful attempt at removal

⇓

Consider IV or systemic smooth muscle relaxants; ultrasound venogram; consult interventional radiologist

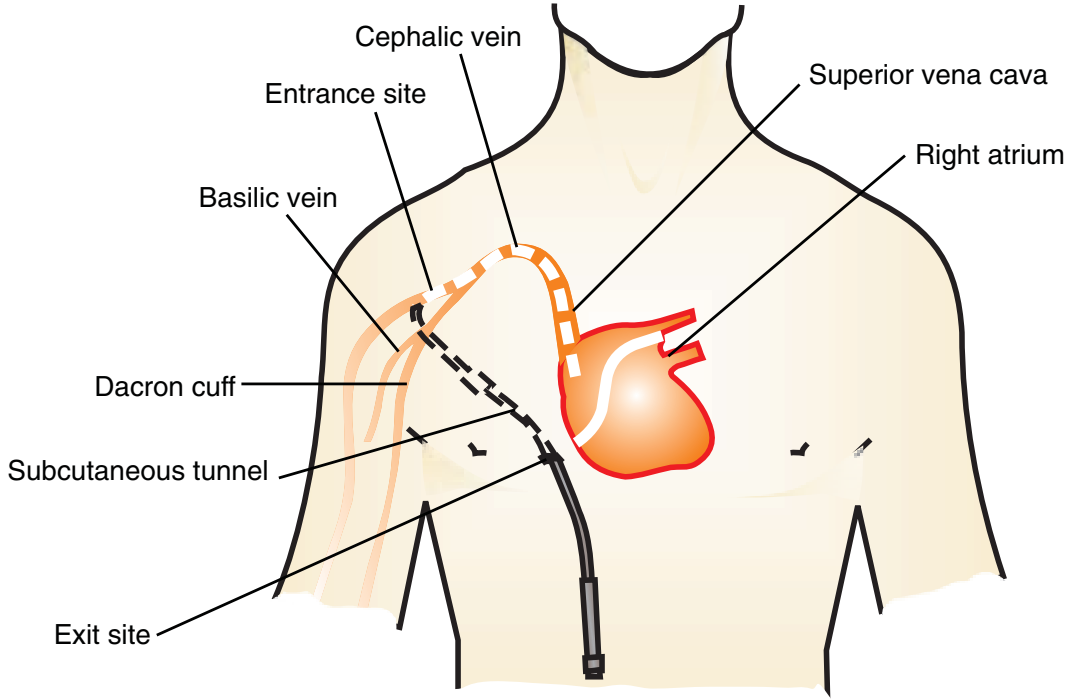
Blood Sampling with PICC

- A 4 Fr or larger catheter for blood sampling
- The walls of PICC lines are soft so they collapse easily when strong vacuum is applied; use of gentle touch with syringe method is recommended
- Vacutainers may be used with large catheters

Blood Administration with PICC

- Blood products may be administered through a 4 Fr or larger PICC
- Flush line thoroughly after administering blood product
- Infusion pump may be necessary

CVTC



CVTC

Key Points

- Intended to be used for months or years; provides long-term venous access
- Composed of polymeric silicone with a Dacron polyester cuff that anchors CVTC in place subcutaneously. Cuff about 2 inches from CVTC's exit site
- Available with Groshong two-way valve
- Available with single, double, triple, or quadruple lumens
- Can be used for many purposes
- Needs daily to weekly site care
- Must be inserted surgically
- Can affect patient's body image
- Should be clamped if malfunction is suspected
- Never use scissors or pins on or near
- Dressing required until site healed or patient hospitalized
- If CVTC leaks or breaks, take a nonserrated clamp and clamp between broken area and exit site; cover with sterile gauze and tape securely
- Protect CVTC when showering or bathing by covering with TSM dressing or clear plastic wrap
- Flush CVTC after blood drawn with 10 mL of 0.9% sodium chloride
- Heparin is used to maintain patency, except for the Groshong catheter

Irrigating Procedure

Flush the CVTC with twice the catheter volume of heparinized saline. After medication administration or daily maintenance, flush the catheter with saline; then follow with heparinized saline. The use of heparinized saline is usually unnecessary for Groshong valve catheter.

Procedure: Irrigating CVTC

Equipment: 10-mL syringe, preservative-free 0.9% sodium chloride, gloves, sharps container, antiseptic solution, heparin 10 U–100 U/mL vials, 5 mL (or custom-made kits)

- Verify physician order
- Educate patient on purpose of procedure and site observation after discontinuation
- Follow hand hygiene procedures
- Observe standard precautions
- Aseptically prepare sterile supplies
- Don gloves
- Prepare air-purged heparin flush
- Remove tape holding catheter chest wall
- Cleanse cap-catheter connection point with alcohol for 30 seconds
- Place on sterile 2 x 2 sponge and allow to dry
- Close clamp
- Pick up catheter hub protected by sterile sponge; do not touch cleansed connection
- Attach syringe containing 0.9% sodium chloride to injection port via needleless system
- Aspirate to check patency
- Instruct patient to perform Valsalva maneuver; open the CVC clamp if hub to syringe connection (if not accessing through resealable diaphragm)
- Flush the line with 10–20 mL of 0.9% sodium chloride using *push-pause* method
- Attach the syringe with air-purged heparinized saline to injection port
- Flush the line with heparin. Clamp the line while infusing the last 0.5 mL of solution. **Note:** If a positive-pressure injection port is used, the line does not need to be clamped.
- Document procedure on patient record

Procedure: Blood Sampling from CVAD

Equipment: 10-mL syringe with 5 mL of preservative-free 0.9% sodium chloride, gloves, sharps container, antiseptic solution, empty 10 mL or larger syringe, 20-mL syringe prefilled with 20 mL of sodium chloride heparin, 10 U–100 U/mL vials, 5 mL (or custom-made kits)

- Verify physician order
- Educate patient on purpose of procedure and site observation after discontinuation
- Follow hand hygiene procedures
- Observe standard precautions
- Discontinue administration of all infusates into the CVAD prior to obtaining blood samples
- Confirm order for laboratory work
- Check patient identification
- Don gloves
- If injection port is not in use: prepare the valve access port with alcohol and allow to dry, followed by 2% CHG or povidone-iodine

OR

- If injection port is in use, discontinue IV tubing and cap end to maintain sterility of tubing. Prepare the valve access port with alcohol; allow to dry
- Attach the 10-mL syringe prefilled with 5 mL of NS, then vigorously irrigate with 5 mL of sodium chloride using the pulsatile *push-pause* method
- Draw 5–10 mL of blood into the attached syringe to discard; remove syringe
- Attach sterile syringe and withdraw blood sufficient to fill required collection tubes
- Attach syringe with sample blood to Vacutainer and fill collection tubes
- Irrigate injection port with at least 20 mL of NS using pulsatile *push-pause* method
- Reconnect the infusion line and begin infusion

OR

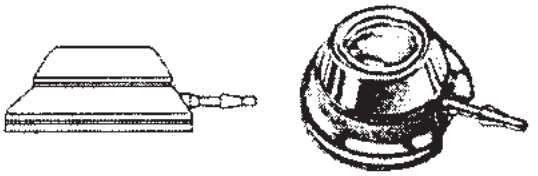
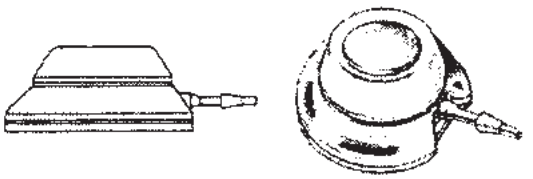
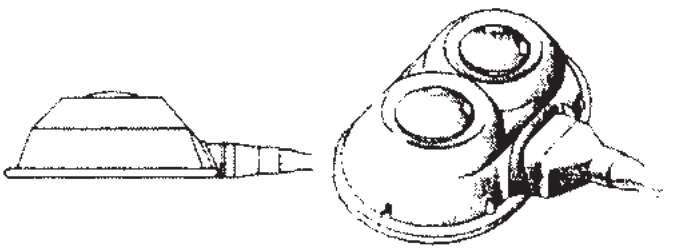
- Attach prefilled air-purged heparinized saline and flush with heparin if catheter does not have Groshong valve
- Label the collection tubes and deliver the sample to the laboratory as soon as integrity of the CVC is ensured
- Dispose of used equipment in sharps container
- Document procedure in patient record

Implanted Ports

Key Points

- Implanted ports are available in one or two septum designs
- Can be placed in SVC, hepatic artery, peritoneal space, and epidural space
- Port made of stainless steel or titanium and has raised edges to facilitate puncture
- Use noncoring (Huber) needle unless manufacturer specifies
- Less risk of infection when used intermittently
- Minimal site care
- Less body image disturbance
- Change administration set every 24 hours
- Dressing and extension tubing and dressing changed every 7 days
- Flush port when not in use with 10–20 mL 0.9% sodium chloride and heparin every 4 weeks
- Change dressing every 72 hours for continuous infusion

Examples of Port Designs

Portal Design	Material Composition
 Hickman® Titanium Port	Titanium and Silicone
 MRI® Port	Thermo Plastic and Silicone
 Dome™ Port	Titanium and Silicone
 MRI® Dual Port	Thermo Plastic and Silicone

Procedure: Accessing the Port

Equipment: Sterile gloves, mask, gauze pads, alcohol swabs, TSM dressing, injection caps, povidone-iodine swab sticks or CHG swabsticks, noncoring needle with clamping extension set, flush solutions 0.9% sodium chloride, heparin (100 U/mL), 5 mL syringes 10 mL, sharps container

- Verify physician order
- Educate patient on purpose of procedure and site observation after discontinuation
- Follown hand hygiene procedures
- Observe standard precautions
- Don gloves and mask
- Palpate site to locate septum
- Cleanse port access with alcohol, rotating in a circular motion from inside out; repeat two more times; let dry
- Cleanse access site with 2% CHG or povidone iodine, rotating in a circular motion from inside out; repeat two more times; let dry
- Remove and discard gloves
- Don second pair of sterile gloves
- Prepare noncoring needle by flushing device, with clamped extension tubing attached, with 10 mL preservative-free 0.9% sodium chloride injection
- Relocate port by palpation and immobilize device with nondominant hand
- Insert noncoring needle perpendicular to the septum, pushing firmly through skin and septum until needle tip contacts back of port
- Aspirate for blood return to confirm patency; flush with attached 10 mL sodium chloride
- Maintain positive pressure when removing syringe from port by engaging clamping device
- If port is to remain accessed:
  - Place sterile gauze under device wing to prevent rocking motion of needle
  - Anchor noncoring needle to skin using sterile tape
  - Cover needle and gauze with TSM dressing
  - Initiate prescribed therapy
- Document in patient record

Deaccessing Implanted Port

To deaccess needle from port:

- Don gloves.
- Loosen the dressing covering the noncoring needle. Note discharge/drainage and discard in appropriate biohazard receptacle.
- Cleanse injection port with alcohol and attach 10-mL syringe containing sodium chloride.
- Vigorously irrigate the port using a pulsatile *push-pause* method.
- Withdrawing the noncoring needle requires a two-handed technique. With the nondominant hand, use your thumb and index finger to stabilize the port.
- Steadily, with an upward pull (perpendicular to the site), remove the needle with dominant hand. While withdrawing needle, activate the safety feature on the noncoring needle (Huber-Plus).
- If bleeding occurs at site, apply direct pressure using sterile gauze sponge.
- Apply dressing if needed.
- Document in patient record.

Complications of CVADs

Complication	Signs & Symptoms	Treatment
Insertion-Related		
Pneumothorax: Collection of air in pleural space	Sudden chest pain, shortness of breath, dyspnea, crunching sound on auscultation, tachycardia, persistent cough, diaphoresis	Oxygen Chest tube may be necessary Monitor vital signs
Hemothorax: Blood enters pleural cavity	Sudden chest pain Dyspnea Tachycardia, hypotension, dusky skin color, diaphoresis, and hemoptysis	Remove the catheter and insertion needle and apply pressure to site Monitor vitals Oxygen Chest tube
Chylothorax: Chyle or lymph enters the pleural cavity due to transsection of thoracic duct on left side	Same as hemothorax Milk-like substance drawn into the needle or catheter	Notify physician for catheter removal Oxygen Chest tube

Complications of CVADs

Complication	Signs & Symptoms	Treatment
Brachial plexus injury: Nerves in upper dorsal spinal that supply arm, forearm, and hand	Tingling sensation in the fingers, pain shooting down the arm, or paralysis	Notify physician Pain medication Physical therapy
Extravascular malposition	Similar symptoms as pneumothorax or hemothorax	X-ray confirmation of catheter tip placement Removal of the catheter Oxygen Chest tube
Intravascular malposition	Tip into internal jugular rather than subclavian Noted when catheter is first used; difficulty in aspiration or infusion Discomfort or pain in shoulder, neck, or arm Ear gurgling sign	Not always removed Attempt to reposition if possible

(Continued on the following page)

Complications of CVADs *(Continued)*

Complication	Signs & Symptoms	Treatment
Post-Insertion Complications		
Air embolism: Entry of air into the circulatory system	Chest pain, dyspnea, hypotension, lightheadedness, pallor, precordial churning murmur, thready pulse, unresponsiveness	Place patient in left lateral Trendelenburg position Clamp catheter Notify physician Prepare for resuscitation
Dislodgment (Twiddler's syndrome)	External portion of catheter is longer; catheter tip no longer positioned in SVC; exposed Dacron cuff; leaking of solution from catheter exit site; edema, burning sensation, or pain during infusion	X-ray confirmation of catheter placement May need to be removed Apply sterile dressing over site
Catheter migration: CVC moves from insertion placement site	Aspiration difficulties, burning sensation, discomfort or pain during infusion, edema of chest or neck, increased external catheter length; leaking around the insertion site, cardiac dysrhythmias, palpation of catheter in external jugular vein, patient complains of gurgling sound in ear	Radiographic verification of placement Assist with CVC removal or replacement

Complications of CVADs

Complication	Signs & Symptoms	Treatment
Catheter occlusion—Nonthrombolytic: Crystalization of TPN; drug-drug or drug-solution incompatibilities	Sluggish flow rate, total occlusion, inability to flush or obtain blood withdrawal	Attempt to restore patency. See Troubleshooting Guide next section.
Thrombolytic occlusions: Deposits of fibrin and blood components within and around the CVC, intraluminal blood clot, fibrin sheath	Sluggish flow rates, total occlusion, inability to flush or obtain blood withdrawal; fibrin may be able to infuse solutions, but unable to aspirate blood "ball-valve effect"	Attempt to aspirate clot Initiate appropriate fibrinolytic treatment with t-PA; see Troubleshooting Guide next section

(Continued on the following page)

Complications of CVADs *(Continued)*

Complication	Signs & Symptoms	Treatment
External damaged catheter: Break caused by scissors, penetration with needle; internal: rupture caused by use of smaller than 10-mL syringe formation that occludes the SVC	**External:** Leakage from catheter, wet dressing, leakage at insertion site **Internal:** Swelling in chest area, infusion of solution into chest wall; swelling at point of rupture	**Internal:** Monitor for pin holes, leaks, wet dressing **External:** Apply nonserrated clamp proximal to damaged part of catheter **Internal:** Stop infusion; bed rest; prepare to repair or remove catheter
Site infection: Includes exit site, pocket or tunnel infections	Cording of vein; site drainage, redness, tenderness, warmth; increase in basal temperature	Notify physician Draw blood cultures from CVC Obtain peripheral blood cultures Administer antibiotics, anticoagulants Evaluate CVC removal

Complications of CVADs

Complication	Signs & Symptoms	Treatment
Superior vena cava syndrome: Condition caused by blood clot, fibrin formation, that occludes the SVC	Progressive shortness of breath; cough; sensation of skin tightness; unilateral edema; cyanosis of face, neck, shoulder, and arms; jugular, temporal, and arm veins engorged; prominent venous pattern present over chest	Notify physician Radiographic confirmation of SVD syndrome Catheter may or may not be removed Anticoagulant therapy Place patient in semi-Fowler's position Oxygen Monitor fluid volume status

Troubleshooting Guide for Occluded Central Catheters

Purpose of Catheter/ Agent Infused	Cause of Occlusion	Treatment
Prolonged use of catheter	Fibrin sheath or thrombosis	Thrombolytic: t-PA
Blood draw	Fibrin sheath or thrombosis	Thrombolytic: t-PA
Transfusion	Fibrin sheath or thrombosis	Thrombolytic: t-PA
Medication administration	Precipitate	$NaHCO_3$ or HCl
Cold medication or solution	Precipitate	$NaHCO_3$ or HCl
Stability (pH of medication)	Precipitate	$NaHCO_3$ or HCl
Medication with poor solubility (e.g., Dilantin)	Precipitate	$NaHCO_3$ or HCl
Time elapse since medication mixed	Precipitate	$NaHCO_3$ or HCl
Fat emulsions (or three-in-one TPN)	Lipid aggregation	Ethanol

HCl = hydrochloric acid $NaHCO_3$ = sodium bicarbonate

Care of CVC

INS STANDARDS (2000) AND CDC (2002) STANDARDS

Catheter and Use	Flushing Maintenance	Administration Set Change	Site Care Dressing Change
Percutaneous Intended for days to several weeks. Placement time: 7 days	Daily heparin flush 1:10 to 1:100 U heparin in volume equal to twice the volume of catheter plus any add-on devices	Replace sets and add-on devices every 72 hours Replace to administer blood products or lipid emulsions within 24 hours	Gauze every 2 days, TSM every 7 days Replace dressing when catheter is replaced; 2% chlorhexidine-based solution is preferred for cleansing site
Midline catheters In adults: replace every 72–96 hours Pediatric: do not replace unless clinically indicated	Daily heparin flush with 1:10 to 1:100 U heparin in volume equal to twice the volume of catheter plus any add-on devices	Replace tubing and add-on devices every 72 hours Replace to administer blood or lipids within 24 hours	Replace dressing when the catheter is removed or dressing integrity compromised Visualize site daily

(Continued on the following page)

Care of CVC *(Continued)*

INS STANDARDS (2000) AND CDC (2002) STANDARDS

Catheter and Use	Flushing Maintenance	Administration Set Change	Site Care Dressing Change
CVC including PICC and hemodialysis catheters	With open-ended valves: 1:10 or 1:100 U heparin in volume equal to twice the volume capacity of catheter plus any add-on devices; daily to weekly With closed-end catheters (Groshong or PASV) tip: use 10–20 mL of 0.9% sodium chloride weekly	Replace tubing and add-on devices every 72 hours Replace tubing used to administer blood or lipid emulsions within 24 hours	Replace gauze dressings every 2 days, TSM every 7 days Tunneled catheters that are well healed may not need dressing

Care of CVC

INS STANDARDS (2000) AND CDC (2002) STANDARDS

Catheter and Use	Flushing Maintenance	Administration Set Change	Site Care Dressing Change
Implanted ports: use long-term (years)	1:10 or 1:100 U heparin in volume equal to twice the volume of catheter and any add-on devices. If not being used, flush every 4 weeks.	Replace tubing and add-on devices every 72 hours. Replace tubing used to administer blood or lipid emulsions within 24 hours.	Replace gauze every 2 days, TSM every 7 days. No dressing is needed after incision is healed. Change no-coring needle at least weekly.

Use lowest heparin dose to maintain patency
Use single-use flushing systems if available
Use 10-mL syringe for all flushing procedures
Use pulsatile *push-pause* method to flush

Notes

Contents: BLOOD

ABO Blood Grouping Chart

Blood Grouping	Recipient Antigens on RBC	Antibodies Present in Plasma
A	A	Anti-B
B	B	Anti-A
AB	A and B	None
O	None	Anti-A and Anti-B

ABO Compatibilities for Packed Red Blood Cell (RBC) Components

Recipient Blood Type	Donor Unit, First Choice	Donor Unit, Second Choice
A+	A+	O, A+
B+	B+	O−, B+
AB+	AB+	O−, A+, B+, AB+
O+	O+	O+
A−	A−	O−, A−
B−	B−	O−, B−
AB−	AB−	O−, A−, B−, AB−
O−	O−	O−

Note: The universal RBC donor is O-negative; the universal recipient is AB-positive.

Donor Blood Testing

Key Points

- The ABO group must be determined by testing the RBCs with anti-A and anti-B sera.
- The Rh type must be determined with anti-D serum. Units that are D-positive must be labeled as Rh-positive.

- All donor blood must be tested to detect transmissible disease.
- Screening tests include:
  - Hepatitis B surface antigen (HBsHg)
  - Hepatitis B core antibody (anti-HBc)
  - Hepatitis C virus antibody (anti-HCV)
  - HIV-1 and HIV-2 antibody (anti-HIV-1 and HTVL-II)
  - HIV p 24 antigen
  - HTLV-I and HTLV-II antibody (anti-HTLV-I and HTLV-II)
  - Serologic test for syphilis
  - Nucleic acid amplification testing (NAT)
  - NAT for West Nile Virus (WNV)

Blood Preservatives

CPDA-1: Citrate phosphate dextrose adenine; shelf life 35 days
Contains adenine, which helps RBCs synthesize adenosine triphosate (ATP) during storage
CP2D: Citrate phosphate dextrose dextrose; shelf life 35 days
AS: Sodium chloride dextrose adenine; shelf life 42 days
AS-1: Adsol®, AS-3 Nutrice, and AS-5 Opitsol
Combination of saline or mannitol. RBCs with these additives have a better flow rate.

Blood Donor Collection Methods

Homologous
Transfusion of any blood component that was donated by someone other than the recipient

Autologous
Collection, storage, and delivery of a recipient's own blood

Types
Predeposit or Preoperative Autologous Blood Donation
Predeposit is collection and storage of the recipient's own blood for reinfusion during or after a later operation

Typical Uses
Hip or knee replacement surgery
Elective cardiac surgery
Spinal fusion
Elective major vascular surgery
Heart-lung transplant

Contraindications
Hemoglobin less than 11 g/dL
Bacterial infection
Severe aortic stenosis
Unstable angina
Severe left main coronary artery disease

Intraoperative Blood Salvage
Typical Use
Surgical procedure with anticipated blood loss
Patient unable to donate preoperatively

Contraindications
Malignancy at operative site
Bacterial contamination at operative site
Use of microfibrillar collagen materials
Postoperative salvage

Designated/Directed
Donation of blood from selected friends or relatives of the patient
Designated donors have the same screening as homologous donation
The unit must be compatible with that of the intended recipient

Equipment: Blood Administration

Follow institutional protocol (policies/procedures) for equipment.

General Recommendations
Catheter: 18 g or larger catheter to provide adequate flow rates. A 20-g thin-walled catheter may be used for limited transfusions.

Solution: 0.9% sodium chloride is the only acceptable solution to be used with blood products.

Administration sets: Blood administration sets available in two-lead Y-type tubing or single-lead tubing. The sets come with an inline filter (170 micron) designed to remove debris in stored blood.

Filters: 170-micron filter used for blood administration. Minimum time for a blood filter is 4 hours.

Microaggregate filters: Added to standard blood administration set. Designed to remove 20–80 micron particles, filtering out the microaggregates that develop in stored blood.

Leukocyte depletion filters: HLA immunization is directly linked to the number of leukocytes present in blood products. These filters remove 99.9% of leukocytes present in the unit.

Blood warmer: Temperature device specifically designed to warm blood. Most transfusions do not require use of blood warmers. Adhere to manufacturer guidelines when using specific warmer. Blood warmer is most often used for rapid or massive transfusions, in neonatal exchange transfusion, and for a patient with potent cold agglutinins. DO NOT USE HOT WATER BATH OR MICROWAVE!

Electronic monitoring devices: Only pumps designed for infusion of whole blood or RBCs may be used. Check with manufacturer.

Pressure bag: Used to increase flow rates during transfusion, usually emergencies.

Summary of Blood Components				
Blood Component	**Volume**	**Action/Use**	**Infusion Guide**	**Special Considerations**
RBCs	250–350 mL	Improves oxygen-carrying capacity Symptomatic anemia, bone marrow failure	0.9% NaCl primer; transfuse in 4 hours; use 170-micron filter Y set; recommend leukocyte reduction filter	AB- and Rh-compatible; 1 U raises the Hgb 1 g and Hct 3%–4%
Platelets: random donor	50–70 mL/U Usual dose: 6–10 U	Control or prevent bleeding associated with platelet deficiencies	Administer rapidly: 1 U/10 min Use blood filter, syringe push, or standard Y set	1 U increases platelet count by 5000 Infuse individually or may be pooled; ABO/Rh preferred
Fresh frozen plasma FFP	200–250 mL	Replacement of clotting factors; not used for volume expansion	Storage: 18°C for 1 yr Standard blood filter; may be infused 20 mL over 3 min or more slowly within 4 hours	Does not provide platelets 1 U raises the level of clotting factor 2%–3% Must be ABO-compatible

Summary of Blood Components

Blood Component	Volume	Action/Use	Infusion Guide	Special Considerations
Cryoprecipitate	5–10 mL/U; usual order is for 6–10 U	Each unit contains factor VIII and factor XI; controls bleeding in coagulation disorders. Use to treat hemophilia A; hypofibrinogenemia; factor VIII deficiency, DIC	Standard Y filter	ABO-compatible. Infuse within 6 hours from thawing; saline may be added to bag to facilitate recovery of product

(Continued on the following page)

Summary of Blood Components *(Continued)*				
Blood Component	**Volume**	**Action/Use**	**Infusion Guide**	**Special Considerations**
Albumin *5% = 12.5g/250 mL* *25% = 12.5g/50 mL*	5% in 250–500 mL: isotonic 25% in 50–100 mL: hypertonic	Plasma volume expander; used for hypovolemic shock, support blood pressure; induces diuresis in fluid overload	Rate 2–4 mL/min for 5% solution; 1 mL/min for 25% solution Supplied in glass bottles	25%—hypertonic and is 5× more concentrated than 5% Give with extreme caution—can cause circulatory overload No type and cross Store at room temperature

Summary of Blood Components				
Blood Component	**Volume**	**Action/Use**	**Infusion Guide**	**Special Considerations**
Plasma protein fraction	Glass bottle with tubing: 250 mL	Same as for albumin	Equivalent to 5% albumin	Has fewer purification steps than albumin; no type and cross. High sodium content
Immune serum globulin (ISG)	See guidelines for nonspecific ISG preparations	Treatment of AIDS to supply passive immune protection	Use filter needle to draw up; use filter for drip	Nonspecific: Gammimune N, Gammogard, Gammar-IV, IGIV, Iveegam, Sandoglobulin, Venoglobulin-1, and Venoglobulin-S

Procedure: Administration of Blood Components

Verify physician order: Order is required. Patient needs to sign informed consent.

Type and cross-matching: ABO and Rh typing accomplished in blood banking department. Each unit transfused must be typed and crossed with individual paperwork.

Select equipment: Refer to equipment list. Ensure a patent IV prior to obtaining blood from bank: #18-g catheter is ideal; use blood administration set for most transfusions with 170-micron filter; use 0.9% sodium chloride as primer. Addition of extra filter requires a physician's order.

Prepare patient: Patient education regarding the procedure: explain need for blood, the procedure, and related concerns. Assessment of patient includes baseline vitals, evaluation of kidney function, and respiratory assessment. Premedicate if ordered (diuretics, antihistamines, or antipyretics). Document education in chart. Make sure IV catheter is patent or start new line using #18-g catheter, hand Y administration set with 0.9% sodium chloride.

Obtain blood from blood bank: Obtain blood when notification of type and cross completed. Blood cannot be returned to the bank after 30 minutes. Make sure ready to handle blood once obtained. Blood stored in special refrigerator 1–6°C. Blood may not be stored in refrigerators on the unit. Sign out blood checking:

Donor number
ABO and Rh type
Check color, appearance, and expiration date of component
Patient name on unit

Procedure: Administration of Blood Components

Preparing for administration:

Upon return to unit, check blood component with another qualified nurse. Checking:

Patient name on unit to armband

ABO and Rh

Donor unit number

Color, appearance, and expiration date of component

Component to be administered

Establish baseline vitals; record on flow sheet

Initiating the transfusion:

All blood must be infused within 4 hours

Handle blood wearing gloves

Make sure Y set is primed so saline covers filter

Begin transfusion slowly, turning off saline

Monitor patient

Stay with patient for the first 5–15 minutes of transfusion

Monitor vitals and record following institution policy

Note: No medications can be added to blood!

Discontinuing transfusion:

Once completed: dispose of administration set; empty transfusion bag in biohazard container; note time completed on flow sheet and transfusion record

Document time of transfusion, volume given, patient's condition, and tolerance to transfusion

Risks of Transfusion Therapy

Viral Infection	Estimated Risks per Unit
HIV-1 and HIV-2	1:1,900,000
HTLV-1 andHTLV-2	1:641,000
HAV	1:1,000,000
HBV	1:63,000
HCV	1:1,600,000
Parvovirus B19	1:40,000
Parasitic Infections	
Babesia and malaria	1:1,000,000
Noninfectious Risks	
Fatal hemolytic transfusion reaction	1:1,300,000
Febrile nonhemolytic transfusion reaction	1%
Minor allergic reaction	1%
Anaphylaxis	1/20,000
Noncardiogenic Pulmonary	
Edema/transfusion-related acute lung injury	1/5,000

Summary of Common Transfusion Reactions

Transfusion Reaction	Signs & Symptoms	Interventions	Prevention
Immune Reaction			
Acute Hemolytic Transfusion Reaction	Burning sensation along vein; lumbar pain, flushing of face and chest, bleeding, tachycardia, tachypnea, hemoglobinemia, hemoglobinuria, shock, vascular collapse, death	**STOP THE TRANSFUSION!** Get help immediately Treat shock Maintain BP with colloidal solutions Administer diuretics to maintain blood flow	Extreme care during entire identification process. Strict attention to cross-matching protocols. Start transfusion slowly and monitor for first 5–15 minutes.
Delayed Hemolytic Reaction	Decreased hematocrit and hemoglobin levels; fever (continual, low-grade); jaundice (mild); malaise Indirect hyperbilirubinemia	No acute treatment required; monitor hematocrit level, renal function; coagulation profile Notify physician and transfusion services	Strict attention to cross-matching protocols

(Continued on the following page)

Summary of Common Transfusion Reactions *(Continued)*			
Transfusion Reaction	**Signs & Symptoms**	**Interventions**	**Prevention**
Nonhemolytic Reactions			
Febrile Reaction	Fever, rise in temperature of 1°F in association with transfusion Chills, headache, nausea, vomiting, chest pain, nonproductive cough, malaise	Stop transfusion, and start normal saline. Notify physician. Monitor vitals. Anticipate order for antipyretic agents. If ordered, restart transfusion slowly.	Use leukocyte-reduced blood component, filter

Summary of Common Transfusion Reactions

Transfusion Reaction	Signs & Symptoms	Interventions	Prevention
Allergic Reaction	Itching, hives, rash, urticaria, facial flushing, runny eyes, anxiety, dypnea, wheezing	Stop transfusion. Keep vein open with normal saline. Notify physician. Monitor vitals. Anticipate antihistamine order. If ordered, restart transfusion slowly. Mild reaction can precede severe allergic reaction—monitor.	If known, mild allergic reaction may occur with blood transfusion; may receive diphenhydramine (Benadryl) before transfusion.
Allergic Anaphylaxis	Anxiety, urticaria, wheezing, hypotension, GI distress, shock, cardiac distress—death	Stop transfusion. Keep vein open with normal saline. CPR if necessary. Anticipate order for steroids. Maintain BP.	Use autologous blood. Use blood from donors who are IgA-deficient or by administering only well-washed RBCs in which all plasma has been extracted.

(Continued on the following page)

Summary of Common Transfusion Reactions *(Continued)*			
Transfusion Reaction	**Signs & Symptoms**	**Interventions**	**Prevention**
Graft-Versus-Host Disease (GVHD)	Diarrhea, fever, rash, hepatitis, bone marrow suppression, overwhelming infection	No effective therapy; treat symptoms Morbidity rate high	Irradiation of blood products used in immunocompromised patients; use leukocyte-reducing filter
Non-Immune Reactions			
Circulatory Overload	Hypervolemia, headache, dyspnea, constriction of chest, coughing, cyanosis	Stop transfusion. Elevate head of bed. Notify physician. Rapid-acting diuretics, oxygen, therapeutic phlebotomy may be indicated.	Frequent monitoring of patient Administration of components slowly

Summary of Common Transfusion Reactions

Transfusion Reaction	Signs & Symptoms	Interventions	Prevention
Coagulation Imblances	Abnormal bleeding from surgical sites, IV site, or breaks in skin	Monitor laboratory reports Coagulation studies Platelet counts, protect from injury Anticipate platelet administration	Administration of fresh blood less than 1 week old
Potassium Toxicity	Elevated potassium levels, slow irregular heart rate, nausea, muscle weakness, ECG changes, diarrhea, renal failure	Stop or slow transfusion. Monitor ECG, notify physician, remove excess potassium: concurrent administration of hypertonic dextrose and insulin or administer polystyrene sulfonate orally or by enema	In patient receiving multiple transfusions: use only the freshest blood; potassium level in blood rises as blood ages

(Continued on the following page)

Summary of Common Transfusion Reactions *(Continued)*			
Transfusion Reaction	**Signs & Symptoms**	**Interventions**	**Prevention**
Hypothermia	Drop in core temperature, chills, peripheral vasoconstriction, ventricular arrythmias, cardiac arrest	Monitor patient. Use external warming techniques (blankets, lights)	Use blood warmers if possible. Warm blood to 37°C
Citrate Toxicity	Hypocalcemia-induced cardiac dysrhythmias Tingling of fingers, muscle cramps, confusion, hypotension, cardiac arrest	Slow rate of infusion. Administer calcium chloride or calcium gluconate. Do not add calcium to infusion blood.	Administer fresh blood. Monitor calcium levels during pre/post transfusion, monitor patients with liver impairment closer for hypocalcemia.

Summary of Common Transfusion Reactions			
Transfusion Reaction	**Signs & Symptoms**	**Interventions**	**Prevention**
Non-Immune Infection Related			
Hepatitis B and C	Elevated liver enzymes, fever, jaundice, malaise, nausea, pharyngitis, dark urine	No specific treatment—nursing care revolves around symptomatic treatment	Hepatitis B vaccine. Pretransfusion testing of donor blood. No vaccine for hepatitis C
HIV-1	6 stages by Walter Reed Classification System. Positive HIV flu-like syndrome to total anergy with chronic fungal and viral infections	No cure; treatment is symptomatic	Donor screening. New NAT test
Cytomegalovirus (CMV)	Systemic CMV: pneumonia, hepatitis, and retinits	No specific treatment	Reduce CMV exposure in specific patient populations; use blood from CMV seronegative donors or depleted leukocytes

Notes

Contents: NUTRI SUPPORT

Components of a Nutrional Assessment

History

- Medical
- Social
- Dietary

Anthropometric Measurements

- Skinfolds
- Height and weight
- Midarm circumference
- Midarm muscle circumference

Biochemical Assessment

- Serum albumin and transferrin levels
- Serum electrolytes
- Total lymphocyte count
- Urine assays (creatinine, height index)

Energy Requirements

Physical Examination

Other Indices

- Nitrogen balance
- Indirect calorimetry
- Prognostic nutritional Index (PNI)

CALCULATIONS

Calculation of current weight as % of the usual weight:

% Ideal Body Weight (IBW) = [Current weight/IBW] × 100

Recent change in body weight calculation

% of Usual Body Weight (UBW) = [Current body weight/UBW] × 100

Total Lymphocyte Count (TLC) calculation (used for immunocompromised clients)

$$TLC = \frac{\% \text{ lymph} \times WBC}{100}$$

A loss of 10% of the usual weight or a current weight less than 90% of IBW is considered to be a risk factor of nutrition-related complications.

Mild malnutrition = 85–95% IBW
Moderate malnutrition = 75–84% IBW
Severe malnutrition = less than 75% IBW

Note: In simple starvation 20% loss of body weight is associated with marked decreases in muscle tissue and subcutaneous fat.

Types of Malnutrition

MARASMUS

Decrease in the intake of calories with adequate protein-calorie ratio. Gradual wasting of body fat and skeletal muscle, with preservation of visceral proteins. Looks emaciated; decreased anthropometric measurements and anergy. Associated with chronic illness and starvation.

KWASHIORKOR

Characterized by an adequate intake of calories along with a poor protein intake. Causes visceral protein wasting and preservation of fat and somatic muscle. Associated with liquid diets, fat diets, and long-term use of IV fluids containing dextrose. May appear obese and have adequate anthropometirc measurements—depressed immune function.

MIXED MALNUTRITION

Characterized by aspects of marasmus and kwashiorkor. Associated with depleted fat stores, immune incompetence, and acute catabolic stress. Associated with highest risk of morbidity and mortality.

Dextrose Solutions for Total Parenteral Nutrtion

SOLUTION %	g/L	kcal/L	mOsm/L
5	50	170	252
10	100	340	505
20	200	680	1010
30	300	1020	1515
40	400	1360	2020
50	500	1700	2525
60	600	2040	3030
70	700	2380	3535

Note: Dextrose increases the metabolic rate, which raises ventilatory requirements.

Note: A 10% solution is the highest percentage that can safely be infused into a peripheral vein.

Note: Solutions of 20% and above must be infused into a central vein.

Protein (Amino Acids) for Total Parenteral Nutrition

Protein requirements for healthy adults: 0.8% g/kg/d
In critical illness state: 1.2–2.5 g/kg/d

Examples of Amino Acid Solutions

Protein Solution	Concentration (%)	Nitrogen (%)	Osmolarity (mOsm/L)
Aminosyn	3.5	0.55	357
Aminosyn II	4.25	0.65	438
Stress formula (Aminosyn-HBC)	7	1.12	665
Travasol	5.5	0.924	575
Novamine	15	2.37	1388
FreAmine III	3	0.46	300
HepatAmine	8	1.2	785

Lipid Administration for Total Parenteral Nutrition

Note: 1g fat = 9 kcal
Use of fat can help control hyperglycemia in stress states

Emulsion (%)	Available	Osmolarity (mOsm/L)
Liposyn II 10%	50/50 safflower oil, soybean oil	1.1 kca/mL - 276
Liposyn III 20%	Soybean oil	2.0 kcal/mL - 292
Intralipid 10%	Soybean oil	1.1 kcal/mL - 280
Nutrilipid 10%	Soybean oil	1.0 kcal/mL - 280
Nutrilipid 20%	Soybean oil	2.0 kcal/mL - 330

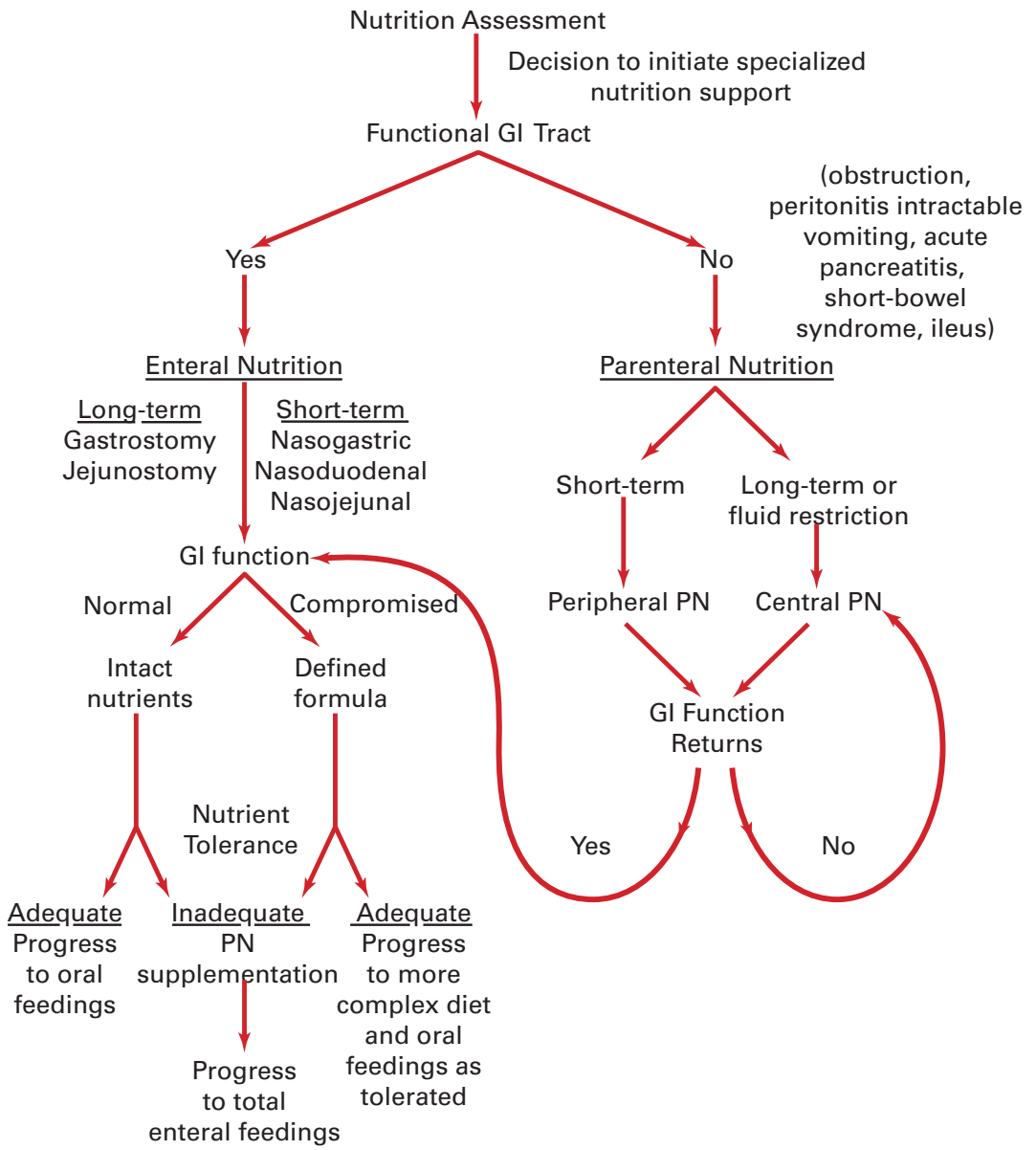
*30% emulsions are available but are not to be given by direct IV infusion; used in combination with dextrose solutions and amino acids so total fat content does not exceed 20%.

Rate of Administration

May be administered via injection port on administration set near infusion site.
10% - 0.1 mL/min for first 10–15 min. Rate to administer 500 mL over 4–6 hr.
20% - 0.5mL/min for first 15–20 min. Administer 1 g/kg of body weight over 4 hr
Note: An infusion pump is recommended; a 1.2-micron filter must be used with lipids

Modalities for Delivery of Nutritional Support

Algorithm for determining the choice of nutritional support



General Guidelines for Administration of Nutritional Support

1. One catheter lumen should be designated for nutritional support only; it should be labeled "Nutritional Support Only."
2. The container of nutritional support must not infuse beyond a 24-hour period of time. If the next solution container is not ready, a 10% dextrose solution must be hung to prevent rebound hypoglycemia.
3. Refrigerated nutritional support admixtures should be removed from the refrigerator 1 hour prior to administration.
4. When initiating TPN the infusion is to be introduced at a relatively slow rate (50 mL/hr) to prevent hyperglycemia.
5. The infusion MUST be maintained at the prescribed rate. If it should get behind, do not "catch up". The infusion may be adjusted with no more than a 10% margin (up or down) of the original rate.
6. Nutritional support should be administered using an electronic infusion pump.
7. The flow rate should be monitored at intervals of 30–60 minutes even if an EID is used.
8. Vital signs should be monitored every 4 hours, including temperature.
9. The patient's weight should be monitored with serial weights daily.
10. Strict intake and output should be monitored.
11. A chemistry panel should be drawn every 3 days initially when starting TPN.
12. Adequate oral or enteral intake must be assessed prior to discontinuing TPN.
13. Patients must be weaned off nutritional support to prevent rebound hypoglycemia. This is done over 24–48 hours by gradually decreasing the volume of TPN while monitoring patient response.
14. Use a 0.2-micron filter when administering parenteral nutrition of dextrose and amino acids. Use a 1.2-micron filter with lipid emulsions.

Peripheral Parenteral Nutrition (PPN)

Key Points

- Nutritional support delivered via peripheral vein
- Used to nourish patients who are either already malnourished or who have potential for developing malnutrition
- Considered "nitrogen-sparing" therapy
- Usually used for up to 2 weeks in selected patients who cannot ingest or absorb oral or enteral tube-delivered nutrients
- Provides dextrose in 10% solution and amino acids 1.75–3.5%
- Fat emulsions can be given via a peripheral line

Advantages

- Avoids insertion and maintenance of central catheter
- Delivers less hpertonic solution than central venous TPN
- Reduces chance of metabolic complications
- Increases calorie source

Disadvantages

- Cannot be used in nutritionally depleted patients
- Cannot be used in volume-restricted patients
- Does not usually increase a patient's weight
- May cause phlebitis

Monitoring

- Follow general guidelines

Total Parenteral Nutrition (TPN)

Key Points

- TPN is provided via central line due to hyperosmolarity (1800–3000 mOsm/L) of the solutions
- TPN is administered at rates not to exceed 200 mL/hr
- Dextrose 20%–70% is administered as a calorie source
- Used for prolonged periods in malnutrition states: months to years

- Reverses starvation and achieves tissue synthesis, repair, and growth
- All TPN solutions must be filtered; a 0.2-micron filter is used for dextrose and amino acid solutions; a 1.2-micron filter must be used with lipids
- Must have a dedicated lumen

Advantages

- For long-term use
- Useful in patient with large caloric and nutrient needs
- Provides calories, restores nitrogen balance, and replaces essential vitamins, electrolytes, and minerals
- Promotes tissue synthesis, wound healing, and normal metabolic function
- Allows bowel rest and healing
- Is nutritionally complete

Disadvantages

- May require a minor surgical procedure to insert catheter or port
- May cause metabolic complications
- Fat emulsions may not be used effectively in a severely stressed patient
- Risk of pneumothorax or hemothorax

Monitoring

- Follow general guidelines

Total Nutrient Admixtures (TNAs)

Key Points

- TNAs are solutions that have combinations of dextrose, amino acids, and fat emulsion in one container
- Referred to as “3-in-1” or “all-in-one”
- Provide 3-L container that infuses over 24 hours
- Used frequently in home care settings

- TNA **must** use a 1.2-micron filter
- Risk of cholestasis and that long-chain triglycerides may depress the immune system
- Catheter occlusions resulting from fat deposits have been reported
- Bacterial or fungal growth may be enhanced by TNA solutions

Monitoring

- See general guidelines

Cyclic Therapy (C-TPN)

Key Points

- Delivers concurrent dextrose, amino acids, and fat over a regimen of a reduced period—usually 12–18 hours
- Indicated for patients stabilized on continuous TPN
- Used for long-term parenteral nutrition
- Patient's cardiovascular status must be able to accommodate fluid volume during cyclic phase
- For patients without complaints such as glucose intolerance or precarious fluid balance, a 12-hour cycling regimen can be used
- A patient who is septic or metabolically stressed is not a good candidate for C-TPN
- Improves quality of life by encouraging normal daytime activities
- Observe for symptoms of hypoglycemia, hyperglycemia, dehydration and excessive fluid, and sepsis associated with central line
- Hyperglycemia can occur during peak C-TPN flow rate.
- Check blood sugar 1 hour after tapering off C-TPN daily until stable.

Monitoring

- See general guidelines

Specialized Parenteral Formulas

RENAL FORMULAS

Key Points

- For patients in renal failure who are in need of TPN
- Minimal quantities of essential amino acids
- Do not contain nonessential amino acids
- Standard crystalline amino acid solutions contain essential and nonessential amino acids
- Decrease rate of blood urea nitrogen formation and minimize deterioration of serum potassium, magnesium, and phosphorus
- Common preparations: Aminess 5.2%; Aminosyn-RF 5.2%; NephrAmine

HEPATIC FORMULAS

Key Points

- Solutions high in branched-chain amino acids (BCAA) are designed for patients with liver disease
- Formulas are limited to patients with encephalopathy
- Common preparations: BranchAmin, HepatAmine, Novamine
- Contraindicated in patients who are anuric

STRESS FORMULAS

Key Points

- Used for patients with infections, sepsis, and trauma of burns, surgery, shock, and blunt or penetrating injuries
- Severely stressed patient needs more protein to meet increased nutritional needs—high metabolic stress formulas are needed; increase in nitrogen excretion caused by altered protein metabolism—occurs in stressed patients
- Formulas with high BCAA replenish those depleted in the stressed patient
- Examples of stress formulas: Aminosyn-HBC, BranchAmin, FreAmine HBC, Novamine

Common Complications Associated with Nutritional Support			
Complication	**Symptoms**	**Treatment**	**Prevention**
Air Embolism	Cyanosis, tachypnea, hypotension, churning heart murmur, shock	Immediately place patient on left side and lower the head of bed; oxygen; call for assistance; prepare for resuscitation	Line placement by appropriately trained personnel; use care in injection cap changes; use Luer locks; no scissors near catheter
Vein Thrombosis	Swelling or pain in one or both arms, shoulders, or neck; increased anterior chest venous pattern	Diagnosis made by arm venography, contrast studies, MRI Treatment—extent of thrombus Conservative treatment—anticoagulants	Tip placement in SVC, not upper arm or subclavian Early recognition of symptoms
Catheter Malposition	Swelling of arm, neck, or pain; difficulty flushing catheter; patient complains of ear gurgling	Reposition with guidewire Reposition patient before flushing line	Not always possible to prevent Follow techniques to prevent malposition

Common Complications Associated with Nutritional Support

Complication	Symptoms	Treatment	Prevention
Altered Glucose Metabolism—Hypoglycemia: Rebound	Diaphoresis, irritability, nervousness, shaking, decreased serum glucose	Administer dextrose or decrease insulin	Maintain IV at constant rate; wean gradually Monitor blood sugars q 6 hr
Hyperglycemia	Increased serum glucose, acetone breath, anxiety, confusion, dehydration, polydipsia, polyuria, malaise	Decrease dextrose TPN concentration or decrease rate of administration of insulin per sliding scale	Accurate glucose monitoring, gradual TPN rate increases
Hypokalemia	Serum K^+ below 3.5 mEq/L, anorexia, fatigue, muscle weakness, decreased gastric motility, ECG changes	TPN supplementation; replace GI losses	Monitor serum potassium, strict I and O, assess for digitalis toxicity

(Continued on the following page)

Common Complications Associated with Nutritional Support *(Continued)*			
Complication	**Symptoms**	**Treatment**	**Prevention**
Sepsis	Chills, fever, malaise, elevated WBC count, diarrhea, tachycardia, tachypnea, flushing hypotension	Remove catheter or replace catheter over guidewire Antibiotics Administer oxygen Prepare to treat septic shock	Maintain aseptic technique Aseptic dressing changes Use 0.22-micron filter
Refeeding Syndrome *Occurs during initial phase of TPN; causes an electrolyte shift*	Cardiorespiratory complications, edema, hypernatremia, hypokalemia, hypomagnesemia, hypophosphatemia	Once body has reestablished normal albumin and electrolyte balance, the refeeding processes are reversed	Averted by starting TPN slowly and gradually increasing rate. Monitor patient response to TPN

Common Complications Associated with Nutritional Support

Complication	Symptoms	Treatment	Prevention
Essential Fatty Acid Deficiency	Minimal symptomatology until long-term soft-tissue calcification, hypocalcemia, tetany (numbness and tingling of mouth and fingers) Increased BUN, alopecia, cracked skin with dermatitis	Fat emulsion supplementation in TPN	Accurate calculation of protein and fat and CHO ratios to maintain positive nitrogen balance

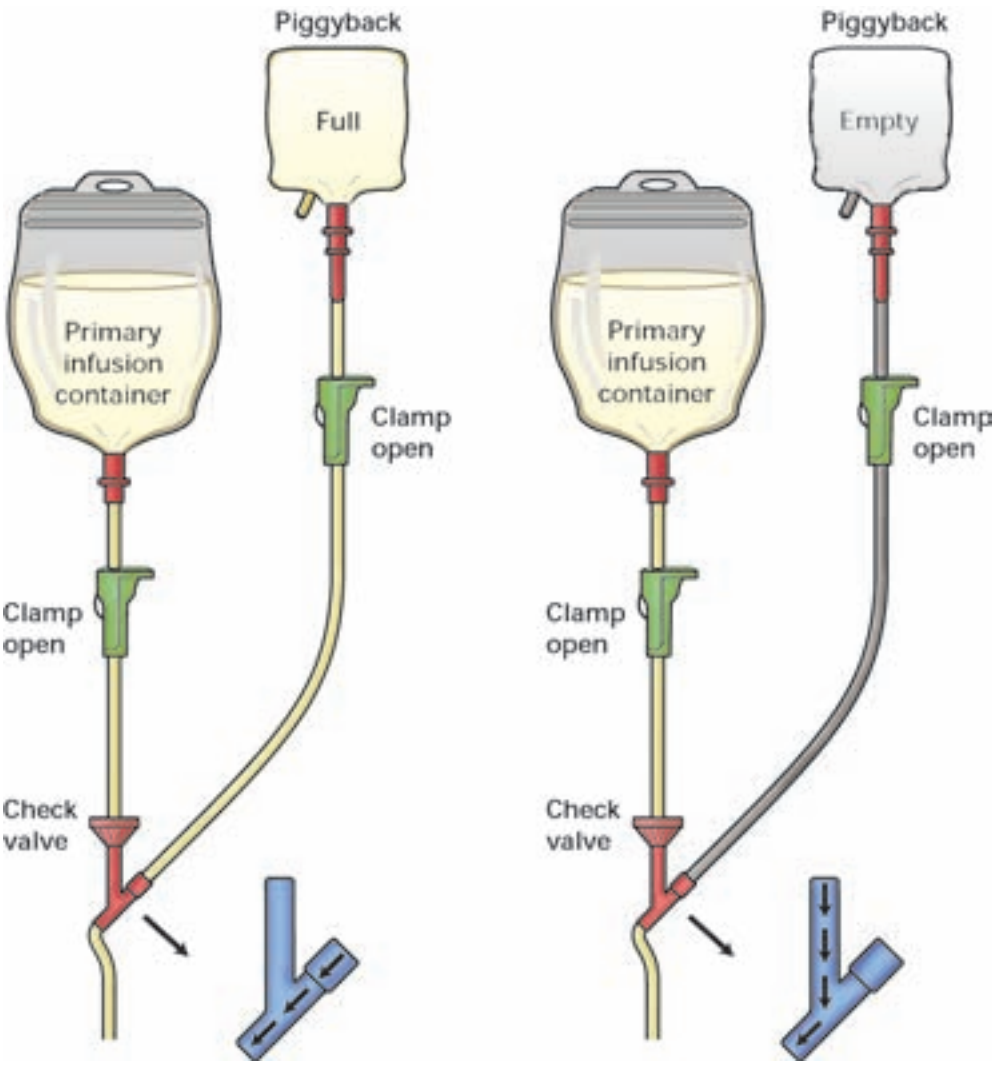
Notes

Contents: MEDICATION ADMINISTRATION

Intermittent Infusion—Piggyback Through Primary Pathway

Key Points

- The secondary infusion (piggyback) must be higher than the primary infusion bag
- Use extension hook supplied in secondary administration set
- Adjust secondary infusion rate
- Once secondary infusion is completed, primary solution will start to drip again



Direct IV Push Medications

Key Points

- Check compatibility of drug with primary solution
- Dilute opioid narcotics; follow recommendation of manufacturer
- Use separate syringe for each drug administered; select syringe size large enough to accommodate volume of medication and aspirate-procedure to confirm VAD patency
- Wear gloves
- Swab lowest medication injection port with alcohol
- Insert needleless syringe
- Aspirate to check for blood return
- Slowly administer medication over **1 minute** minimum
- Flush with sodium chloride if appropriate

Advantages

- Barriers of drug absorption are bypassed
- Drug response is rapid and usually predictable
- Patient is closely monitored during full administration of medication

Disadvantages

- Adverse effects occur at the same time and rate as therapeutic effects
- The IV push method has the greatest risk of adverse effects and toxicity because serum drug concentrations are sharply elevated
- Speed shock is possible from too-rapid administration of medication

Medication Delivery Through Volume Control Chamber

Key Points

- Used most frequently with pediatric clients
- Medication is added to the volume control chamber and diluted with IV solutions

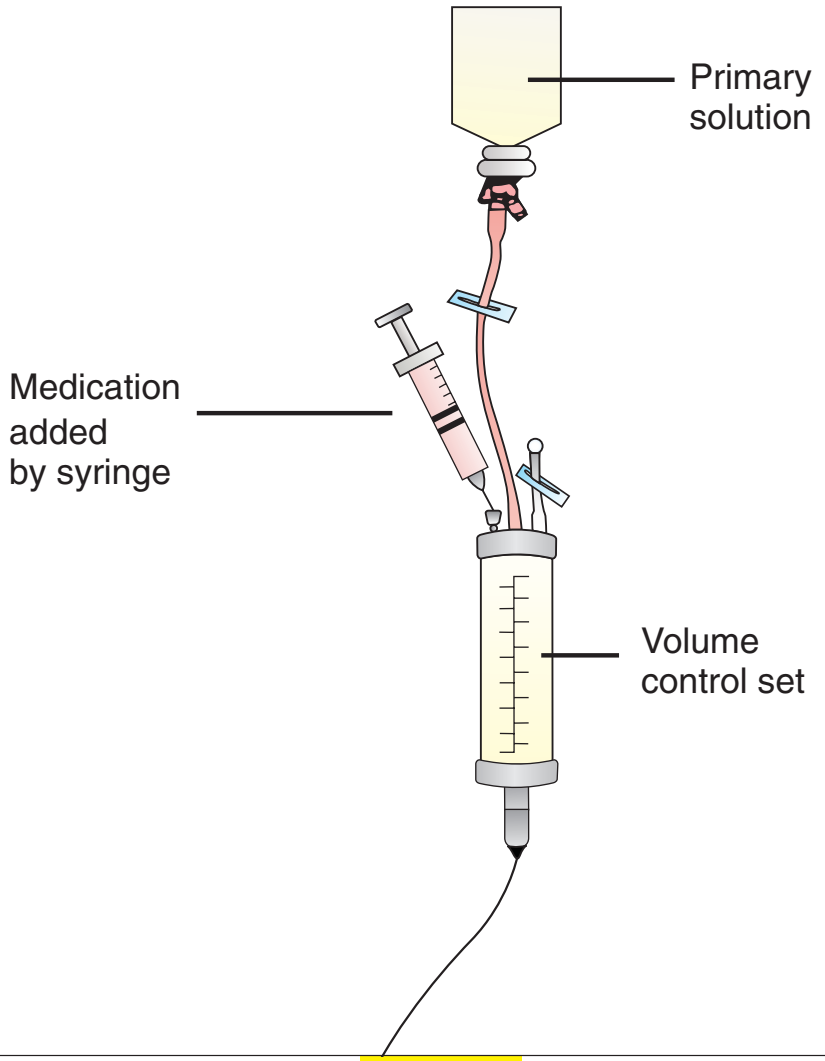
- Infusion is generally over 15 minutes to 1 hour, or adjusted continuous
- Chamber must be labeled

Advantages

- Runaway infusions avoided
- Volume of fluid in which the drug is diluted can be adjusted

Disadvantages

- Medication must travel the length of the tubing
- A portion of the medication can be left in the tubing after the chamber empties
- Incompatibilities may occur



Subcutaneous Medication Administration

Key Points

- Select insertion site with adequate subcutaneous tissue: a fat fold of at least 1 inch (supraclavicular, anterior chest wall, lower abdomen, outer aspects of arms and thighs)
- Avoid areas that are scarred, infected, irritated, edematous, bony, or highly vascularized
- Used for delivery of pain medication
- Use 25–27 g, $^1/_2$-inch catheter
- Rotate access site every 3–5 days
- Wear gloves

Advantages

- Easy care for home management of pain
- Decreases the number of times tissue is traumatized by repeated injections
- Better home management of pain
- Decrease in pain breakthrough

Disadvantages

- Local irritation at site
- Route inappropriate for volume larger than 1 mL/hr

Intraosseous Medication Administration

Key Points

- Alternative for infusion of fluids and drugs in infants and children up to 6 years of age
- Use of vascular network of the long bones—medullary cavity
- Use intraosseous needle; must be removed with 24 hours
- Use this route only in emergency
- Once needle removed, sterile gauze pressure dressing should be applied; inspect daily and redress for 48 hours

Advantages

- Provides quick access in emergency cases for fluid and drug administration

Disadvantages

- Potential for osteomyelitis, cellulitis
- Potential damage to the epiphyseal plate

Refer to Chapter 11 in Phillips, L. Manual of IV Therapeutics, 4th ed., F.A. Davis Co., 2005, for more information on intraosseous medication and fluid administration.

Epidural Medication (Catheters and Ports)

Key Points

- Placement of epidural catheter or port is a medical act
- Epidural space surrounds the spinal cord
- Used for pain management
- Use as single-bolus injection or continuous infusion
- Medications that can be administered by epidural route include:
  - Preservative-free Astromorph or Duramorph
  - Sublimaze (Fentany)
  - Bupivacain (Marcain)
- Avoid preservatives (alcohol, phenol, sodium metabisulfite) in medications—can damage the neural tissue
- After insertion, lay the exposed catheter length cephalad along the spine and over the shoulder
- Use a 0.22-micron inline filter to prevent particulate matter from infusing into the spinal fluid
- Clearly label the epidural catheter after placement
- Evaluate the effects of the drug on patient's alertness
- Site care must be done carefully to avoid dislodgement of catheter

Advantages

- Permits control or alleviation of severe pain without sedative effects
- Permits delivery of smaller doses of narcotic to achieve desired level of analgesia
- Allows for continuous infusion if needed

Disadvantages

- Nurses lack understanding of pharmacologic agents
- Only preservative-free narcotics can be used
- Complications such as paresthesia, urinary retention, respiratory depression, and pruritus can occur
- Catheter-related risks (dislodgement, infection)

Monitoring Epidural Medication Administration

- Mental status
- Respiratory rate
- Indications of numbness in the lower extremities
- Signs of infection
- Bowel function
- Bladder function
- Integrity of the epidural system
- Narcotic dose
- Patient's pain rating
- Epidural site observation and care
- Observe for ascending loss of sensation

Intrathecal Medication Administration

Key Points

- Intrathecal space lies between the ligamentum flavum and the dura mater
- Requires 10 times less medication than the epidural route
- Associated with greater risk for infection
- Intrathecal narcotics given as single injection
- Intrathecal infusions require implanted infusion pump

Advantages

- Useful for delivery of certain antineoplastic agents, antibiotics, analgesics, and anesthetic agents
- Effective alternative to oral or parenteral therapy for abatement of pain
- Allows for low doses of drug

Disadvantages

- Possible life-threatening side effects
- Potential for spinal fluid leak
- Potential for infection

Refer to Chapter 11 in Manual of IV Therapeutics, *4th ed., for more information on medication delivery routes.*

Intraperitoneal (IP) Medication Administration

Key Points

- Tenckhoff catheter used or implanted port
- Instills high concentration of drugs directly into body cavity
- Used most frequently to deliver antineoplastic agents
- The peritoneal cavity acts as reservoir for drug
- Obtain baseline weight and measure abdominal girth
- Assess for complications associated with IP therapy:
  - Pain
  - Subcutaneous leakage
  - Hematoma or bleeding (rare)
  - Local infection
  - Colon perforation
- Flush catheter or port with sterile saline after use; if using port, follow with heparinized saline

Advantages

- When not in use, IP device is invisible
- No catheter site care
- Cytotoxic drugs are administered directly into tumor area

Disadvantages

- Can be difficult to locate and access the port
- Catheter infection can occur
- Buildup of fibrin sheath can occur on the distal catheter tip
- Abdominal adhesions can cause spaces in the cavity, preventing the flow of the infusion

See Chapter 14 in Manual of IV Therapeutics, *4th ed., for more information on administration of medications via IP routes*

Notes

Notes

Contents: TOOLS

Common Laboratory Values

General Chemistry

Laboratory	Conventional	SI Units
Albumin	3.5–5.0 g/100 mL	35–50 g/L
Aldolase	1.3–8.2 U/L	22–137 nmol · s^{-1}/L
Alkaline phosphatase	13–39 U/L, infants and adolescents up to 104 U/L	217–650 nmol · s^{-1}/L, up to 1.26 μmol/L
Ammonia	12–55 μmol/L	12–55 μmol/L
Amylase	4–25 U/mL	4–25 arb. unit
Anion gap	8–16 mEq/L	8–16 mmol/L
AST, SGOT	Male: 8–46 U/L	0.14–0.78 μkat/L
	Female: 7–34 U/L	0.12–0.58 μkat/L
Bilirubin, direct	Up to 0.4 mg/100 mL	Up to 7 μmol/L
Bilirubin, total	Up to 1.0 mg/100 mL	Up to 17 μmol/L
BUN	8–25 mg/100 mL	2.9–8.9 mmol/L
Calcitonin	Male: 0–14 pg/mL	0–4.1 pmol/L
	Female: 0–28 pg/mL	0–8.2 pmol/L
Calcium (Ca^{+})	8.5–10.5 mg/100 mL	2.1–2.6 mmol/L
Carbon dioxide	24–30 mEq/L	24–30 mmol/L
Chloride (Cl^{-})	100–106 mEq/L	100–106 mmol/L
Cholesterol	<200 mg/dL	<5.18 mmol/L
Cortisol	a.m. 5–25 μg/100 mL	0.14–0.69 μmol/L
	p.m. <10 μg/100 mL	0–0.28 μmol/L
Creatine	Male: 0.2–0.5 mg/dL	15–40 μmol/L
	Female: 0.3–0.9 mg/dL	25–70 μmol/L
Creatine kinase (CK)	Male: 17–148 U/L	283–2467 nmol · s^{-1}/L
	Female: 10–79 U/L	167–1317 nmol · s^{-1}/L

(Continued)

General Chemistry		
Laboratory	**Conventional**	**SI Units**
Creatinine	0.6–1.5 mg/100 mL	53–133 μmol/L
Ferritin	10–410 ng/dL	
Folate	2.0–9.0 ng/mL	4.5–20.4 nmol/L
Glucose	70–110 mg/100 mL	3.9–5.6 mmol/L
Ionized calcium	4.26–5.25 mg/dL	1.1–1.3 mmol/L
Iron (Fe)	50–150 μg/100 mL	9.0–25.9 μmol/L
Iron-binding capacity (IBC)	250–410 μg/100 mL	44.8–73.4 μmol/L
Lactic acid	0.5–1.8 mEq/L	0.8–1.8 mmol/L
Lactic dehydrogenase (LDH)	45–90 U/L	750–1500 nmol s^{-1}/L
Lipase	2 U/mL or less	Up to 2 arb. unit
Magnesium (Mg^{++})	1.5–2.0 mEq/L	0.8–1.3 mmol/L
Osmolality	280–296 mOsm/kg water	280–296 mmol/kg
Phosphorus	3.0–4.5 mg/100 mL	1.0–1.5 mmol/L
Potassium (K^{+})	3.5–5.0 mEq/L	3.5–5.0 mmol/L
Prealbumin	18–32 mg/dL	
Protein, total	6.0–8.4 g/100 mL	80–84 g/L
PSA	0.0–4.0 ng/mL	
Pyruvate	0–0.11 mEq/L	0–0.11 mmol/L
Sodium (Na^{+})	135–145 mEq/L	135–145 mmol/L
T_3	75–195 ng/100 mL	1.16–3.00 nmol/L
T_4, free	Male: 0.75–2.0 ng/dL	
	Female: 0.75–2.0 ng/dL	
T_4, total	4–12 μg/100 mL	52–154 nmol/L
Thyroglobulin	3–42 μ/mL	3–42 μg/L
Triglycerides	40–150 mg/100 mL	0.4–1.5 g/L
TSH	0.5–5.0 μU/mL	0.5–5.0 arb. unit
Urea nitrogen	8–25 mg/100 mL	2.9–8.9 mmol/L
Uric acid	3.0–7.0 mg/100 mL	0.18–0.42 mmol/L

Hematology (ABC, CBC, Blood Counts)		
Blood volume	8.5–9.0% of body weight in kg	80–85 mL/kg
Red blood cell (RBC)	Male: 4.6–6.2 million/mm^3	4.6–6.2 × 10^{12}/L
	Female: 4.2–5.9 million/mm^3	4.2–5.9 × 10^{12}/L
Hemoglobin (Hgb)	Male: 13–18 g/100 mL	8.1–11.2 mmol/L
	Female: 12–16 g/100 mL	7.4–9.9 mmol/L
Hematocrit (Hct)	Male: 45–52%	0.45–0.52
	Female: 37–48%	0.37–0.48
Leukocytes (WBC)	4.300–10.800/mm^3	4.3–10.8 × 10^9/L
■ Bands	0–5%	0.03–0.08
■ Basophils	0–1%	0–0.01
■ Eosinophils	1–4%	0.01–0.04
■ Lymphocytes	25–40%	0.25–0.40
• B Lymphocytes	10–20%	0.10–0.20
• T Lymphocytes	60–80%	0.60–0.80
■ Monocytes	2–8%	0.02–0.08
■ Neutrophils	54–75%	0.54–0.75
Platelets	150,000–350,000/mm^3	150–350 × 10^9/L
Erythrocyte sedimentation rate (ESR)	Male: 1–13 mm/h Female: 1–20 mm/h	1–13 mm/h 1–20 mm/h

Coagulation

Laboratory	Conventional	SI Units
ACT	90–130 s	
PTT (activated)	21–35 s	21–35 s
Bleeding time	3–7 min	3–7 min
Fibrinogen	160–450 mg/dL	1.6–4.5 g/L
INR (target therapeutic)	2–3	2–3
Plasminogen	62–130%	0.62–1.30
Platelets	150,000–300,000/mm^3	$\times 10^6$/L
PT (prothrombin time)	10–12 s	10–12 s
PTT (partial thromboplastin time)	30–45 s	30–45 s
Thrombin time	11–15 s	11–15 s

Normal Blood Gases

Laboratory	Conventional	SI Units
pH	7.35–7.45	36–45 μmol/L
Po_2	75–100 mm Hg	10.0–13.3 kPa
Pco_2	35–45 mm Hg	4.7–6.0 kPa
HCO_3	22–26 mmol/L	22–26 mmol/L
Base excess	(−2)–(+2) mEq/L	(−2)–(+2) mmol/L
CO_2	19–24 mEq/L	19–24 mmol/L
Sao_2	96–100%	0.96–1.00

Common Abbreviations: Infusion Therapy

AGC	= absolute granulocyte count
BCAA	= branched-chain amino acids
BSA	= body surface area
BSC	= biologic safety cabinet
CDC	= Centers for Disease Control and Prevention
CPDA	= citrate-phosphate-dextrose-adeninine
C-TPN	= cyclic total parenteral nutrition
CVC	= central venous catheter
CVTC	= central venous tunneled catheter
ECF	= extracellular fluid
EID	= electronic infusion device
HD	= hazardous drugs
HLA	= human leukocyte antigen
HPN	= home parenteral nutrition
ICF	= intracellular fluid
IP	= intrapertioneal
OSHA	= Occupational, Safety, and Health Administration
PPN	= peripheral parenteral nutrition
PICC	= peripherally inserted central catheter
PPE	= personal protective equipment
PRN	= (*pro re nata*) = used to describe devices for intermittent transfusions
PSI	= pounds per square inch
TLC	= total lymphocyte count
TNA	= total nutrient admixture
TPN	= total parenteral nutrition
VAD	= vascular access device

CDC (HICPAC) Isolation Precautions

Tier One: Standard Precautions

Hand Hygiene

- Guidelines for hand washing and use of alcohol based

Gloves

- Guidelines for use of gloves when touching blood, body fluids, secretions, excretions, and contaminated objects

Mask—eye and face protection

- Wear a mask and eye protection to protect mucous membranes of eyes, nose, and mouth during procedure and patient-care activities that generate splashes or sprays

Gown

- Wear gown to protect skin and prevent soiling of clothing during procedures and patient-care activities that are likely to generate splashes or sprays

Patient Care Equipment

- Handle used patient-care equipment in a manner that prevents skin and mucous membrane exposures

Linen

- Handle, transport, and process used linen soiled with blood, body fluids to prevent exposure and contamination of clothing

Occupational health and bloodborne pathogens

- Guidelines for use of sharps, mouthpieces, resuscitation bags, and other ventilation devices

Tier Two: Transmission-Based Precautions

1. Airborne precautions—Patients known or suspected to be infected with organism transmitted by airborne droplet nuclei smaller than 5 microns (e.g., varicella, TB)
   - Private room
   - Monitor negative air pressure (6–12 air changes per hour)
   - Room door closed and patient in room
   - Wear respiratory protection (N95 respirator)
   - Limit transportation
2. Droplet precautions—Use for known or suspected patients who have illnesses transmitted by particle droplets larger than 5 microns (e.g., mycoplasma pneumonia)

- Private room
- If private room not available, place patient with a spatial separation of 3 ft or more
- Door may remain open
- Wear mask as in standard precautions when working within 3 ft of patient
- Limit transportation; mask patient

3. Contact precautions—Use for known illnesses transmitted by direct contact with client (e.g., GI illnesses; respiratory, skin, or wound colonization with multi–drug-resistant bacteria, e.g., *Clostridium difficile*)
   - Private room
   - Wear gloves and gown
   - Change gloves frequently
   - Good hand hygiene
   - Limit transportation
   - Dedicated equipment

OSHA Guidelines

Controlling Occupational Exposure to Hazardous Drugs (HDs)

1. Enviromental Protection
   - Risk: aerosols, dermal absorption, and ingestion
   - HD prep-restricted-centralized area
   - Signs restricting access: posted
   - Smoking, drinking, applying cosmetics, chewing gum, and eating restricted
   - Biologic Safety Cabinet (BSC) use
   - Emergency procedures for spill and skin or eye contact available to workers
2. Personal Protective Equipment (PPE)
   - PPE must be donned before work started
   - Gloves: Use thicker, longer latex gloves that cover gown cuff
   - Gloves with no powder
   - Double-gloving recommended

- Change hourly or if torn
- Gowns made of lint-free, low-permeability fabric; long sleeves, elastic cuffs
- NIOSH-approved respirator worn when a BSC is not available
- Use respirator with full face piece
- Eyewash facilities should be available
- Label all syringe and IV bags containing HDs

3. Drug Administration
   - Wash hands prior to gloving
   - Use Luer-lock fittings
   - A plastic-backed absorbent pad should be placed under tubing during administration
   - Sterile gauze should be placed around push sites
   - Prime and air-purging should be done under BSC
   - Use sterile gauze to wipe clean any drug contamination
   - Dispose of administration set intact
   - Protective goggles should be cleaned with detergent and rinsed
4. Waste Disposal
   - Thick leak-proof bags should be colored differently from other hospital trash
   - Use sharps container
   - Waste should be clearly labeled "HD Waste Only"
   - Incidental spills and breakages should be cleaned up by properly protected person
5. Storage and Transport
   - Storage areas: limit access to authorized personnel
   - Do not use for storing other drugs
   - Warning labels should be applied to all HD containers
   - HDs should be securely capped or sealed
   - Personnel transporting HDs should be trained in spill procedures
6. Medical Surveillance
   - Preplacement medical examination prior to working with HDs
   - Update every 2–3 years
   - Postexposure evaluation tailored to type of exposure

7. Hazardous Communication
   - Employers must develop, implement, and maintain written hazard communications for employees handling HDs.
8. Training and Information Dissemination
   - Employees must be informed of the requirements of the hazard communication standard and those for any operation or procedure in their work area where drugs that present a hazard are present.

Resource List

American Association of Critical Care Nurses (AACN) www.aacn.org
American Pain Society www.ampainsoc.org
American Society for Parenteral and Enteral Nutrition www.aspen.org
Association for Professionals in Infection Control and Epidemiology www.apic.org
Centers for Disease Control and Prevention www.cdc.gov
Epinet www.med.virginia.edu
Infusion Nurses Society (INS) www.ins1.org
Joint Commission on Accreditation of Health Care Organizations www.jcaho.org/standard
Latex Allergy www.latexallergyn.com
Medical Glove Guidance Manual www.fada.gov/cdrh/manual/glovenaul.pdf
National Association of Vascular Access Networks www.navannet.org
Oncology Nursing Society www.ons.org
Occupational Safety and Health Administration www.osha.gov

Labs/Diagnostics

Time	General Chemistry										
↓	Na^+	Cl^-	K^+	Ca^+	Mg^{++}	Glu	BUN	Creat.			

	Hematology					Cardiac Enzymes					
	Hct	Hgb	RBC	WBC	Platelets	Troponin -I	Troponin -T	CPK -MB	SGOT	LDH	Myoglobin

	Coagulation					Blood Gases						
	ACT	PT	INR	PTT	thrombin-time	pH	PO_2	PCO_2	HCO3	BE	CO_2	SaO_2

Intake	Amt in	Output	Amt out
IVF		Urine	
IVPB		NG drainage/emesis	
Blood/Colloid			
Oral Intake		Liquid stool	
		Other	
Total in		Total out	

Notes

Symbols

1° .....primary, 1st degree
2° .....secondary, 2nd degree
3° .....tertiary, 3rd degree
Δ .....change
ø .....no, none
Ψ .....psychiatric
< .....less than
> .....greater than
μ .....micro
μg .....microgram
≈ .....approximately
.....pound, number
″ .....second, inch
⬆ .....increase
⬇ .....decrease
= .....equal to, the same
≠ .....unequal, not equal
≥ .....greater than or equal to
≤ .....less than or equal to
♂ .....male
♀ .....female
° .....hour, degree
@ .....at
α .....alpha
β .....beta
R_x .....prescription, to treat, medications

Assessment Flowsheet

Patient **DX/ S/P**

Time ↓	Vital Signs					Notes
	BP	HR	RR	O_2 sats	Temp	
				on		
				on		
				on		
				on		
				on		
				on		
				on		
				on		

Notes

Index

Note: Page numbers followed by f refer to illustrations.

D

Notes

Notes

Notes

Notes

Notes

Notes

Notes