F. A. Davis Company

Always at your side...

Critical Care Notes

Clinical Pocket Guide

Waterproof and Reusable

Janice Jones, PhD, RN, CNS
Brenda Fix, MS, RN, NP

Includes...

- ✔ Pathophysiology and management of common critical care problems
- ✔ Critical nursing interventions
- ✔ Evidence-based protocols and resources
- ✔ Sedation, agitation and delirium management
- ✔ Ventilators and capnography
- ✔ ECG and ABG interpretation
- ✔ Critical care drugs

Critical Care Notes

Clinical Pocket Guide

Janice Jones, PHD, RN, CNS
Brenda Fix, MS, RN, NP

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: Robert G. Martone
Acquisitions Editor: Jonathan Joyce
Senior Developmental Editor: William F. Welsh
Project Editor: Meghan K. Ziegler

Reviewers:
Lisa Ann Behrend, RN, MSNc, CCRN-CSC
Deborah Little, MSN, RN, CCRN, CNRN, APRN, BC
Janice Garrison Lanham, RN, MSN, CCNS, FNP
Danette Wood, EdD, MSN, RN, CCRN
Laura Carousel, MSN, RN, CCRN
Jeanie Krause-Bachand, MSN, EdD, RN, BC
Deborah Pool, MS, RN, CCRN

Sticky Notes

✓HIPAA Compliant
✓OSHA Compliant

Waterproof and Reusable
Wipe-Free Pages

Write directly onto any page of *Critical Care 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, 2nd edition

ISBN-13: 978-0-8036-1335-5

LPN Notes: Nurse's Clinical Pocket Guide, 2nd edition

ISBN-13: 978-0-8036-1767-4

DocuNotes: Nurse's Clinical Pocket Guide to Effective Documenting and Reporting

ISBN-13: 978-0-8036-2092-6

ECG Notes: Interpretation and Management Guide

ISBN-13: 978-0-8036-1347-8

IV Med Notes: IV Administration Pocket Guide

ISBN-13: 978-0-8036-1466-8

IV Therapy Notes: Nurse's Clinical Pocket Guide

ISBN-13: 978-0-8036-1288-4

LabNotes: Guide to Lab and Diagnostic Tests

ISBN-13: 978-0-8036-1265-5

MedNotes: Nurse's Pharmacology Pocket Guide, 2nd Edition

ISBN-13: 978-0-8036-1531-1

MedSurg Notes: Nurse's Clinical Pocket Guide, 2nd edition

ISBN-13: 978-0-8036-1868-8

NCLEX-RN® Notes: Core Review & Exam Prep

ISBN-13: 978-0-8036-1570-0

NutriNotes: Nutrition & Diet Therapy Pocket Guide

ISBN-13: 978-0-8036-1114-6

OB Peds Women's Health Notes: Nurse's Clinical Pocket Guide

ISBN-13: 978-0-8036-1466-6

PsychNotes: Clinical Pocket Guide, 2nd edition

ISBN-13: 978-0-8036-1853-4

For a complete list of Davis's Notes and other titles for health care providers, visit www.fadavis.com.

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:

Physical Assessment

Reusable Assessment Form

Name:	Room:		Age:
Diagnosis:			
Surgeries/Past Hx:			
Activity:	Diet:		DNR/DNI:
Allergies:			
Neurological/MS: ICP:			
Cardiac: VS/A-line: ECG: Hemodynamics: PAD IABP:	PAS	PCWP	CVP
Respiratory: Ventilator: ABGs/SpO_2:			
GI:			
GU:			
Wounds/Incisions:			
Drainage Tubes:			
Treatments:			
Special Needs:			
Other:			

Normal Arterial and Venous Blood Gases

Blood Gas Components	Arterial	Venous
pH	7.35–7.45	7.31–7.41
PO_2	80–100 mm Hg	35–40 mm Hg
PCO_2	35–45 mm Hg	41–51 mm Hg
HCO_3	22–26 mEq/L or mmol/L	22–26 mEq/L or mmol/L
Base Excess (BE)	–2 to +2 mEq/L or mmol/L	–2 to +2 mEq/L or mmol/L
O_2 saturation	95%–100%	68%–77%

Blood Gas Results

Arterial		Venous
	pH	
	PO_2	
	PCO_2	
	HCO_3	
	Base Excess (BE)	
	O_2 saturation	

Quick Blood Gas Interpretation

Acid-Base Disorder	pH	PCO_2	↑ HCO_3
Respiratory acidosis	↓	↑	↑ if compensating
Respiratory alkalosis	↑	↓	↓ If compensating
Metabolic acidosis	↓	↓ if compensating	↓
Metabolic alkalosis	↑	↑ if compensating	↑

Full or total compensation: pH will be within normal limits

Compensation:

- Respiratory problem → the kidneys compensate by conserving or excreting HCO_3^-
- Metabolic problem → the lungs compensate by retaining or blowing off CO_2

Also look for mixed respiratory and metabolic problems.

$PaCO_2$ or HCO_3^- in a direction opposite its predicted direction or not close to predictive value.

Common Causes of Acid-Base Imbalances

Respiratory acidosis	COPD, asthma, head injury, pulmonary edema, aspiration, pneumonia, ARDS, pneumothorax, cardiac arrest, respiratory depression, CNS depression, or head injury
Respiratory alkalosis	Hyperventilation, anxiety, fear, pain, fever, sepsis, brain tumor, mechanical overventilation
Metabolic acidosis	Diabetes mellitus, acute and chronic renal failure, severe diarrhea, alcoholism, starvation, salicylate overdose, pancreatic fistulas
Metabolic alkalosis	Loss of gastric acid (vomiting, gastric suction), long-term diuretic therapy (thiazides, furosemide), excessive $NaHCO_3$ administration, hypercalcemia

Pulse Oximetry

SpO_2 monitoring: Monitoring saturation of peripheral O_2

SpO_2 Level	Indication
>95%	Normal
91%–94%	May be acceptable, provide O_2 as necessary, encourage C&DB or suction prn
85%–90%	Provide O_2 as necessary, encourage C&DB or suction prn, may be normal for COPD patient
<85%	Prepare for possible intubation

False readings may occur because of anemia, CO poisoning, hypothermia, hypovolemia, peripheral vasoconstriction caused by disease or medications.

Lactic Acidosis

Lactic acid is a byproduct of anaerobic metabolism. Increased levels indicate inadequate perfusion of vital organs with resultant tissue hypoxia. May result from inadequate perfusion and oxygenation of vital organs; post cardiac or respiratory arrest; cardiogenic, ischemic, or septic shock; drug overdoses, seizures, cancers, or diabetes mellitus.
Critical values: Blood pH, <7.35, and lactate >5–6 mEq/L or >45 mg/dL.
Treat with sodium bicarbonate IV if acidosis is readily evident.

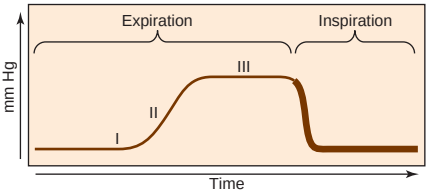
Capnography

Capnography is the measurement, display, and monitoring of the concentration or partial pressure of CO_2 ($PETCO_2$) in the respiratory gases at the end of expiration. The capnogram displays the maximum inspiratory and expiratory CO_2 concentrations during a respiratory cycle, which indirectly reflect the production of CO_2 by the tissues and the transport of CO_2 to the lungs. Sudden changes in CO_2 elimination should be monitored in selected cardiorespiratory patients and postoperatively after major cardiothoracic surgeries. Capnography can also be used to verify ETT position and monitor the effectiveness of CPR.

Causes of ↑ $P_{ET}CO_2$	Causes of ↓ $P_{ET}CO_2$
Fever	Hypothermia
Hypertension	Hypotension
Increased cardiac output	Decreased cardiac output
Hypoventilation	Hyperventilation
Hypovolemia	Hypervolemia
Airway obstruction	Airway obstruction
Bronchial intubation	Accidental extubation
	Pulmonary embolus
	Cardiac arrest
	Apnea

Normal range of $_{ET}CO_2$ is 35–45 mm Hg
↑ RR (hyperventilation) → ↓ CO_2 → $_{ET}CO_2$ < 35 = respiratory alkalosis
↓ RR (hypoventilation) → ↑ CO_2 → $_{ET}CO_2$ > 45 = respiratory acidosis
There are five characteristics of the capnogram that should be evaluated: frequency, rhythm, height, baseline, and shape.

Normal Capnogram



Phases I, II, and III represent expiration, the bolded lines represent inspiration. Long periods of a flat wave form indicate apnea, dislodged endotracheal tube, esophageal intubation, or patient disconnect from ventilator.

Artifical Airways and Mechanical Ventilation

Artifical Airways

Endotracheal Tube

- Adult oral tube sizes: Males 8.0–8.5, I.D. (mm); females 7.0–8.0. I.D. (mm) (internal diameter).
- Placement is 2 cm above the carina. Verify by auscultating for breath sounds bilaterally, uniform up-and-down chest movement, CXR, and checking end-tidal CO_2 immediately after intubation.
- Cuff pressure: 20–25 mm Hg.

Tracheostomy Tube

- Size will vary.
- Cuff pressure: 20–25 mm Hg.

Minimal leak technique or minimal occluding volume verifies that an ETT or tracheostomy tube is at its lowest inflation point. Attach a 10-mL syringe to the balloon of the inflated cuff. Position your stethoscope on the patient's neck at the area of the carotid pulse. Inflate balloon cuff to a point where no leak is heard. Slowly remove air from the inflated cuff until you hear a slight leak at the height of inspiration. Then add 1 mL of air back into the cuff.

Cuff pressure can also be monitored via a calibrated aneroid manometer device. Connect manometer to cuff. Deflate cuff. Reinflate cuff in 0.5 mL increments until desired cuff pressure is achieved. Check cuff pressure every 8–12 hrs or per agency protocol.

Mechanical Ventilation

Classification of Ventilators

Positive Pressure Ventilation

- **Volume-Cycled Ventilator:** Delivers a preset constant volume of air and preset O_2.
- **Pressure-Cycled Ventilator:** Produces a flow of gas that inflates the lung until the preset airway pressure is reached.
- **Time-Cycled Ventilator:** Programmed to deliver a volume of gas over a specific time period through adjustments in inspiratory-to-expiratory ratio.

- **High-Frequency Jet Ventilator (HFJV):** Delivers 60–100 bpm with low tidal volumes under considerable pressures.

Negative Pressure Ventilation

Uses the old iron lung principle by exerting a negative pressure on the chest wall to cause inspiration. No intubation required. Custom fitted "cuirass" or "turtle" shell unit that fits over the chest wall. May be utilized at night for patients who require assistance during sleep.

Modes of Ventilation

- **Controlled Mechanical Ventilation (CMV):** Machine controls rate of breathing. Delivery of preset volume (TV) and rate regardless of patient's breathing pattern. Sedation or paralyzing agent (e.g., Pavulon) usually required.
- **Assist Controlled Ventilation (ACV):** Patient controls rate of breathing. Inspiratory effort triggers delivery of preset volume.
- **Intermittent Mandatory Ventilation (IMV):** Patient breathes spontaneously (own tidal volume) between ventilator breaths of a preset volume and rate.
- **Synchronized Intermittent Mandatory Ventilation (SIMV):** A form of pressure support ventilation. Administers mandatory ventilator breath at a preset level of positive airway pressure. Monitors negative inspiratory effort and augments patient's spontaneous tidal volume or inspiratory effort. Synchronized with patient's breathing pattern.
- **Positive End-Expiratory Pressure (PEEP):** Increases oxygenation by increasing functional residual capacity (FRC). Keeps alveoli inflated after expiration. Can use lower O_2 concentrations with PEEP; decreases risk of O_2 toxicity. Ordered as 5–10 cm H_2O.
- **Continuous Positive Airway Pressure (CPAP):** Maintains positive pressure throughout the respiratory cycle of a spontaneously breathing patient. Increases the amount of air remaining in the lungs at the end of expiration. Less complications than PEEP. Ordered as 5–10 cm H_2O.
- **Bilevel Positive Airway Pressure (BiPAP):** Same as CPAP but settings can be adjusted for both inspiration and expiration.
- **Pressure Support Ventilation (PSV):** Patient's inspiratory effort is assisted by the ventilator to a certain level of pressure. Patient initiates all breaths and controls flow rate and tidal volume. Decreases work of breathing.

- **Inverse Ratio Ventilation (IRV):** All breaths are pressure limited and time cycled. Inspiratory time usually set longer than expiratory time.

IMV, SIMV, CPAP, BiPAP and PSV can all be used in the weaning process.

Weaning

Sample Criteria for Weaning: Readiness

- Alert and cooperative
- $FIO_2 \leq$ 40%–50% and PEEP $\leq$5–8 cm H_2O
- Hemodynamically stable
- pH $\geq$7.34
- PaO_2 >80 mm Hg
- $PaCO_2$ <45 mm Hg
- PaO_2/FIO_2 ratio >200
- Vital capacity 15 mL/kg and minute ventilation <10
- Hemoglobin >7–9 g/dL and serum electrolytes within normal limits
- Spontaneous respirations >6 b/min. or <35 b/min.
- Negative inspiratory pressure –30 cm H_2O
- Relatively afebrile with limited respiratory secretions
- Inotropes reduced or unchanged within previous 24 hrs
- Sedation discontinued

Weaning Methods

- **T-tube weaning:** Place patient on T-tube circuit on same FIO_2 as on ventilatory assistance. Monitor ABGs after 30 min. Provide a brief rest period on the ventilator as needed and continue to monitor ABGs until satisfactory. Extubate when patient is rested, good spontaneous respiratory effort, and ABGs within acceptable parameters.
- **IMV/SIMV weaning:** Decrease IMV rate every 1–4 hrs. Monitor spontaneous breaths. Obtain ABGs within 30 min. of ventilator change. Allows for gradual change from positive-pressure ventilation to spontaneous-pressure ventilation.
- **PSV:** Use low levels of PSV (5–10 cm H_2O). Decrease in 3–6 cm of H_2O increments. Useful in retraining respiratory muscles due to long-term ventilation.

- **CPAP/BiPAP:** Provides expiratory support, maintains positive intrathoracic pressure. BiPAP adds inspiratory support to CPAP. Prevents respiratory muscle fatigue.

Nursing assessment during weaning

- Vital signs and hemodynamics (PAS, PAD, PCWP, CO, CI)
- Dysrhythmias or ECG changes
- Oxygenation/Efficiency of gas exchange
- CO_2 production and elimination
- pH level
- Bedside pulmonary function tests
- Work of breathing including use of accessory muscles
- Level of fatigue
- Patient discomfort
- Adequate nutrition

Ventilator Alarms

Ventilator alarms should never be ignored or turned off. They may be muted or silenced temporarily until problem is resolved.

Checklist of Common Causes of Ventilator Alarms

Patient causes:

- Biting down on endotracheal tube
- Patient needs suctioning
- Coughing
- Gagging on endotracheal tube
- Patient "bucking" or not synchronous with the ventilator
- Patient attempting to talk
- Patient experiences period of apnea

Mechanical causes:

- Kinking of ventilator tubing
- Endotracheal tube cuff may need more air
- Leak in endotracheal tube cuff
- Excess water in ventilator tubing
- Leak or disconnect in the system
- Air leak from chest tube if present
- Malfunctioning of oxygen system
- Loss of power to ventilator

Pathophysiological causes:

- Increased lung noncompliance, such as in ARDS
- Increased airway resistance, such as in bronchospasm
- Pulmonary edema
- Pneumothorax or hemothorax

Nursing Interventions

- Check ventilator disconnects and tubing.
- Assess breath sounds, suction as needed.
- Remove excess water from ventilator tubing.
- Check endotracheal cuff pressure.
- Insert bite block or oral airway.

If cause of the alarm cannot be found immediately or cause cannot be readily resolved, remove patient from ventilator and manually ventilate patient using a resuscitation bag.

Call respiratory therapy stat.

Continue to assess patient's respiratory status until mechanical ventilation is resumed.

Ventilator Complications

Complication	Signs & Symptoms/Interventions
Barotrauma or volutrauma—acute lung injury, may result in pneumothorax or tension pneumothorax, pneumomediastinum, pneumoperitoneum, subcutaneous crepitus	• High peak inspiratory and mean airway pressures • Diminished breath sounds • Tracheal shift • Subcutaneous crepitus • Hypoxemia Insert chest tube or needle thoracostomy.
Intubation of right mainstem bronchus	• Absent or diminished breath sounds in left lung • Unilateral chest excursion Reposition ETT.

Continued

Ventilator Complications—*Cont'd*

Complication	Signs & Symptoms/Interventions
Endotracheal tube out of position or unplanned extubation	• Absent or diminished breath sounds Note location of tube at the lip (21–22 cm). Reposition ETT or reintubate. Restrain only when necessary.
Tracheal damage due to excessive cuff pressure (>30 cm H_2O)	• Blood in sputum when suctioning • Frequent ventilator alarm Monitor ETT cuff pressure every 4–8 hrs. Perform minimal leak technique. Ensure minimal occluding volume.
Damage to oral or nasal mucosa	• Skin breakdown or necrosis to lips, nares, or oral mucous membranes Reposition tube side-side of mouth every day. Apply petroleum jelly to nares. Provide oral care with toothbrush every 2 hrs.
Aspiration Tracheo-esophageal fistulas	• Feeding viewed when suctioning • If blue dye is used, sputum is blue in color Use blue dye with enteral feedings if aspiration suspected. Keep head of bed 30–45 degrees. Administer proton pump inhibitors or histamine H_2-receptor antagonists.
Ventilator-assisted pneumonia Respiratory infection Increased risk of sinusitis	• Refer to section on VAP Assess color and odor of sputum. Monitor temperature, WBC count, ESR.
Decreased venous return → decreased cardiac output due to increased intrathoracic pressure	• Hypotension • Decreased CVP, RAP, and preload Monitor vital signs and hemodynamics.

Continued

Ventilator Complications—*Cont'd*

Complication	Signs & Symptoms/Interventions
Stress ulcer and GI bleeding	• Blood in nasogastric drainage • Hematemesis and/or melena Hematest nasogastric drainage, emesis, feces. Administer proton pump inhibitors or histamine H_2-receptor antagonists.
Paralytic ileus	• Absence of diminished bowel sounds Provide nasogastric drainage with intermittent suction. Turn and position patient frequently.
Inadequate nutrition, loss of protein	• Refer to section on nutrition. Start enteral feedings if appropriate. Start total parenteral nutrition if GI tract nonfunctional or contraindicated.
Increased intracranial pressure	• Changes in level of consciousness • Unable to follow commands Assess neurological status frequently.
Fluid retention due to increased humidification from ventilator, increased pressure to baroreceptors causing a release of ADH	Assess for edema. Administer diuretics. Drain ventilator tubing frequently.
Immobility Skin breakdown	Turn and position patient frequently. Assess skin for breakdown. Assist patient out of bed to chair unless contraindicated. Keep skin clean and dry, sheets wrinkle-free.
Communication difficulties	Keep communication simple. Obtain slate or writing board. Use letter/picture chart. Communicate using sign language.

Continued

Ventilator Complications—*Cont'd*

Complication	Signs & Symptoms/Interventions
Urinary tract infection	• Urine becomes cloudy, concentrated, odorous Change/remove Foley catheter. Ensure adequate hydration. Administer antiinfectives.
Deep vein thrombosis	• Painful, swollen leg; pain may increase on dorsiflexion Assess for pulmonary embolism. See respiratory section. Administer heparin or enoxaparin.
Psychosocial concerns: fear, loss, powerlessness, pain, anxiety, sleep disturbances, nightmares, loneliness	• Anxious • Difficulty sleeping • Poor pain control Administer anxiolytics, sedatives, analgesics. Cluster activities to promote periods of sleep. Allow patient to make choices when appropriate. Allow for frequent family visits. Keep patient and family informed.

Hemodynamic Monitoring

Hemodynamic Parameters

Arteriovenous oxygen difference . . . . . 3.5–5.5 vol% or 4–8 L/min
Aortic pressure:

- Systolic . . . . . .100-140 mm Hg
- Diastolic . . . . . .60–80 mm Hg
- Mean . . . . . .70–90 mm Hg

Cardiac output (CO = HR X SV) . . . . . .4–8 L/min
Cardiac index (CO/BSA) . . . . . .2.5–4 L/min
Central venous pressure (CVP) . . . . . .2–8 mm Hg
** Same as right atrial pressure (RAP)
Cerebral perfusion pressure (CPP) . . . . . .2–6 mm Hg or 5–12 cm H_2O
Coronary artery perfusion pressure (CAPP) . . . . . .60–80 mm Hg
Ejection fraction (Ej Fx or EF) 60%–75%
Left arterial mean pressure . . . . . .4–12 mm Hg
Left ventricular systolic pressure . . . . . .100–140 mm Hg
Left ventricular diastolic pressure . . . . . .0–5 mm Hg
Left ventricular stroke work index (LSWI) . . . . . .30–50 g/beats/m^2
Mean arterial pressure (MAP) . . . . . .70–100 mm Hg
Oxygen consumption (VO_2) . . . . . .200–250 mL/min
Oxygen delivery (Do_2) . . . . . .900–1100 mL/min
Pulmonary artery pressure (PAP):

- Systolic . . . . . .20–30 mm Hg
- Diastolic . . . . . .10–20 mm Hg
- Mean . . . . . .10–15 mm Hg

Pulmonary capillary wedge pressure (PCWP) . . . . . .4–12 mm Hg
Right arterial mean pressure . . . . . .2–6 mm Hg
Right ventricular pressure:

- Systolic . . . . . .20–30 mm Hg
- Diastolic . . . . . .0–8 mm Hg
- End Diastolic . . . . . .2–6 mm Hg

Right ventricular stroke work index (RSWI) . . . . . .7–12 g/m^2/beat
Pulmonary vascular resistance (PVR) . . . . . .20–130 dynes/sec/cm^{-5}
Pulmonary vascular resistance index (PVRI) . . . . . .200–400 dynes/sec/cm^5/m^2
Pulmonary ventricular stroke index . . . . . .5–10 g/beat/m^2
Right atrial pressure (RAP) . . . . . .2–6 mm Hg
Stroke index (SI) . . . . . .30–650 mL/beat/m^2
Stroke volume (SV = CO/HR) . . . . . .60–100 mL/beat
Systemic vascular resistance (SVR) . . . . . .900–1,600 dynes/sec/cm^{-5}
Systemic vascular resistance index . . . . . .1,360–2,200 dynes/sec/cm^{-5}/m^2
Systemic venous oxygen saturation (SvO_2) 60%–80%

Cardiac Output Components

Preload	Contractility	Afterload
PaO_2	SaO_2	Hemoglobin (Hgb)
Right atrial pressure	Stroke volume	Pulmonary vascular resistance
Central venous pressure	Cardiac output	Systemic vascular resistance
Left ventricular end diastolic pressure	Tissue perfusion	Blood pressure

Pulmonary Artery Catheter

The purpose of the pulmonary artery catheter, also known as the Swan-Ganz catheter, is to assess and monitor left ventricular function and can determine preload, assess contractility, and approximate afterload.

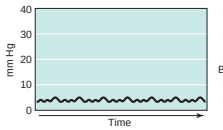
PCWP approximates left atrial pressure and left ventricular end diastolic pressure.

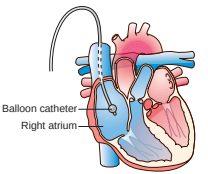
Increases in PCWP, LAP, or LVEDP indicates heart failure, hypervolemia, shock, mitral valve insufficiency, or stenosis. Decreases in PCWP, LAP, or LVEDP indicate hypovolemia.

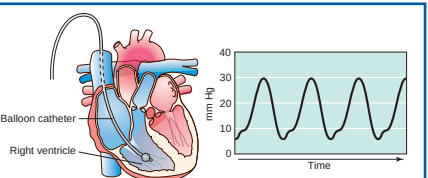
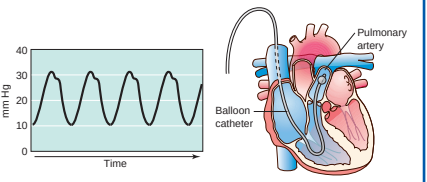
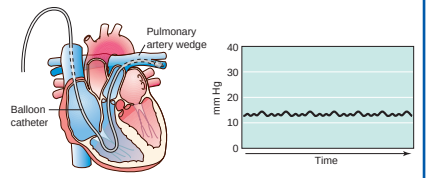
PA Catheter Waveforms

The pulmonary artery catheter is threaded through the right atrium and right ventricle and into the pulmonary artery. Insertion is done via fluoroscopy or monitoring waveform changes.

Catheter advanced to right atrium, balloon is inflated. Pressure is low, usually 2–5 mm Hg.





Catheter is floated to right ventricle with the balloon inflated. Waveforms indicate a systolic pressure of 25–30 mm Hg and a diastolic pressure of 0–5 mm Hg.	
As the catheter moves into the pulmonary artery, the systolic pressure remains the same but the diastolic pressure elevates to 10–15 mm Hg.	
The catheter is moved until it can be wedged in a smaller vessel. When the balloon is inflated, the pressure recorded is that pressure in front of the catheter. It is an approximate measure of the left ventricular end diastolic pressure.	

Problems with Pulmonary Artery Catheters	
Problem	**Check For/Action**
No waveform	• Loose connections • Tubing kinked or compressed • Air in transducer • Loose/cracked transducer • Stopcock mispositioned • Occlusion by clot: Aspirate as per policy
Overdamping (smaller waveform with slow rise, diminished or absent dicrotic notch)	• Air bubble or clot in the system • Catheter position: Reposition patient or have patient cough • Kinks or knotting • Clot: Aspirate as per policy
Catheter whip (erratic waveform, variable and inaccurate pressure)	• Catheter position: Reposition patient or catheter; obtain chest x-ray
Inability to wedge catheter (no wedge waveform after inflating balloon)	• Balloon rupture: Turn patient on left side; check catheter position for retrograde slippage

Complications of Pulmonary Artery Catheters

- Risk for infection
- Altered skin integrity
- Air embolism
- Pulmonary thromboembolism
- Cardiac tamponade
- Dysrhythmias
- Altered cardiopulmonary tissue perfusion due to thrombus formation; catheter in wedged position leading to pulmonary infarction
- Catheter displacement/dislodgement
- Loss of balloon integrity or balloon rupture
- Pneumothorax
- Hemothorax

- Frank hemorrhage
- Pulmonary artery extravasation
- Pulmonary artery rupture

Intra-Arterial Monitoring

An arterial line (A-line) is used if frequent blood pressure and arterial blood gas determinations are needed. It is especially useful

- After surgery.
- For patients with unstable vital signs.
- For patients experiencing hypoxemia.

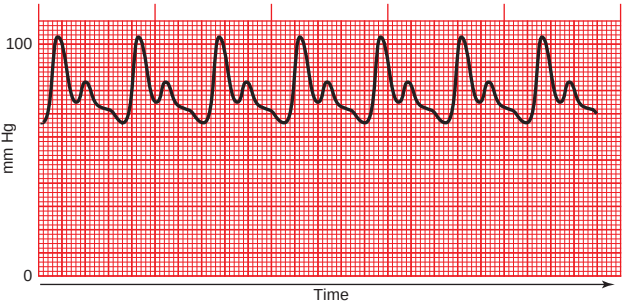
Perform Allen's test prior to insertion. Elevate the patient's hand with his or her fists clenched. Release pressure over only the ulnar artery. Color returns to the hand within 6 seconds if the ulnar artery is patent and adequate collateral blood flow present.

Compressing the radial and ulnar arteries

Observing for pallor

Releasing pressure and observing for return of normal color

Intra-Arterial Waveform



Components of Waveform

- **Systolic peak:** Ventricular ejection and stroke volume. Sharp rise and rounded top.
- **Dicrotic notch:** Aortic valve closure, end ventricular systole, start ventricular diastole. Should be one-third or greater of height of systolic peak. If lower → suspect ↓ C.O.

Tapering of down stroke following dicrotic notch

Important assessments: changes in capillary refill/blanching, sensation, motion, or color that may indicate lack of perfusion to the extremity

$$\text{MAP} = \frac{\text{systolic BP} + (\text{diastolic BP} \times 2)}{3} = 70\text{–}100 \text{ mm Hg}$$

Decreased tissue perfusion—decreasing urine output, elevation in BUN:Creatinine ratio, altered mental status with decreasing level of consciousness, restlessness, dyspnea, cyanosis, dysrhythmias, abnormal ABGs, weak or absent peripheral pulses, increased capillary refill time (>3 sec), diminished arterial pulsations, bruits.