

humidity deficit The difference between what is provided by the humidifier and the amount of humidity required by the patient.

hyperinflation See *overinflation*.

hyperosmolar A substance or condition with increased osmolarity.

hyperthyroidism A condition that results from increased activity of the thyroid gland. An increase in metabolic activity that is characterized by nervousness, tremors, hunger, weight loss, fatigue, palpitations, and related symptoms occurs.

hyperventilation Ventilation in excess of a level required to meet metabolic demands (e.g., $\text{PaCO}_2 < 30$ mm Hg).

hypoventilation A respiratory condition resulting in elevated blood carbon dioxide and generalized reduction in respiratory function.

hypoxemia Lower than normal oxygen pressure in the arterial blood.

hypoxia Lower than normal oxygen pressure in the alveolus or at the tissue level resulting in an inadequate amount of oxygen available to the body cells to meet their metabolic needs.

hysteresis Can be thought of as a lagging of one of two associated phenomena; that is, two associated phenomena fail to coincide or occur simultaneously. An example of hysteresis is the difference between the inspiratory and expiratory curves in a pressure–volume loop for the lungs.

I
iatrogenic Caused by a medical procedure or treatment.

ileus An obstruction of the intestinal tract associated with immobility of the bowel or a mechanical blockage of the bowel.

incisura A small negative deflection on the pressure–time tracing present in the aortic and pulmonary artery pressure tracings; caused by the transient reversal of blood flow toward the heart during the last part of systole that pushes against the respective semilunar valve.

independent lung ventilation A form of mechanical ventilation.

indirect calorimetry Estimate of the caloric expenditure of the body by measurement of exhaled gas volumes and fractional concentrations of oxygen and carbon dioxide rather than direct heat production from the body.

inflammatory mediators Chemical substances produced by the body that are involved in the inflammatory response.

inflection point Occurs during deflation (also sometimes called the *deflection point*) and represents collapse of a significant number of lung units after full inflation (recruitment) of the lungs.

inspiratory pause Mechanical ventilator setting that involves a short prolongation of the inspiratory phase of a breath. Inspiratory pause or inflation hold maneuvers are used to measure plateau pressure.

inspiratory positive airway pressure (IPAP) The application of positive pressure to the airway during inspiration. Compare *expiratory positive airway pressure*.

inspissated secretions Airway secretions that are thickened or hardened through the loss or evaporation of the liquid portion.

intermittent abdominal pressure ventilator (IAPV) A motorized inflatable bladder that fits over the abdomen and assists spontaneous breathing. The motor inflates the bladder, which in turn pushes the diaphragm upward to facilitate exhalation. When the bladder deflates, the diaphragm returns to its resting position allowing for passive inhalation. See *pneumobelt*.

intermittent positive pressure breathing (IPPB) The application of positive pressure breaths to the upper airway on a periodic basis; used to provide short-term or intermittent mechanical ventilation for the purpose of augmenting lung expansion, delivering aerosol medication, or assisting ventilation.

intermittent positive pressure ventilation (IPPV) A general term for mechanical ventilation provided by positive pressure. The acronym *IPPV* can also be used to mean *invasive positive pressure ventilation* in which the patient has an endotracheal or tracheostomy tube in place to connect to the ventilator.

internal pneumatic circuit A series of gas-conducting tubes on the inside of a ventilator that direct gas flow within the ventilator to the outside of the ventilator for delivery to the patient.

internal respiration Movement of oxygen and carbon dioxide between the cells and blood.

international normalized ratio (PT/INR) Calculation made to standardize prothrombin time. INR depends on the ratio of the patient's prothrombin time and the normal mean prothrombin time. Prothrombin time shows how fast the blood clots in patients receiving oral anticoagulant medication.

intrinsic PEEP (PEEP_i) See *auto-PEEP*.

iron lung A negative pressure ventilator. Also called a *tank ventilator*, *artificial lung*, or *Drinker respirator*.

ischemia A reduction in the flow or supply of oxygenated blood to a body organ or area; may be accompanied by severe pain and organ dysfunction (e.g., cardiac ischemia when an adequate oxygenated blood flow to the heart is lacking).

ischemic Condition characterized by a deficiency of blood supply to an organ.

isothermic saturation boundary The point in the airway where inspired air is warmed and humidified to 100% relative humidity at 37°C and contains 44 mg/L of water (absolute humidity). This point is approximately at the level of the fourth to fifth generation of subsegmental bronchi and varies with rate of gas flow, minute ventilation, and ambient air conditions.

K

ketoacidosis Acidosis accompanied by an increase in ketones; occurs primarily as a complication of diabetes mellitus.

kinetic therapy The use of automated rotating beds to reduce the incidence of ventilator-associated pneumonia (VAP), particularly in surgical patients or patients with neurologic problems.

L

late-onset pneumonia Pneumonia that develops later than 72 hours after exposure to a hospital or clinic setting.

limit variable The phase variable whose size is set at some predetermined maximum that cannot be exceeded during inspiration.

lower inflection point A point of significant change in the slope of a static pressure–volume curve at the beginning of lung inflation; indicates the pressure at which large numbers of alveoli are beginning to be recruited; sometimes called P_{flex} .

M

mandatory breaths Breaths for which the ventilator determines the start time (time triggered based on the set rate) or the volume (volume targeted) or pressure (pressure targeted) or both the start time and the tidal volume or pressure delivered.

mandatory minute ventilation (MMV) A closed-loop system in which the ventilator monitors set parameters and makes adjustments based on those parameters and the patient's spontaneous breathing efforts. The operator sets a minute ventilation (\dot{V}_E) lower than the patient's spontaneous \dot{V}_E . If monitored \dot{V}_E falls below the minimum set \dot{V}_E , the ventilator increases support to the patient, and vice versa. Also called *minimum* \dot{V}_E .

mask pressure Term often used to describe the airway opening pressure.

mechanical dead space The amount of rebreathed volume in a ventilator circuit.

meconium aspiration syndrome The inhalation of meconium by the fetus or newborn, resulting in blockage of the airways, failure of the lungs to expand, potential pneumonia, and possible respiratory failure.

metabolic monitor Device used to measure concentrations of inspired and expired gases (i.e., oxygen and carbon dioxide), as well as sensors for measuring the volume and/or flow of respired gases.

microprocessors Integrated electronic circuits that contain the central processing unit functions of a computer.

minute ventilation The volume of gas per minute inhaled or exhaled from a person's lungs. The calculation of minute ventilation is the product of rate and tidal volume.

miosis The constriction of the pupil of the eye to 2 mm or less.

mode Term used to describe various mechanical ventilator strategies employed to deliver a breath. Ventilator modes are typically characterized by how an inhalation is initiated and ends and how exhalation begins.

mouth pressure (P_M) Pressure at the upper airway (mouth); also called *airway opening pressure (P_{awo})*, *airway pressure (P_{aw})*, *upper airway pressure*, *mask pressure*, and *proximal airway pressure*.

multidrug-resistant (MDR) microorganism A bacteria that resists distinct drugs or chemicals of a wide variety of structure and function targeted at eradicating the organism.

multiple organ failure Modified organ function in an acutely ill patient requiring medical treatment to achieve homeostasis.

multisystem organ failure (multiple organ dysfunction syndrome [MODS]) Severe pathological failure occurring all at once of many organ systems, such as the lungs, gastrointestinal tract, liver, and heart; may accompany acute lung injury or acute respiratory distress syndrome.

N

negative end-expiratory pressure (NEEP) Negative pressure applied to the airway at the end of exhalation during mechanical ventilation.

neonate A newborn younger than 4 weeks of age.

neurally adjusted ventilator assist (NAVA) A mode of mechanical ventilation that provides respiratory assistance for the patient in comparison to and in synchrony with the patient's respiratory efforts.

nocturnal hypoventilation An elevated P_aCO_2 and accompanying fall in oxygen saturation that occurs in response to a progressive fall in minute ventilation occurring during sleep, most often in the rapid eye movement (REM) stage.

nondepolarizing agents Agents that causes skeletal muscle paralysis by causing competitive inhibition of acetylcholine at the muscle receptor site.

noninvasive positive pressure ventilation (NIV) Delivery of positive pressure mechanical ventilation to the lungs without the use of an artificial airway.

nosocomial infections Infections in hospitals and other health care facilities.

O

obstructive sleep apnea (OSA) A condition characterized by episodes of breathing cessation during sleep. Relaxation of the muscles of the upper part of the throat during sleep causes the upper airway to close, blocking the upper airway (oropharynx) and preventing air from entering the lungs. This results in failure of air movement through the obstructed passage while breathing efforts persist. At least five episodes of apnea (lack of air movement) lasting 10 or more seconds are characteristic of OSA.

oliguria A diminished output of urine relative to fluid intake.

open-loop system A control scheme in which a variable is set and the operating system makes no comparisons between output and input signals and no changes to the designated variable; an "unintelligent" system; the opposite of a closed-loop system.

operational verification procedure (OVP) A checklist used to verify that the ventilator systems are fully functional and safe before use with a patient; sometimes a part of the respiratory therapy department's policy and procedure manual. The self-test performed by the ventilator may be part of the OVP.

overdistention See *overinflation* and *hyperinflation*.

overinflation When excessive pressure or volume delivery during mechanical ventilation causes too much stretching of lung parenchyma; overdistention or hyperinflation.

P

paradoxical breathing Abnormal breathing pattern characterized by movement of the thorax outward during expiration and collapsing inward during a spontaneous breath.

paralytic agents Drugs used to facilitate invasive procedures (e.g., surgery, endotracheal intubation) and to prevent movement and ensure the stability of artificial airways. Paralysis may also be used to decrease mean airway pressure (P_{aw}) during uncoordinated or uncontrolled mechanical ventilation.

partial ventilatory support (PVS) Any amount of mechanical ventilation with ventilator rates that are less than those used with continuous mandatory ventilation (CMV), in which the patient is participating in the work of breathing to help maintain effective alveolar ventilation.

patent ductus arteriosus (PDA) An abnormal opening between the pulmonary artery and the aorta resulting when the ductus arteriosus does not close at birth.

patient circuit A series of gas-conducting tubes that conduct gas from the ventilator output connector to the patient and from the patient to the ventilator exhalation valve; also called the *ventilator circuit*.

patient triggering When inspiration begins because of the ventilator sensing a change in pressure, flow, or volume as a result of a patient effort.

patient-ventilator asynchrony A situation in which the patient breathing pattern and ventilator breathing pattern are not harmonious.

patient-ventilator system check See *ventilator flow sheet*.

peak airway pressure The highest pressure achieved during inspiration on positive pressure ventilation; also called *peak pressure* and *peak inspiratory pressure*.

peak inspiratory pressure See peak airway pressure.

peak pressure See peak airway pressure.

pediatric An infant, child, and adolescent from birth to 21 years of age.

perivascular Pertaining to an area around a blood vessel.

permissive hypercapnia Higher than normal P_aCO_2 values resulting from ventilator strategies used to protect the lung from injury associated with the ventilator.

phase variable A signal that is measured and used by the ventilator to begin some part (phase) of the breathing cycle.

physiological shunt The total shunt fraction.

plateau pressure A pressure measurement taken during positive pressure ventilation after a breath has been delivered to the patient and before exhalation has begun. A condition of no flow exists, reflecting the pressure in the lungs and patient circuit.

pneumbelt A belt containing a bladder that inflates during exhalation to move the diaphragm upward (cephalad) to assist exhalation. Inhalation is passive.

polymicrobial infection Infection by multiple pathogenic microorganisms.

polyneuritis Inflammation of many nerves at once or disseminated neuritis.

positive end-expiratory pressure (PEEP) Pressure above atmospheric, applied to the airway during exhalation, that increases the functional residual capacity.

preload The filling pressure of the ventricle at the end of ventricular diastole.

pressure augmentation Dual-control mode that provides pressure-limited ventilation with volume delivery targeted for each breath.

pressure control A mode of ventilation that is normally patient or time triggered, pressure targeted, and time cycled.

pressure cycling Inspiration ends when the ventilator measures a set pressure during inspiration.

pressure gradient A pressure difference between two points, one pressure being higher than the other.

pressure limiting A set maximum pressure that cannot be exceeded.

pressure support A mode of ventilation that is normally patient triggered, pressure targeted, and flow cycled.

pressure-targeted ventilators Ventilators that provide multiple modes for presetting the maximum inflation pressure rather than a fixed tidal volume.

pressure triggering When a change in pressure starts gas flow from the ventilator to deliver inspiration.

problem An unwelcome or harmful matter requiring immediate attention that must be dealt with and overcome.

prone positioning Placing the body with the chest (ventral side) down and back (dorsal side) up.

prophylactic therapy Therapy aimed at defending against or preventing disease.

protected specimen brush (PBS) An invasive microbiologic procedure to culture lower respiratory secretions often necessary to ensure effective treatment of patients with ventilator-associated pneumonia (VAP).

proximal airway pressure Term used to indicate an estimate of the alveolar distending pressure.

pruritus Itching leading to the desire to scratch.

pulmonary angiogram A radiological image of the pulmonary vasculature bed obtained by injecting an opaque contrast medium into the pulmonary circulation.

pulmonary artery catheter (PAC) A long, thin flow-directed tube with a balloon tip on the end (also known as *Swan-Ganz*) that allows it to flow into the right chamber of the heart.

pulmonary vascular resistance The afterload the right ventricle must overcome to eject blood into the pulmonary circulation.

pulse Vibrating sensation or sound that is associated with expansion and contraction of the arteries as blood is propelled through them.

pulse oximetry A technique that uses a sensor placed on a digit, an earlobe, the forehead, or the bridge of the nose to determine oxygen saturation and pulse rate. Pulse oximetry actually combines two physical techniques: (1) the spectrophotometric technique, which is used to determine a patient's percent arterial oxyhemoglobin; and (2) optical plethysmography, which is used to estimate the pulse rate.

pulse pressure The difference between the systolic and diastolic pressure.

pulsus paradoxus A systolic blood pressure that is more than 10 mm Hg lower during inspiration than during expiration.

Q

qualitative Measures the quality of something rather than its quantity.

quantitative Measures the quantity of something rather than its quality.

R

ramp A comfort feature incorporated in many noninvasive pressure-targeted ventilators that allows an incremental rise in set pressures over a set period of time; most often used in conjunction with the *delay time control*.

Ramsay Sedation Scale A graduated single-category scale used to assess the level of sedation in an individual receiving sedation.

recruitment maneuver Denotes activating an intentional transient increase in transpulmonary pressure to open unstable airless alveoli.

relative humidity The actual or absolute amount of humidity in a gas compared with its maximum carrying capacity at that

temperature, calculated as a percent. Relative humidity (absolute)/(maximum capacity) $\times 100$.

rescue therapy A life-threatening event requiring nonsurgical treatment.

residual volume The volume of air in the lungs after a maximum exhalation.

resistance Frictional forces associated with ventilation due to the anatomical structure of the conductive airways and the resistance to gas flow through the airways, and the tissue viscous resistance of the lungs and adjacent tissues and organs as the lungs expand and contract.

respiration The movement of gas molecules across a membrane.

respiratory alternans Alternation between using the diaphragm to breathe and the accessory muscles of respiration; an indication of end-stage respiratory muscle fatigue.

respirometer A device used to measure breathing variables such as tidal volume and vital capacity.

respite care Allowing caregivers of a ventilator-assisted individual to have an opportunity to rest and relax by providing another caregiver to care for the patient.

retrograde To direct or turn backward.

rocking bed A motorized bed that moves continuously in a longitudinal plane. Expiration is assisted when the head is in the down position and the abdominal contents and diaphragm are moved by gravity toward the thorax (cephalad).

S

scalar A way to specify the waveforms for pressure, flow, and volume that are graphed against time (e.g., pressure, flow, volume scalars). The resulting waveform is referred to as a *scalar*.

sedatives Used to reduce anxiety and agitation and to promote sleep and anterograde amnesia.

silent chest Term used to describe the absence of audible breath sounds in a patient experiencing a severe asthma exacerbation. It is characterized by the absence of wheezing due to severe airway obstruction.

simethicone agents A nonprescription agent that reduces the surface tension of gas bubbles in the stomach.

single-circuit ventilator A ventilator in which the internal pneumatic circuit allows the gas to go directly from its power source into the patient.

spontaneous breaths A breath or inspiratory gas flow that is started by the patient (patient triggered) and tidal volume delivery is determined by the patient (patient cycled). With spontaneous breaths, the amount of volume and/or pressure delivered is based on patient demand and not by a preselected amount set on a ventilator.

static compliance/static effective compliance Compliance measurement obtained during conditions of no gas flow. Compliance is equal to a volume change divided by a pressure change.

status asthmaticus A severe and prolonged asthma episode that is poorly responsive to adrenergic agents; associated with decreased airway diameter due to bronchospasm, increased mucous plugging, and inflammation of the airway. Signs and symptoms of potential respiratory failure may be present.

stroke index Stroke volume divided by body surface area.

stroke work Cardiac work; calculated by using mean blood pressure multiplied by the stroke volume multiplied by a correction factor.

superinfections Infections that develop during drug treatment for another infection, caused by a different microorganism that is resistant to the treatment used for the first infection.

Swan-Ganz catheter A multilumen, balloon-tipped, pulmonary artery catheter originally designed by Swan, Ganz, and colleagues.

system compressibility See tubing compliance for a description of system compressibility.

systemic vascular resistance The afterload the left ventricle must overcome to eject blood into the aorta and systemic circulation.

T

tachycardia Heart rates in the adult greater than 100 beats/min.

threshold resistor A device that provides a constant pressure throughout expiration regardless of the rate of gas flow; used in the exhalation line of a ventilator. The exhaled air proceeds unimpeded through the resistor until pressure falls to a preset value (PEEP). At that time, the exhaled gas flow stops and the system pressure is maintained.

thrombolytic therapy Drug therapy directed at dissolving a clot (e.g., administration of streptokinase or urokinase to dissolve an arterial clot in a patient with an acute myocardial infarction resulting from clots in the coronary vessels).

thrombotic mediators Chemical substances produced by the body that cause an abnormal vascular condition, resulting in a clot developing inside a blood vessel in the body.

time constant The product of compliance (C) and resistance (R).

time cycling When the ventilator ends inspiration after measuring a specific time that has elapsed during the inspiratory phase.

time triggering The beginning of inspiration initiated by a ventilator when it detects that a certain period of time has elapsed. Time is commonly based on a rate or frequency control setting.

tracheoesophageal fistula A congenital malformation resulting in a tubelike opening between the trachea and esophagus.

tracheomalacia Erosion of the tracheal wall, often associated with excessive pressure from an endotracheal or tracheostomy tube cuff, which reduces effective blood flow through the tracheal wall, resulting in injury to the tissue.

train-of-four monitoring An electrophysiological technique used to assess the effectiveness of neuromuscular blocking agents. An electrical current consisting of four impulses is applied to the peripheral nerve over 2 seconds, and the muscle contractions (twitches) produced provide information about the level of muscle paralysis.

transairway pressure The difference between airway pressure and alveolar pressure.

transcutaneous monitoring A noninvasive method of indirectly assessing ABGs. Unlike pulse oximetry and capnography, which rely on spectrophotometric analysis, transcutaneous monitoring uses modified blood gas electrodes to measure the oxygen and carbon dioxide tensions at the skin surface.

transpulmonary pressure The difference between alveolar pressure and pleural pressure.

transpyloric Across the pyloric region of the stomach.

transrespiratory pressure The difference between airway opening pressure and body surface pressure ($P_{TR} = P_{awo} - P_{bs}$).

transthoracic pressure The difference between alveolar pressure and body surface pressure; also called *trans-chest wall pressure*.

trigger variable The phase variable that begins inspiration.

tubing compliance (C_T) System compressibility; reflects the amount (in milliliters) of gas compressed in the ventilator circuit for every

centimeter of water pressure generated by the ventilator during the inspiratory phase. ($C_T = \text{Change in volume divided by change in pressure } [\Delta V/\Delta P] \text{ in mL/cm H}_2\text{O}$).

U

upper airway pressure Term used to describe airway opening pressure.

upper inflection point A point of significant change in the upper slope of a static pressure–volume curve at the end of lung inflation near total lung capacity (TLC). The change indicates a point at which large numbers of alveoli are being overinflated.

user interface The dials, knobs, controls, and touch screen devices used by the ventilator operator to determine how the ventilator will function.

V

ventilation The movement of air into and out of the lungs.

ventilator-associated pneumonia (VAP) Pneumonia that develops 48 hours after a patient has been placed on mechanical ventilation.

ventilator flow sheet A regularly performed check of the patient–ventilator system, usually done by the respiratory therapy staff; includes patient assessment data, monitored information, and ventilator parameters or parameter changes. Can be handwritten or computer based and is usually performed every 2 to 4 hours, unless an unusual event requires earlier checking.

vital capacity (VC) The total amount of air that can be exhaled after a maximum inspiration. The sum of the inspiratory reserve volume, the tidal volume (V_T), and the expiratory reserve volume.

volume-controlled ventilation Mechanical ventilatory mode in which a specific tidal volume is set and delivered for each breath.

volume cycled Inspiration ends when a preset volume is delivered to the patient.

volume limiting A maximum volume set by the clinician that is set and cannot be exceeded.

volume triggering When the ventilator detects a small drop in volume in the patient circuit during the latter part of exhalation and begins inspiration.

volutrauma A form of lung injury associated with excessive volume delivery by a ventilator, resulting in tissue injury at the alveolar level.

W

weaning The process of discontinuing ventilation and liberating the patient from the ventilator.

Z

zero end-expiratory pressure (ZEEP) A baseline pressure of zero during the expiratory phase of mechanical ventilation.

Note: Page numbers followed by “f” indicate figures, “t” indicate tables, and “b” indicate boxes.

A

AARC. *See* American Association for Respiratory Care
 Abdominal distention, 351
 ABG. *See* Arterial blood gas
 Abnormal hemoglobin, 168b
 Abnormal right atrial pressure, values and patterns, causes of, 202b
 Absorption atelectasis, 247–248, 333
 Accessory muscles
 of breathing, 2b
 usage, 333
 Accidental lavage, source of, 107b
 ACCP. *See* American College of Chest Physicians
 Acid-base factors, in weaning, 408
 Acidosis, untreated, 48
Acinetobacter, 287–289
 ACPE. *See* Acute cardiogenic pulmonary edema
 Acquired airway lesions, 450
 Activated alarms, algorithms for troubleshooting of, 358f
 Actual delivered volume, set volume *versus*, 38
 Actual flow waveform, shadow trigger and shape signal comparison, 335f
 Acute asthma, initial ventilator settings, 114b
 Acute cardiogenic pulmonary edema (ACPE), 119–120
 case study on, 120b
 causes of, 119b
 NIV in, 371, 372b
 Acute care facility, transport of mechanically ventilated patients within, 238–239
 Acute care setting
 decisions made in, evidence-based criteria for, 46–47
 noninvasive positive-pressure ventilation in, 370–372, 370b
 patient selection criteria in, 373–375, 374b
 Acute care sites, 420
 Acute head injury, clinical scenario, 117b
 Acute hypercapnic respiratory failure, 48
 Acute hypoxemic respiratory failure, 47
 severity of, indicators of, 54b
 Acute lung injury, 47b
 APRV settings in, weaning, 497t
 Acute-on-chronic respiratory failure, 55
 Acute pancreatitis, case study on of, 326b
 Acute renal failure, laboratory evaluation of, 236

Acute respiratory distress syndrome (ARDS), 47b, 117–118, 261–262
 AECC definition of, 263t
 Berlin definition of, 264t
 case study on, 119b
 categories of, 266
 clinical scenario, 118b, 279b
 computed tomogram with, changes in, 263–265
 conditions associated with, 117b
 diagnostic criteria for, 117b
 guidelines for, 117–118
 as heterogeneous disorder, 266–267
 improving oxygenation and management of, 244–285
 as inflammatory process, 265–267
 inflammatory response in, chemical mediation in, 266b
 long-term follow-up on, 268
 lung-protective strategies in, 267–268, 267b–268b
 lungs
 normal *vs.*, 266–267
 region creation of, 259f
 management of
 with HFO, case study on, 478b
 protocol for, 276f
 on mechanical ventilation, 260t
 medical management of, 119
 noninvasive positive-pressure ventilation in, 371
 pathophysiology, 263, 264f
 PEEP/F_iO₂ levels with, 271b
 pressure-volume curves, 144f, 269f
 pressure-volume loops in, 268–275, 269f
 prone positioning in, 276–278, 277f
 recruitment maneuvers in, 271–275, 271b–272b
 static pressure-volume curve, 268, 270f
 vertical gradient in, 267
 weighing, 501
 Acute respiratory failure (ARF), 47–48
 case study on, 49b
 definition of, 47–48
 indications of, 50t
 patient history and diagnosis of, 48–51
 physiological measurements, 51–54
 Acute status asthmaticus, case study on, 464b
 Acute ventilatory failure, 48
 Acute ventilatory insufficiency, 55b
 Adaptive lung ventilation (ALV), 398
 Adaptive support ventilation, 395, 398
 Added mechanical dead space, 130, 130f, 130b

Adults

acute care ventilators for, 377–378
 acute respiratory failure in, indications for invasive mechanical ventilation in, 55b
 cardiac output of, 200
 critical-care ventilator for, 377
 high-frequency oscillatory ventilation in, 497–498
 mechanically ventilated, with artificial airways, endotracheal suctioning of, 226b
 mechanical ventilatory support in, 50t
 NIV indications, symptoms and selection criteria for, 373t
 noninvasive positive pressure ventilation in, indications and contraindications for, 56b
 resting heart rate of, 200
 weaning and extubation of, physiological parameters for, 401t
 Adult ventilators, tidal volume delivery, 111
 Aerobic gram-negative bacilli, 287–288, 288b
 Aeroneb Professional Nebulizer System, medication delivery by, 506
 Aerosol delivery, 506
 factors influencing, 227f
 heated humidifiers affecting, 229
 during mechanical ventilation, 507–509
 in noninvasive ventilation, 384
 factors affecting, 384b
 ventilator-related factors, 228t, 229b
 Aerosol-generating devices, types of, 228–232
 Aerosolized bronchodilators, delivery of, 229
 Aerosolized medication, delivery of, 107
 Aerosols
 administration, 226
 circuit-related factors, 229
 deposition, 230b
 patient-related factors, 229
 Afterload, 193
 Agitated patient, case study on, 304b
 Airflow
 limitation of, 463–464
 monitoring, 185
 Air leak
 identification of, 340f
 indication, 158f
 Air, mechanical delivery of, 494
 Airtight garments, for negative pressure ventilation, 432f

- Air trapping, 99, 330–333, 331f–332f
 auto-PEEP and, 159, 159f
 representation of, 105f
- Airway occlusion pressure ($P_{0.1}$), 402
 graphic representation of, 402f
- Airway pressure, 3, 3f
 curve
 assist ventilation, 35f
 using inspiratory pressure support, 396f
 measurements of, 183–184
 on mechanical ventilation, 183f
 monitoring of, 130–134, 131b
 transmission of, to pleural space, 260
 waveforms of, tracing illustration of, 203f
- Airway pressure release ventilation (APRV), 41, 79, 79f, 472, 472f, 493
 advantages of, 494–495
 airway pressures and, 495
 clinical scenario of, 497b
 with curves, 495f
 disadvantages of, 495
 discontinuation of, 497
 high pressure, setting, 495–496
 high time, setting, 496
 initial settings for, 495–496
 low pressure, setting, 496
 low time, setting, 496
 names of, 493–494, 494b
 pressure-time curve, and flow-time curve during, 494f
 pressure-time waveforms, CPAP and, 493f
 settings, 159, 159f–160f
 settings, example of, 497t
 ventilation, compared with, 494–495
- Airway pressure transmission ratio (APTR), 203
- Airway resistance, 6, 185
 determination of, case study on, 8b
 effects of, 311
 equation of, 6b
 increased, 7, 48b
 increased, high peak pressures from, 314, 315f
 measurement of, 7–8
 monitoring of, 141–142
 quantifying the degree of, 51
 reduction in, 313
- Airways
 clearance, during mechanical ventilation, 221
 collapse, 105f
 gas flow through, 504
 management of, equipment for, 427b
 opening pressure (P_{awo}), 3, 3f
 problems in, 349–350
 causes of, 349b
 protecting patient's, 55b
- Alarms, 107–109, 108b
 activation of, 133
 algorithms for troubleshooting of, 358f
 additional, 356
 apnea, 356
 common situations in, 353–356
 failure of, 109b, 133b
- Alarms (*Continued*)
 function of, alteration of, 364
 inspiratory-to-expiratory ratio indicator and, 356
 levels of, 108b
 situations, 353–356
- Allen test, modified, 135b
- ALV. *See* Adaptive lung ventilation
- Alveolar dead space, increased, 218, 219b
- Alveolar distending pressure, 3
- Alveolar filling, 330f
- Alveolar minute ventilation, 177, 177f
- Alveolar oxygenation, 47b
- Alveolar plateau, 171–172
- Alveolar pressure (P_{alv}), 3, 3f, 13, 151
 P_{plat} and, 183b
- Alveolar-to-arterial oxygen tension ($P_{(A-a)O_2}$), 256
- Alveolar ventilation (\dot{V}_A), 47b
 calculation of, 130b
 final alveolar ventilation, 130, 131b
 monitoring of, 130
 reductions in, 48
- Ambient light, pulse oximeter and, 169
- American Association for Respiratory Care (AARC)
 bronchoscopy assistance, 234b
 clinical practice guidelines for
 endotracheal suctioning, 226b
 mechanically ventilated patient, in-hospital transport of, 239b
 recommendations from, 399b
- American College of Chest Physicians (ACCP)
 guidelines for liberation from mechanical ventilation, 412, 413b
 recommendations from, 399b
- American Thoracic Society (ATS), 372
 guidelines for liberation from mechanical ventilation, 412, 413b
- γ -Aminobutyric acid (GABA) receptor complex, 301
- Amplitude, 499–500
- Analgesia, monitoring of, 300–301, 300t, 300b
- Analgesics, 299–308, 299b
 practices of, 300
- Anatomical dead space ($V_{D_{anat}}$), 130
- Anatomical shunts, 205
- Anesthesia, 300b, 302
 strategies and protocols for, 399b, 410
 used in mechanically ventilated patients, 304b
- Anterograde amnesic effects, 301
- Antibiotics
 “bimodal” effect of, 296
 inappropriate use of, 288, 288b
 regimens, algorithm of, 292f
- Apnea alarms, 108, 356
 usage, 108
- APRV. *See* Airway pressure release ventilation
- Aptaér Heliox Delivery System, 506f
 mode of operation of, 506
- APTR. *See* Airway pressure transmission ratio
- ARDS. *See* Acute respiratory distress syndrome
- ARF. *See* Acute respiratory failure
- Arginine vasopressin, 316
- Armature, position of, 26
- Arterial blood gas (ABG)
 analysis of, 48, 449
 goals, adjusting settings, 502–503, 502b–503b
 kidney function and, 317
 sample, obtaining, 214
- Arterial blood, pressure measurements, effect, 201f
- Arterial catheter, insertion and maintenance of, 196b
- Arterial oxygen content, calculation of, 54b
- Arterial oxygen saturation, pulse oximetry and, 167
- Arterial partial pressure of carbon dioxide (P_aCO_2)
 factors affecting, 214f
 pH and, 256
 reduce, during high-frequency oscillatory ventilation, 503b
 rise in, 503
- Arterial partial pressure of oxygen (P_aO_2), 50t
 elevated, 53
 mean airway pressure and, 313
 P_aO_2/F_iO_2 , 256
 ratio, use of, 54
 $P_aO_2/P_{A-a}O_2$ ratio, use of, 54
- Arterial PO_2 , 256
- Arterial to end-tidal CO_2 tension gradient ($P_{(a-et)CO_2}$), 256
- Arterial to maximum end-expiratory PCO_2 difference, 175, 175f
- Arterial-to-venous oxygen content difference, 257
- Artificial airway
 complications of, 339–341, 341b
 cuff leak in, algorithm, 139f
 mechanically ventilated adults with, endotracheal suctioning of, 226b
 reducing work imposed by, 334–335
 removal of, 399b, 403–404
 secretion clearance from, 221–226
- Artificial intelligence systems, 398
- Ascending ramp, 93, 148f
- Ascites, 351
- Assist/control (A/C) pressure-controlled ventilation, 463, 464f
- Assist-control pressure curve, 36f
- Assisted breaths, 43, 65
- Assisted ventilation, 69–70
- Assist pressure curve, 35f
- Asthma, 113–114, 371
 acute exacerbation of, mechanical ventilation in, 113b
 case study on, 51b, 464b
 clinical scenario, 57b–58b, 114b
 guidelines for, 114

Asthma (*Continued*)

- NIV in treatment of, 371
- severe, clinical scenario, 505b
- Asynchrony, 157b, 335, 348–349
 - case study on, 305b
 - cycle, 157–158, 158f
 - flow, 157–158, 157f
 - trigger, 157, 157f
- Atelectasis
 - avoidance of, 88
 - lung region creation, ARDS and, 259f
 - mask CPAP for, 261
 - mean airway pressure and, 248–249
 - occurrence of, 495
 - prevention of, 47b
- Atelectrauma, 321, 324–325
- Atmospheric pressure, 3
- Atracurium, 306
- Atracurium besylate (Tracrium), 304b
- Atrial natriuretic factor, 316
- Atrial pressures, 201–202
 - pressure tracing of, 201f
- Atropine, administration of, 233–235
- Audible alarms, 107
 - activation of, 133
- Augmented minute ventilation, 78
- Aura CPAP system, 434f
- Aura nasal interface, 434f
- Automatic tube compensation, 40, 393, 395–397
 - advantages of, 396b
 - arguments against, 396–397
 - summary of, 397
 - using closed-loop control, 395
- Automode, 397
- Auto-PEEP, 13, 63, 330–333, 330f–331f, 359
 - air trapping and, 105f, 159, 159f
 - case study on, 106b
 - definitions of, 104b
 - dynamic hyperinflation and, 350–351
 - effect on ventilator function, 332
 - expiratory flow pattern in, 466f
 - expiratory hold and, 41
 - identification of, 331–332, 331f–332f
 - measurement of, 331–332, 331f–332f
 - Braschi valve in, 331
 - methods of reducing, 332–333
 - occurrence of, 330
 - physiological factors that lead to, 330–331
 - presence of, 104, 129, 335
 - static compliance with, measuring, 332
 - tidal volume and, 88
- Auto-Trak sensitivity system, 376
- Autotriggering, 34, 157, 157f, 335
- Average volume assured pressure support (AVAPS), 376

B

- Bag-in-a-chamber (bellows), 21–23
- β -Agonists, larger dose of, 230b
- Balloon flotation catheter, positioning, 201
- Balloon-tipped, flow-directed catheter, 197
- Barotrauma
 - occurrence of, 113

Barotrauma (*Continued*)

- volutrauma and, 323–324
- Baseline ABG, unavailability of, 104
- Baseline pressure, 12–13, 12f
 - exhalation end, 13f
 - expiration and, 40
 - setting of, 96–100
- Baseline variable, 33
 - expiratory phase, 40–43
- Bellows
 - bag-in-a-chamber, 21–23
 - volume device, usage of, 6f
- Bennett ventilators, 39b
- Benzodiazepine, 301–302
 - effects of, 301
 - reversal, 301
 - potency of, 301
- Bias flow, 500
- Bicarbonate
 - administration of, 114
 - for metabolic acid-base imbalances, 329–330
- Bilevel positive airway pressure (BiPAP), 43, 43f, 43b, 75–76
 - manufacturer names for, 76b
 - in pediatric patients, 455–457
 - ventilation, initial settings for, 99
- Biotrauma, 325
- Biot respirations, 49
- BiPAP. *See* Bilevel positive airway pressure
- BiPAP Vision, 376–377
- Bird Mark 7 (pneumatically powered ventilator), 18, 19f
- Bleeding, occurrence of, 197
- Blood gases, noninvasive measurements of, 167–170
- Blood oxygenation, decreased, measures of, 267b
- Blood pressure, 134–135
 - PEEP study and, 254
 - ventilator changes in, 311b
- Body position
 - change in, 351
 - during PPV, importance of, 275–279
- Body suit, 431
- Body surface area (BSA)
 - calculation of, 86
 - cardiac output and, 204
- Body temperature, 135
- Body ventilators, 369
- Body wrap, 431
- Bonnet fixation, 452f
- Boyle's law, 4
- Bradycardia, 200
- Braschi valve, 331, 332f
- Breath
 - phases of, 33–43
 - phase variables of, 33–43, 34b
 - premature breath cycling, case study on, 38b
 - sculpturing of, 74
 - sloping, 74
 - sounds, 135
 - assessment of, 112b–113b
 - PEEP and, 255

Breath (*Continued*)

- types of, 43, 43b, 44f
 - case study on, 65b
 - volume-cycled ventilation, 38
 - Breath delivery, 29–45
 - modes of ventilation and, 64–67
 - timing of, 67
 - type of, 64–65
 - worksheet for reviewing, 81f
 - Breathing
 - defining, 32f
 - equation of motion and, 30, 30f
 - flow-controlled, 32
 - nomogram, 89f
 - pressure-controlled, 32
 - spontaneous, 73
 - time-controlled, 32
 - ventilator maintenance of, 32f
 - volume-controlled, 32
 - work of, disorders that increase, 48b
 - Bronchodilator therapy
 - evaluation of, case study on, 232b
 - patient response to, 232, 232f
 - Bronchomalacia, 456
 - Bronchopleural fistulas, 11
 - Bronchopulmonary dysplasia, 465
 - Bronchoscopy
 - assistance, AARC clinical practice guidelines for, 234b
 - usage, 233
 - Bronchospasm, 350
 - Bubble CPAP (B-CPAP), 453
 - Bubble humidifiers, usage of, 295
- C**
- Capnograph contours, 172–175, 174f
 - Capnography (capnometry), 170–177
 - capnograph contours in, 172–175, 174f
 - chemical methods in, 170–171
 - clinical applications of, 172–175
 - clinical practice guideline for, 172b
 - during intubation, 175b
 - physiological considerations in, 171–172, 172f
 - volumetric capnometry, 175–177, 176f
 - Capnometry, 170–177
 - Carbon dioxide (CO₂), 2
 - elimination of, 495
 - measurement of, 170
 - monitoring, application, 205
 - narcosis, 220b
 - presence of, 510–511
 - rebreathing of, 376, 377b
 - trending, production, 177, 177f
 - Carbon dioxide production ($\dot{V}CO_2$)
 - increased, 219
 - clinical scenario, 219b
 - Carboxyhemoglobin, 167f, 168, 168b
 - smoke exposure, 168b
 - Cardiac arrhythmias, occurrence of, 223
 - Cardiac dysrhythmias, development of, 110
 - Cardiac index
 - calculation of, 204
 - case study on, 204b

- Cardiac output (\dot{Q}), 204–205, 257
 - adult, 200
 - factors influencing, 193
 - measurements, 204
- Cardiac tamponade, 322
 - effect, 311
- Cardiac transmural pressure, calculating, 312b
- Cardiac work, 206–207
- Cardiogenic pulmonary edema, 350, 371–372
 - ARF associated with, 55–56
- Cardiopulmonary Venturi, double-circuit ventilator example, 21–23, 23b
- Cardiovascular disorders, long-term mechanical ventilation and, 421b
- Cardiovascular factors, in respiratory failure, 400b
- Cardiovascular function, compensation in, 311, 311b
- Cardiovascular instability, 55b
- Cardiovascular principles, review of, 193
- Cardiovascular stabilization, 110
- Cardiovascular system, fentanyl, effects on, 303
- CareFusion AVEA, 493–494
 - clinician control and, 41
- CareFusion Infant Flow SiPAP System, 453, 453f
- CareFusion LTV 1200 ventilators, 93b, 428
- Caregiver skill performance, assessment sheet for, 425f
- Catheter
 - arterial, 196b
 - placement, 197–198
 - positioning, 198
 - proximal end of, connection, 222
 - pulmonary artery, 197
 - complications associated with, 199t
 - insertion sites of, 198, 198t
 - placement of, 197–198
 - position of, West's zone relationship in, 199t
 - rupture associated from, risk factors of, 200, 200b
 - in zone 3 position, 199, 199b
- Catheter-associated PA rupture, risk factors, 200b
- Centers for Disease Control and Prevention (CDC), 289
- Central hypoventilation syndromes, 421
- Central nervous system (CNS), depression, 301
- Central nervous system disorders, 48–49, 48b
 - long-term mechanical ventilation and, 421b
- Central venous lines, 197
- Central venous pressure (CVP), 193, 197, 201, 201b
 - catheter, insertion of, 197
 - increase in, 310
 - monitoring, 135
- Cerebral hemorrhage, from head injury, 48–49
- Cerebral perfusion, mechanical ventilation on, 315–316
- Cerebral vessels, carbon dioxide as vasodilator of, 220
- Chemical capnometers, 171f
 - use of, 170–171
- Chemical mediators, 325b
- Chemokines, 325b
- Chest
 - cuirass, 369
 - percussion, 232–233
 - physical examination of, 135
 - radiograph, 112b–113b, 225b
 - respirator, 369f
 - shell, 431
- Chest-abdominal paradox, 335
- Chest cuirass, 431, 431f
- Chest injury, hemodynamic monitoring in, 207b
- Chest radiographic evaluation, 449
- Chest wall
 - deformities of, 48b
 - transpulmonary pressures and, 323b
 - trauma, work of breathing and, 51
- Chest wall compliance
 - change, 140
 - effects of, 312
 - on lung recruitment, 273–274
 - protection from overdistention and, 323b
- “Chest-wiggle factor” (CWF), 499
 - change, 501
 - checked, 501
- Cheyne-Stokes respirations, 49
- CHF. *See* Congestive heart failure
- Children, 448
 - bilevel positive airway pressure in, 455–457
 - continuous positive airway pressure in, 455–457
 - high-frequency ventilation for, 475b
 - mechanical ventilation
 - with artificial airways, endotracheal suctioning of, 226b
 - indications for, 458b
 - normal blood pressures and heart rates in, 200t
 - respiratory distress in, 449
 - ventilation of
 - follow-up and evaluation for, 426b
 - indications for, 458
 - selection criteria for, 422b
- Choanal atresia, 451
- Chronic assisted ventilator care units, 420
- Chronic care setting
 - NIV in, 370b, 372–373
 - patient selection criteria in, 374–375, 374b
- Chronic disorders, NIV indications, symptoms and selection criteria for, 375t
- Chronic hypoventilation, symptoms of, 372b
- Chronic obstructive pulmonary disease (COPD), 55b, 111–112
 - acute exacerbation of, 370–371, 371b
 - air trapping in, 99
- Chronic obstructive pulmonary disease (COPD) (*Continued*)
 - auto-PEEP and, 336f
 - clinical scenario, 58b, 112b–113b
 - history of, initial patient assessment, 112b–113b
 - initial ventilator settings, 112b–113b
 - mechanical ventilation, guidelines, 111–112
 - triggering difficulty, case study on, 332b
 - VC-CMV settings, 112b–113b
- Chronic respiratory failure, treatment of, 431
- Chronic restrictive disorder, clinical scenario on, 58b
- Chronic stable chronic obstructive pulmonary disease, 372
- Circuit disconnect, case study on, 133b
- Circuit leaks, 352
- Circuit tubing, condensate, 107b
- CircuVent ventilator circuit adapter, 108f
- Cisatracurium, 306
- Cisatracurium besylate (Nimbex), 304b
- Cleft palate, 451
- Clinical Pulmonary Infection Score (CPIS), 290–291
- Clinical shunt, calculation of, 253b
- Clinical stability, 420–421
- Closed-circuit technique, 221
- Closed head injury, 115–117
 - clinical scenario, 117b
 - mechanical ventilation for, 116b
- Closed-loop control mode, 395–398
- Closed-loop systems, 19–20, 20b, 21f
- Closed-loop ventilation asynchrony, 338, 338f
- Closed-suction catheters (inline suction catheters), 223, 224f
 - indications for, 224b
- CMV. *See* Continuous mandatory ventilation
- Coanda effect, 20f
- Colonization, conditions and risk factors of, 288b
- Comfort, respiratory zone of, 398
- Communication, difficulty in, case study on, 438b
- Community-acquired pneumonia, 371
- Compliance (C), 5–6, 6b
 - changes in, 143b
 - dynamic, 140–141
 - monitoring of, 140–144
 - nonexistent/low, 138–139
 - respiratory rate, oxygenation, and inspiratory pressure (CROP) index, 402
 - static, 6, 6b, 140
 - case study on, 8b
- Compressible volume, 89, 130
- Compressors (blowers), 23–24
- Computed tomography, terminology of, 266b
- Congenital heart disease, 451
- Congestive heart failure (CHF), 119–120
 - clinical scenario, 58b, 120b, 279b–280b

- Congestive heart failure (CHF)
 - (*Continued*)
 - guidelines for, 119–120
 - PEEP and, 260
 - treatment of, 120b
 - Congregate living centers, 420
 - Conscious sedation (moderate sedation), 300b
 - Consolidation, 266b
 - Constant flow, 93, 150b
 - versus* descending ramp, 93
 - Constant-flow volume ventilation, flow-time curve for, 337f
 - Constant minute ventilation, with
 - changing alveolar ventilation, 78t
 - Continuous aspiration of subglottic secretions (CASS), 225, 294, 294b, 295f
 - Continuous gas flow, during expiration, 41
 - Continuous mandatory ventilation (CMV), 68–70, 69b
 - advantages, risks, and advantages of, 74t
 - Continuous positive airway pressure (CPAP), 63, 73
 - apparatus, stabilization, 452
 - applications of, 249–250, 451–453, 452b
 - complications of, 434, 454
 - conventional, 452–453
 - devices, technical aspects of, 249
 - excessive, 362
 - goals of, 249
 - indications for, 251, 450b
 - infant prongs for, 452f
 - initial pressure for, 453
 - introduction to, 248–250
 - levels of
 - range of, 433
 - selection of, 251–257
 - noninvasive nasal, in neonates, 450–454
 - for obstructive sleep apnea, 433–434
 - in pediatric patients, 455–457
 - positive end-expiratory pressure (PEEP)
 - and, 42–43, 42f
 - with a rate, 454
 - systems, 433–434
 - to regulate gas flow, 452
 - terminology, 249
 - use of, 451
 - Continuous suction tubes, 225
 - Continuously variable decelerating waveform, 150
 - Contractility, 193
 - Controlled ventilation, 69, 69b
 - mechanical, receiving, 186–187
 - pressure curve, 34f
 - Control mode, 34
 - volume, 467
 - Control panel (user interface), 18, 20–21, 22f
 - Control system, 18
 - Control variable, 31, 31b, 43b
 - targeting pressure as, 65–66, 66b, 68f, 69b
 - targeting volume as, 65, 65b, 66f, 66b
 - Conventional CPAP, 452–453
 - Conventional mechanical ventilation (CMV), 457–474
 - pressure-time curve contrasting tidal variations, 502f
 - Conventional ventilation
 - lung-protective strategies in, 472–474, 473t, 474b
 - returning to, 503
 - Conversion system, 23–26
 - COPD. *See* Chronic obstructive pulmonary disease
 - Coronary blood flow, with positive-pressure ventilation (PPV), 311
 - Cough/coughing
 - assessment of, 112b–113b
 - assisted, 434–435
 - CPAP. *See* Continuous positive airway pressure
 - Crackles, 135
 - Cranial vault, 115
 - Critical opening pressure, 8
 - Cuff deflation, 436
 - Cuff inflation
 - device, 137b
 - minimum leak and minimum occlusion techniques for, 134b
 - techniques, case study on, 134b
 - Cuff leak
 - resolution of, algorithm for, 139f
 - test, 404
 - Cuffless endotracheal tubes, 435–436
 - use of, 465
 - Cuff, mechanical problems associated with, 341b
 - Cuff pressure
 - accuracy (improvement), cuff inflation device, 137b
 - high, 138
 - measurement of, 136–138, 137b
 - Posey Cufflator device for, 136f
 - syringe, manometer, and three-way stopcock for, 137f
 - Cuirass, chest, 431, 431f
 - Current generation portable ventilators, 428, 428b
 - Curves. *See* Waveforms
 - Cushing response, 116
 - Cyanosis, causes of, 170b
 - Cycle asynchrony, 157–158, 158f, 337–338
 - Cycle variable, 33
 - Cycling mechanism (cycle variable), 38–40
 - Cystic fibrosis, 261, 372–373
 - Cytokines, 325b
- D**
- Datex-Ohmeda, Inc, 506
 - Dead space, 130
 - anatomic dead space, 130
 - increase in, 53, 327
 - mechanical dead space, 130, 130b
 - ventilation, 176b
 - Decannulation, 435
 - tracheal buttons and, 435–440
 - Decremental PEEP, recruitment and, 274
 - Deep sedation, 300b
 - Deep sulcus sign, 322
 - Deescalating antibiotic therapy, 291, 293b
 - Deflation point, 269–270
 - Dehydration, test for, 58b
 - Delay-time controls, 376
 - Deoxygenated blood, drainage of, 205
 - Depolarizing agents (succinylcholine), 304b, 305
 - Depressant drugs, 48b
 - Derecruitment maneuver, 275
 - Derived variables, 185–186
 - Descending ramp, 93
 - versus* constant flow, 93
 - waveform, 99
 - Dexmedetomidine, 302
 - Diaphragm
 - electrical activity, monitoring of, 510–514
 - function, monitor, 510
 - history of, 510
 - pacing of, 433
 - positions of, 327f
 - Diaphragmatic activity, assess, 510
 - Diastole, 193
 - Diazepam, 301, 301b
 - intravenous administration of, 301
 - Digital on/off valve, 26, 27f
 - Direct ARDS, 266
 - Discharge plan, components of, 423b, 426b
 - Disease
 - process of, patient selection and, 420–421
 - reversibility of, 54–55
 - Disinfection, procedures for, 440–441
 - Disposable peak flowmeters, 53f
 - Distal ischemia, 196
 - Distress, drug-induced, 351
 - Documentation
 - importance of, 128b
 - of patient-ventilator system, 125–128
 - “Do Not Intubate” patients, 373
 - Double-circuit ventilator, 21–23, 23f
 - Double triggering, 512
 - Dräger Evita, 493–494
 - Dräger Evita XL, time-cycled ventilators, 38–39
 - Dräger V500, clinician control, 41
 - Dräger ventilator, 338
 - Drinker, Phillip, 369
 - Drive mechanisms, 23
 - Drive to breathe, measurement of, 402
 - Driving pressure, 132
 - Drug delivery, MDI and, 506
 - Drug-induced distress, 351
 - Drug overdose, clinical scenario on, 57b
 - Dry gases, inhalation of, 106f
 - Dual-control mode, 468–472
 - PRVC dual-control mode, 470b
 - Dual-lumen catheters, 197
 - Dubois body surface chart, 87f
 - Durable medical equipment (DME), 423
 - Dyes, dysfunctional hemoglobins and, 168–169
 - Dynamic characteristic (dynamic compliance) (C_D), 131, 140–141

Dynamic compliances, 185–186
 Dynamic effective compliance, 140
 Dynamic hyperinflation, 48b, 331, 350–351
 Dynamic pressure element, 196
 Dynamic P-V loops, 143b
 Dysfunctional hemoglobins, 168–169
 Dyspnea, sudden onset of, 47

E

Early-onset pneumonia, 286–287
 EBUS-TBNA, 233
 ECG. *See* Electrocardiogram
 Edema, lung region creation, ARDS and, 259f
 Edi catheter
 characteristics and placement of, 510–512, 511f
 example of, 511f
 specifications, 511t
 waveform, 511f
 Edi waveform, sinusoidal appearance of, 511
 EEP. *See* End-expiratory pressure
 Ejection fraction (EF), 193, 206
 Elastance, 5
 Electrically activated speaking devices, 436
 Electrically powered ventilators, 18, 18b
 Electrocardiogram (ECG), 134
 Electromagnetic interference, 364
 Emphysema
 interstitial, 322f
 subcutaneous, 322
 End-exhalation, auto-PEEP, 105f
 End-expiratory pause (expiratory hold), 41
 End-expiratory pressure (EEP), 131–132, 132b
 End-inspiratory pause, 40, 95
 Endobronchial ultrasound, 233
 End of exhalation, pressure at, 13, 13f
 Endotracheal intubation, 55b
 Endotracheal suctioning
 AARC clinical practice guidelines for, 226b
 methods of, 221b
 Endotracheal tube (ET), 249–250
 care for, 140
 changer, 138f
 cuffs, management of, 136–140
 mechanical problems with, 341b
 passive humidifiers (heat-moisture exchangers), placement of, 107b
 removal of, AARC clinical practice guideline for, 406b
 selection, changing, and suctioning of, 294
 size, relationships of, 334f
 tidal volume, measurement of, 129f
 Endotracheal tube-associated pneumonia, 224
 End tidal carbon dioxide partial pressure (P_{etCO_2}), dependence, 172
 Enteral feeding, 294
 EPAP. *See* Expiratory positive airway pressure
 Equation of motion, 30, 30f, 31b
 Erosive esophagitis, 429
Escherichia coli, 287–288
 Esophageal graphics, 160, 160f
 Esophageal pressure (P_{es}), 3, 3f, 336f
 curves in, 512f
 flow in, 512f
 pressure in, 512f
 Eucapnic breathing, maintenance of, 220
 Evidence-based weaning, 398
 Evita XL, 509
 Exacerbation, of asthma, 504
 Exclusion criteria, 501
 Exercise, 408–409
 Exhalation end
 baseline pressure, 13f
 pressure at, 13
 Exhalation, single-breath CO_2 loop of
 inspiration and, 176–177, 177f
 Exhaled nitric oxide, monitoring, 177–178
 Exhaled tidal volume, 89
 measurement of, flow transducer in, 6f
 Expiration
 accessory muscles, 2b
 continuous gas flow during, 41
 definition of, 40
 negative end-expiratory pressure (NEEP), 40, 41f
 time-limited, 41
 Expiratory cycle, gas flow, 6–7
 Expiratory flow, pattern
 flow-time waveform of, 331f
 prolonged, 466f
 Expiratory gas flow, factors affecting, 97b
 Expiratory hold (end-expiratory pause), 41
 Expiratory limb, coaxial construction, 507f
 Expiratory muscle aids, 434–435
 Expiratory phase
 attention, 40
 baseline variable, 40–43
 Expiratory positive airway pressure (EPAP), 375
 initiation of, 99
 Expiratory retard, 41–42, 41f
 Expiratory time, 462–465
 tidal volume and, interrelation of, 91b
 time constants and, 9
 Expiratory valve, 230
 unseated or obstructed, 361–362
 Expired air, CO_2 and, 171–172
 Expired tidal volume ($V_{T_{exh}}$), 133f
 External gas source, technical problems associated with, 230
 External pneumatic circuit, 23
 additional components of, 24f
 adjuncts used with, 24b
 basic elements of, 23b, 24f
 External respiration, 2
 Extraalveolar air, 321–323
 Extracorporeal membrane oxygenation (ECMO), 484
 Extrinsic PEEP ($PEEP_E$), 13
 addition of, 129
 definitions of, 104b
 Extrinsic work, 186

Extubated patients, invasive mechanical ventilation in, weaning from, 406b
 Extubation, 482–483
 equipment and procedure for, 405b
 failure, factors of, 404b
 noninvasive positive-pressure ventilation after, 405
 physiological parameters for, 401t
 readiness test, 483b
 risks associated with, 404
 Eyes, damage to, 341b

F

False pressure readings, 133b
 Family education, 423–424
 Fatal tracheal-innominate artery fistula, 225
 Fentanyl, 303, 303b
 administration of, 303
 effects of, 303
 Fentanyl citrate (Sublimaze), 303
 Fiberoptic bronchoscopy
 adapter used during, 235f
 flexible, 233–235, 234b
 usage of, 291
 Fick principle, 204, 204b–205b
 Final alveolar ventilation, 130, 131b
 Final ventilator setup, parameters, 103–104
 F_{IO_2} . *See* Fractional concentration of inspired oxygen
 First-generation portable volume ventilators, 427–428, 428b
 Fitting gauge, for nasal mask, 379f
 Flail chest, work of breathing and, 51
 Flexible fiberoptic bronchoscopy, 233–235, 234b
 Flip-flop valve (beam deflection), example of, 20f
 Flow
 adjustment of, 92b
 asynchrony, 157–158, 157f, 336, 337f
 case study on, 92b
 cycling, 39
 breath termination and, 460
 during pressure support ventilation, 161–162, 161f, 162b
 prevention of, 134
 delivery, graphs, 94f
 determination of, 92
 measurements of, 184–185
 monitor lines, 131b
 occurrence, 131b
 patterns, 92–95, 93f
 pressure, volume, and time relationship, 148, 148b
 scalars, 148–150, 149f
 setting for, inadequate, 352, 353f, 358
 tidal volume and, relationship, 91–92, 91b
 triggering, 459f
 zero, 155b
 Flow chop, 463–464
 Flow-controlled breathing, 32

Flow-cycled ventilation, 39, 39f
 Flow limiting, 37
 Flow resistor, 250
 Flow-through tubes, equations describing, 504b
 Flow-time curve, problem, 362f
 Flow transducer, 6f
 Flow triggering, 34–35, 36f
 response, 104, 104b
 Flow-volume (F-V) loop, 340f, 355f, 362f
 components of, 151, 154f
 indications, 362f
 Flow waveforms, 98f
 studies, summary of findings from, 95b
 various forms of, 148f
 Fluid balance, 236
 Fluidic gas principles, use of, 453
 Fluidic ventilators, 18
 Fluid intake, excessive, 236
 Fluid logic (fluidic) pneumatic mechanisms, components of, 20f
 Fluid pressures, 196
 Fluid status, evaluating, 236b
 Forced expiratory volume in 1 second (FEV₁), 52–53
 Fowler position, 55
 Fractional concentration of inspired oxygen (F_IO₂), 256
 adjustment of, 104, 247
 equation for, 104
 selection of, 103–104, 247–248
 titration of, 104
 in ventilator patients, evaluation of, 246–247
 ventilator settings, 103–104
 Fractional hemoglobin saturation, 168
 Frank-Starling mechanism, 193, 310
 FRC. *See* Functional residual capacity
 Freestanding systems, spontaneous CPAP with
 circuitry for, 250
 using fluidic gas principles, 453
 French (Fr) sizes, 197
 Frequency, 465–466
 control, 34
 Full face mask, 381f
 concerns with, 379–380
 sizing gauge for, 381f
 Full (oronasal) mask, and helmet, 379–382, 381f
 Full ventilatory support, 64
 Functional hemoglobin saturation, 168
 Functional residual capacity (FRC), 6f, 13f
 adequacy of, 47b
 decrease in, 96–97
 shunt result in, 254f
 increased, 202
 maintenance of, 448–449

G

Gas(es)
 distribution of
 effects of mechanical ventilation on, 327–328

Gas(es) (*Continued*)
 gravity, impact, 277
 heating of, 509
 system leaks, 38
 transport mechanisms of, 478, 479f
 trapping. *See* Air trapping
 Gas delivery
 system, changes in, 161f
 to-and-fro motion, 11
 Gas flow, 2, 504, 505b
 expiratory, factors affecting, 97b
 rate of, 92, 92b
 regulation of, 452
 schematic illustration of, 393f
 Gastric distention, positive-pressure ventilation and, 317
 Gastrointestinal bleeding, 295
 Gastrointestinal function, mechanical ventilation effects on, 317
 Gastroprotective agents, 288
 Gastrostomy tube, 424
 Gel-filled nasal masks, 380f
 Geographical assessment, 423
 Glasgow Coma Score, 116b
 Glossopharyngeal breathing, 434
 Gradients, definition of, 2, 4t
 Ground glass opacification, 266b
 “Grunting”, 448–449
 Guillain-Barré syndrome, clinical scenario on, 57b

H

Haloperidol, 302
 action of, onset, 302
 Handwashing, 293–294, 293b
 Hayek Oscillator, 435
 Head injuries
 acute, clinical scenario, 117b
 initial ventilator settings, 117b
 mechanical ventilation, indications for, 116b
 Healthcare-associated pneumonia (HCAP), 286–287
 Heart rate, 134–135, 200
 Heated humidifiers, 106–107, 106b–107b
 affecting aerosol delivery, 229
 Heated-wire flow-measuring device, 509
 Heat-moisture exchanger (HME), 107, 108f, 438b
 ability of, 295
 aerosolized medication delivery, 107
 contraindications for, 107b
 placement of, 107b
 Helium-oxygen (heliox) (He/O₂)
 aerosol delivery, 506, 506f
 clinical scenario, 505b, 507b–508b
 disorders treated with, 503b
 equations describing flow-through tubes, 504b
 mechanical ventilation and, 503–504, 503b–504b, 507–508
 mixture of, 404, 503
 and NIV, 509
 noninvasive positive pressure ventilation, 493
 Helium-oxygen (heliox) (He/O₂)
 (*Continued*)
 therapy
 cost and gas consumption during, 505–506
 gas flows during, 505b
 Helium-oxygen (heliox) (He/O₂) delivery
 devices for, 505–506
 system
 manufactured, 506–507, 506f–507f
 modified nonrebreathing mask for, 506f
 technical considerations in, 508–509, 509b
 Helium, properties of, 504b
 Helmet, 379–382, 381f
 Hemodynamic changes
 renal response to, 316
 in respiratory diseases, 209t
 Hemodynamic data, 255f, 256–257
 Hemodynamic measurements, obtaining, 195–200
 Hemodynamic monitoring, 192–211
 after open-heart surgery, 207b
 in chest injury, 207b
 clinical applications of, 207
 efficacy of, 193
 indication for, 192
 invasive, 193
 potential risks of, 193
 systems for, 195–196
 Hemodynamic parameters, 208t–209t
 Hemodynamic profiles, interpretation of, 200–207
 Hemoglobin
 abnormal, 168b
 dysfunctional, 168–169
 types of, 167f
 Hemothorax, work of breathing and, 51
 HFJV. *See* High-frequency jet ventilation
 HFO. *See* High-frequency oscillation
 HFOV. *See* High-frequency oscillatory ventilation
 HFPPV. *See* High-frequency positive pressure ventilation
 High cuff pressure, 138
 High-frequency flow interruption, 476
 High-frequency jet ventilation (HFJV), 11, 477–478
 High-frequency oscillation (HFO)
 assistance by, 40
 recruitment maneuver, use of, 500b
 technical aspects of, 498
 High-frequency oscillatory ventilation (HFOV), 11, 476–477, 477f–478f
 in adult, 497–498
 amplitude, 499–500
 bias flow, 500
 designs of, 497
 exclusion criteria of, 501
 frequency, 500, 500b
 high-frequency ventilation method, 498
 indication of, 501
 initial control settings of, 499–501
 inspiratory time percentage of, 500
 monitoring, assessment, and adjustment of, 501–502

- High-frequency oscillatory ventilation (HFOV) (*Continued*)
 - oxygenation during, 502
 - patient assessment during, 501b
 - proposed, 497
 - receiving, 501
 - settings of, 500b, 501
 - step to reduce PaCO₂ during, 503b
 - tidal volume, amplitude, and frequency, 503b
 - transition from, 501
 - Vyaire 3100B, 501b
 - waveform for pressure-time and, 500f
 - High-frequency percussive ventilation (HFPV), 476
 - schematic of, 477f
 - High-frequency positive pressure ventilation (HFPPV), 475–476
 - High-frequency positive ventilation (HFPV), 11
 - High-frequency ventilation (HFV), 11, 474–482
 - contraindications and complications of, 475
 - indications for, 475
 - for infants and children, 475b
 - management strategies for, 480–482
 - method of, 498
 - physiology of, 478–480, 479f
 - technique, 475
 - High peak pressures, from increased airway resistance, 314, 315f
 - High-pressure alarms, 354–355, 355f, 355b
 - activation of, 133
 - common causes of, 354b
 - triggers of, 354
 - High pressure, setting, 495–496
 - High tidal volume delivery, 363
 - High time, setting, 496
 - High-volume/low-pressure cuff, 138f, 224
 - Hi-Lo Evac endotracheal tube, 225, 225f
 - Home(s)
 - assessment of, 423
 - discharge to
 - family issues in, 424–426
 - plan for, components of, 426b
 - preparation for, 422–424
 - invasive mechanical ventilation at, alternatives to, 430–434
 - mapping electrical circuits in, 423b
 - mechanical ventilation in, ancillary equipment and equipment cleaning for, 440–441
 - modifications in, 423
 - therapy, adjustment to, 456b
 - ventilation, equipment selection for, 426–428
 - ventilator-dependent patients in, 420
 - respiratory care plan equipment checklist for, 427b
 - ventilator equipment at, guidelines for disinfecting, 441b
 - Homecare ventilators, 428b
 - examples of, 427–428
 - Homecare ventilators (*Continued*)
 - portable, 377
 - SIMV mode in, 428b
 - Homeostasis, maintenance of, 47
 - Hospital-acquired pneumonia (HAP), 286–287
 - HT70 ventilator, 429f
 - Humidification, 106–107, 106f
 - devices, hazards and complications associated with use of, 340b
 - during noninvasive ventilation, 378, 378b
 - Humidifiers, 441
 - Humidity deficit, 107
 - Hydrodynamic pressure, 196
 - Hypercapnia
 - conditions seen with, 49t
 - recognizing, 48
 - untreated, 48
 - Hyperinflation
 - dynamic, 331
 - PEEP and, 260b
 - periodic, 109–110, 109b
 - Hyperkalemia, clinical and ECG changes and, 328b
 - Hypermetabolic states, examples of, 182, 182b
 - Hyperventilation, 321, 329
 - case study on, 216b
 - Hypocapnia, sustained severe, 329
 - Hypokalemia, clinical and ECG changes associated with, 329b
 - Hypometabolic states, examples of, 182, 182b
 - Hypoventilation, 48b, 328–329
 - disorders and agents associated with, 48b
 - increases in P_aCO₂, 220
 - Hypovolemia, relative, 236
 - Hypoxemia
 - conditions seen with, 49t
 - definition of, 245
 - levels of, 245b
 - lower limits of, 333
 - mask CPAP for, 261
 - recognizing, 48
 - treatment for, 54, 54t
 - untreated, 48
 - Hypoxemic respiratory failure, 371
 - Hypoxia
 - clinical and ECG changes and, 328b
 - definition of, 245
 - types of, 245b
 - Hysteresis, 155b
- I**
- Iatrogenic hyperventilation, 115–116
 - intentional, 219–220, 219b–220b
 - Ideal body weight (IBW)
 - calculation of, 88b
 - tidal volume and, 88b
 - Ileus, 429
 - Imposed WOB, determination of, 334
 - Inadvertent PEEP, 330
 - Incisura, 200
 - Indirect ARDS, 266
 - Indirect calorimetry
 - critical care concept, 183b
 - formulas used during, 182b
 - measurements
 - metabolic, clinical practice guideline for, 181b
 - obtaining, 181
 - overview of, 180–183
 - technical considerations in, 180–183, 180f
 - Indirect Fick method, 205
 - Infant Flow Pressure Generator, 452f
 - Infant Flow SiPAP System, 453, 453f
 - Infants
 - abdominal surgery on, 467
 - Apgar scores of, 457–458
 - cardiothoracic surgery on, 467
 - congenital heart disease, 451
 - CPAP in
 - problem solving, case study, 250b
 - use of, 451
 - extubation in, 482–483
 - high-frequency oscillatory ventilation in, management of, 480–482, 481f–482f
 - high-frequency ventilation for, 475b
 - nasal CPAP for, 505
 - prongs, for CPAP, 452f
 - prophylactic therapy for, 483
 - rescue therapy for, 483
 - ventilation for, follow-up and evaluation for, 426b
 - weaning in, 482–483
 - Infasurf, 483
 - Inflation hold, 314, 314f
 - inspiratory pause, 40, 40b
 - positive-pressure ventilation with, 40f
 - Inflection point, 143
 - Infrared spectroscopy, 171, 171f–172f
 - Inhaled nitric oxide therapy, 484, 484b
 - Initial patient assessment, 124–146
 - clinical laboratory tests for, 128b
 - Initial ventilator settings, 85–102
 - acute asthma, 114b
 - based on pulmonary disorder, 121t
 - head injury, 117b
 - neuromuscular disorder, 115b
 - patient situations, 111
 - during pressure ventilation, 96
 - for specific patient situations, 111
 - during volume-controlled ventilation, 86–95
 - Inline suction catheters (closed-suction catheters), 223, 224f
 - Innominate artery, rupture of, emergency treatment for, 349b
 - Inspiration
 - accessory muscles, 2b
 - airway expansion, 6f–7f, 7
 - beginning of, 34–35
 - cycle variable, 33
 - cycling mechanism (cycle variable), 38–40
 - delivery, common methods of, 31b
 - factors, control and measurement, 31–32
 - flow-cycled ventilation and, 39, 39f
 - flow, zero, 154, 155b

- Inspiration (*Continued*)
 limit variable during, 35–38
 flow limiting, 37
 pressure limiting, 36, 37f
 volume limiting, 37
 pressure-cycled ventilation, 39–40
 set volume *versus* actual delivered volume, 38
 single-breath CO₂ loop of, 176–177, 177f
 time-cycled ventilation, 38–39
 trigger variable, 34–35, 34b
 ventilation model in, 30–31
 ventilator control functions during, 31b
 volume-cycled ventilation and, 38
- Inspiratory cycle percent, 75
- Inspiratory flow, 92–95, 313–314, 313f
 setting of, 335
 in time-cycled ventilator, 92b
- Inspiratory hold, 40
- Inspiratory limb, coaxial construction, 507f
- Inspiratory pause, 38, 40b
 inflation hold and, 40, 40b
 setting of, 132f
 during volume ventilation, 95–96
- Inspiratory positive airway pressure (IPAP), 43f, 375
 presence of, 42f
 settings of, 456–457
- Inspiratory pressure, 461–462
- Inspiratory pressure-volume curve, 273f
- Inspiratory rise time control, sloping or ramping, 161, 161f
- Inspiratory time (T_I), 462–465
 tidal volume and, relationship, 91b, 92
 time constants and, 9, 463b
- Inspiratory time percentage(T_{I%}), 500
- Inspiratory-to-expiratory ratio, 314, 314b, 462–465
 calculation of, 91–92
 case study on, 92b
 indicator for, alarms and, 356
 tidal volume and, relationship, 91–92
- Inspiratory waveform, control, overview of, 32–33, 32f
- Inspiratory WOB, 330
- Inspired air, CO₂ and, 171–172
- Inspired oxygen concentration, 466–467
- Inspired tidal volume (V_{Tinsp}), 133f
- Inspissated secretions, complications of NIV, 385
- InSure, 451
- Integrated ventilator, 160, 160f
- Intensive care unit (ICU), 420
 hemodynamic assessment and, 208b
 oxygen analyzers and, 128
 ventilators, 18–19
 control variables, availability, 86
 end-expiratory pause buttons, 331
- Intentional iatrogenic hyperventilation, 219–220, 219b–220b
- Interface
 establishment of, 110
 mouthpiece, 372
- Intermediate care sites, 420
- Intermittent abdominal pressure ventilator, 432–433
- Intermittent mandatory ventilation (IMV), 72–73, 315, 315f, 393
 advantages, risks, and advantages of, 74t
 system for, home use of, 428
- Intermittent positive pressure breathing (IPPB)
 history of, 67
 use of mask or mouthpiece in, 370
- Intermittent positive pressure ventilation (IPPV), 370
 history of, 67
- Internal maximum safety pressure, 38
- Internal pneumatic circuit, 21–23
- Internal respiration, 2
- Interstitial emphysema, development of, 322f
- Intracranial pressure (ICP)
 elevated, 259
 increased, 49, 115
 mechanical ventilation on, 315–317
- Intrapleural pressure (P_{pl}), 3, 3f, 202
 positive-pressure ventilation and, 310f
 spontaneous inspiration and, 310, 310f
- Intrapulmonary pressure, 3, 3f, 13
- Intrapulmonary shunts, occurrence of, 205
- Intrathoracic pressures, positive-pressure ventilation and, 310, 310f
- Intravascular line, fever and, 196–197
- Intrinsic PEEP, 13, 63, 330
 definitions of, 104b
 tidal volume and, 88
- Intrinsic work, 186
- Intubation
 avoiding, heliox, 504–505, 504b
 capnography during, 175b
 resistance values for, 7b
 without ventilation, 56
- Invasive hemodynamic monitoring, 193
- Invasive mechanical ventilation
 home alternatives to, 430–434
 switching to, 384b
- Invasive positive pressure ventilation (IPPV), 51, 64
 tracheostomy tube for, 421
- Invasive vascular monitoring system, 195, 195f
- Invasive ventilation
 alternatives to, 55–58
 indications for, 55b
 noninvasive positive pressure ventilation changed to, 56b
 tracheostomy as, 372
 weaning from, facilitation, 373
- Inverse-ratio alarm, 356
- Inverse (I/E) ratios, 91–92
- Inverse ratio ventilation (IRV), 249b
- IPAP. *See* Inspiratory positive airway pressure
- Iron lungs, 10, 369, 430–431
- Isothermic saturation boundary (ISB), 106, 106f
- J**
 Jejunostomy tube, 424
 Jet mixing, 478
- K**
 Ketoacidosis, 217
 Kinetic therapy, 295
Klebsiella pneumoniae, 287–288
- L**
 Laminar flow, 504
 Laryngeal cough reflex, narcotics and, 235
 Laryngeal injury, from long-term ventilation, 430b
 Larynx, damage to, 341b
 Late-onset pneumonia, 286–287
 Leaks, 352, 358
 checks for, 352
 Left atrial pressure (LAP), 201
 Left ventricular dysfunction, PEEP effects in, 119b
 Left ventricular end-diastolic pressure (LVEDP), 193
 right ventricular (RV) dilation and, 311
 Left ventricular function, altered, 310–311, 311f
 Left ventricular stroke work, calculation of, 206
 Left ventricular stroke work index (LVSWI), 206
 Length-tension relationship, 193
 Light, ambient, pulse oximeter and, 169
 Light-emitting diode (LED) technology, advances in, 169
 Limit variable, during inspiration, 35–38
 Linear drive piston, 25b–26b
 Lips, damage to, 341b
 Liver function, mechanical ventilation effects on, 317
 Long-term acute care hospitals, 420
 Long-term care sites, 420
 clinician familiarity with, 412
 for prolonged ventilation, 412
 Long-term mechanical ventilation (LTMV), 419
 goals of, 419–420
 medical conditions appropriate for, 421b
 patient groups requiring, 421b
 Long-term positive pressure ventilation, complications of, 429–430
 Long-term ventilation, 418–446
 additional preparation for, 424
 complications to the airway in, 430b
 discharge and
 plan for, components of, 426b
 preparation for, 422–424, 422b
 family education in, 423–424
 financial considerations in, 422
 follow-up and evaluation for, 424–426
 geographical and home assessment for, 423
 psychosocial factors in, 421–422
 units, weaning in, 399b, 412

- Long-term ventilator-assisted patients, ACCP definition of, 419b
- Long-term ventilatory support, alternative, sites for, 412b
- Loops, normal, 153–154
- Lorazepam (Ativan), 301–302
 - adverse drug interactions of, 301–302
 - discontinuation, case study on, 302b
- Low cuff pressure, 138–139
- Low-flow (quasi-static) technique, 270
- Low PEEP, 250
- Low PEEP/CPAP alarms, 355
- Low perfusion states, 168
- Low-pressure alarms, 133, 353
 - common causes of, 354b
 - setting of, 108
- Low pressure, setting, 496
- Low-source gas alarms, 108, 108b
- Low-source gas pressure alarm, 356
- Low time, setting, 496
- Low-volume/high-pressure cuff, 138f
- Lower inflection point, 267
- LP10, 428
- LTV 1200 ventilator, 377f
- Lung injury
 - measures, 267b
 - mechanical ventilation for, 321–327
 - from overdistention, 323–324
 - ventilator-associated *versus* ventilator-induced, 321, 321b
- Lung-protective strategies, 267–268, 267b–268b
- Lung recruitment
 - case report, 275b
 - chest wall compliance, effects of, 273–274
 - function of, 271–272
 - patient evaluation for, 268
 - potential complications during, 274
- Lungs
 - ARDS, inspiratory pressure-volume curve in, 272f
 - characteristics of, 4–8
 - collapse, pneumothorax and, 322
 - compliance, 5–6, 6b
 - effects of, 312
 - electron micrograph of, 325f
 - histology of, 264f
 - intrapleural pressures and, 310, 310f
 - low/high volume of, 265f
 - mechanics, negative-pressure ventilation and, 10f
 - nondependent position of, 279f
 - ventilation to, 327
 - normal *vs.* ARDS, 266–267
 - overdistention, 260b
 - perfusion of, 258f
 - pressure, 3–4, 3f
 - pressures and gradients, definition of, 3–4, 4t
 - pressure-volume curves, 144f
 - protection of, PEEP and, 326
 - recruitment, 109, 500b
 - regions of, ARDS and, 259f
 - resistance, 6–8
- Lungs (*Continued*)
 - tissue involvement, 48b
 - units, 8
 - fast, 9
 - filling of, 8f
 - slow, 9
 - ventilation of, 258f
 - model of, 30–31
 - volume of, increase in, 47b
 - West's zones of, 199t
- LVEDP. *See* Left ventricular end-diastolic pressure
- M**
- Machine-triggered breath types, during N-IMV, 454–455
- Mainstream sampling devices, 171
- Malnutrition, mechanical ventilation and, 317, 317b
- Mandatory breath, 43, 64–65
 - delivery, patient effort, 353f
- Mandatory minute ventilation (MMV), 20–21, 78, 78t, 393
 - advantages of, 397b
 - description of, 397
 - as weaning technique, clinical studies on, 397
- Manometer
 - aneroid, 183
 - usage, 13
- Manual ventilation, 110
- Maquet Servo-i ventilator, 94
- Masimo Signal Extraction Technology (SET) pulse oximeter, 168
- Mask CPAP, 250
 - complications associated with, 386t, 434t
- Mask discomfort, 384–385
- Mask heliox, 505
- Mask pressure, 3, 3f
- Mask systems, aspects of, 505
- Maximum airway pressure, 497
 - establishing, 499
 - wide swings in, 499b
- Maximum expiratory pressure (MEP), 187
- Maximum inspiratory pressure (MIP), 50–52
 - device for, 52f
 - measurement of, 187–188
 - measurement of, alternative technique for, 52b
- Maximum safety pressure, 37–38
- McKhann, Charles, 369
- Mean airway pressure (P_{aw}), 92, 131, 185, 466, 499
 - adjustment of, 247–248, 248f
 - calculation of, method for, 249b
 - P_aO_2 and, 313
- Mean arterial pressure (MAP), 200
- Mean left atrial pressure (MLAP), 206
- Mean pulmonary artery pressure (MPAP), 206
- Measured variables, 185
- Mechanical dead space ($V_{D_{mech}}$), 130
 - addition, 130, 130f, 130b
- Mechanical dead space ($V_{D_{mech}}$) (*Continued*)
 - considerations, 90–91
 - definition of, 90
- Mechanical insufflation-exsufflation, 435, 435f
- Mechanically ventilated patients
 - anesthetic agents, usage, 304b
 - management of sudden severe respiratory distress in, 349b
 - neuroleptics, usage, 304b
 - nosocomial pneumonias, risk reduction methods of, 293b
 - opioids, usage, 304b
 - sedatives, usage, 304b
- Mechanical oscillation, 435
- Mechanical positive pressure breath, airway pressure graph, 12f
- Mechanical ventilation
 - accidental disconnections, 340b
 - acute and chronic complications of, 429f
 - in adults and children, with artificial airways, endotracheal suctioning of, 226b
 - airway clearance during, 221
 - alarms and, 108b
 - basic terms and concepts, 1–16
 - complications associated with, 339b
 - controlled, 186
 - conventional, 457–474
 - discontinuation from, 391–417
 - and equipment, 427b
 - establishing need for, 46–61
 - extrapulmonary effects of, 309–319
 - history of, 109b
 - indications for, 113b
 - indirect calorimetry during, 181b
 - initial connection (first 30 minutes), 128–130, 128b
 - initiation of, ethical considerations in, 56–58
 - injury during, volutrauma and, 321–327
 - on intracranial pressure and cerebral perfusion, 315–316
 - on liver and gastrointestinal function, 317
 - measurements, 183
 - metabolic acid-base imbalances and, 329–330
 - metabolic acid-base status in, 328–330
 - minimizing physiological effects and complications of, 312–315, 313f
 - mode of, 202
 - nutritional complications during, 317–318, 317b
 - objectives of, 47b
 - overview of criteria for, 54–55
 - physician's orders for, 125b
 - physiological terms and concepts, 2
 - pMDIs during, 229–230
 - potential mechanical failures with, 339b
 - pressure-volume curves, 142f
 - renal effects of, 316–317
 - respiratory status in, 328–330
 - standard criteria for instituting, 54b

- Mechanical ventilation (*Continued*)
 sudden respiratory distress
 causes of, 348b
 management of, 349b
 SVN during, 230, 230b
 terms used in, 10
 types of, 10–11
 weaning from, 391–417
 work of breathing, reduction of, steps for, 334–339
- Mechanical ventilators
 heliox with, 507–508
 medications with nebulizers during, 231b
 spontaneous CPAP with, 250
- Mechanical ventilatory support
 for acute respiratory failure, 50t
 recognizing need for, 448–449
- Meconium aspiration syndrome, 450
- Medically stable, term, definition of, 374
- Medtronic Puritan Bennet 840, 94t
- Men, ideal body weight for, calculating, 88b
- Mental status, assessment of, 112b–113b
- Metabolic acid-base imbalances, mechanical ventilation and, 329–330
- Metabolic acid-base status, in mechanical ventilation, 328–330
- Metabolic acidosis, 217
 respiratory alkalosis, combined, 218b
- Metabolic acidosis, blood chemistry in, 330t
- Metabolic alkalosis
 acid loss and, 330
 blood chemistry in, 330t
 respiratory acidosis, combined, 218b
- Metabolic carts, 180
- Metabolic disturbances, clinical scenario, 218b
- Metabolic factors, in respiratory failure, 400b
- Metabolic measurements
 clinical applications of, 181–183
 clinical practice guideline for, 181b
- Metabolic monitoring system, major components of, 180, 180f
- Metabolic rate, 86
 factors, 181–182
- Metabolism, increased, 219
 clinical scenario, 219b
- Metered-dose inhaler (MDI)
 use of, 107
 ventilator circuit adaptation, 229f
- Methemoglobin, 167f, 168
- Methicillin-resistant *Staphylococcus aureus*, patient case of, 293b
- Microprocessor-controlled ventilators, 129
- Microprocessors, 18
 random access memory (RAM), usage, 18–19
 read-only memory (ROM), updating, 18–19
 usage, 7–8
 ventilators controlled by, waveform display capability of, 33
- Midazolam, 301, 301b
- Minimal sedation, 300b
- Minimum leak techniques, 134b
- Minimum minute ventilation, 78
- Minimum occlusion techniques, 134b
- Minimum PEEP, 250
- Minute ventilation (\dot{V}_E), 53
 case study on, 88b, 90b
 demands in, reduction of, 338–339
 determining, 86b
 display, 129
 improving, 496
 increase in, 358f
 measurement, respirometer technique for, 129b
 setting of, 86–87
 special considerations, 95
- MIP. *See* Maximum inspiratory pressure
- Mixed acid-based disturbances, 218
- Mixed-mode ventilation, 461
- Mixed venous oxygen saturation, 205, 257
- Mode asynchrony, 338
- Moderate sedation (conscious sedation), 300b
- Modified Allen test, performing, 196b
- Molecular diffusion, simple, 479
- Monitoring equipment, 238b
- Morphine, 303
 effects of, 303
- Motor nerve damage, 50
- Mouth care, 140
- Mouthpiece, headgear or straps,
 requirement (absence), 382
- Mouth pressure (P_M), 3, 3f
- Multidrug-resistant (MDR) infections, risk factors for, 288b
- Multidrug-resistant (MDR) micro-organisms, 287, 287b
- Multiple organ dysfunction syndrome, 265–266, 325
- Multiple organ failure, 265–266, 325
- Muscle dysfunction, 50
- Muscle function, impaired, 48b
- Muscles, respiratory, inactivity of, 31
- Muscle strength, 401–402
- Myasthenia gravis
 case study on, 246b
 initial ventilator settings, 115b
- Myocardial ischemia, borderline, 110
- N**
- Nail polish, pulse oximeter and, 169
- Naloxone hydrochloride, 57b
- Nasal cannula, for heliox, delivery of, 505
- Nasal CPAP, 250, 505
 applications of, 451–453, 452b
 indications and contraindications for, 450–451, 450b
 in neonates, 450–454, 450b
- Nasal headgear, disposable, 379f
- Nasal high-frequency ventilation, in neonates, 455
- Nasal interfaces, 378–382
- Nasal intermittent mandatory ventilation, in neonates, 454–455
- Nasal mask
 for CPAP, 433
 disadvantages of, 378–379
- Nasal mask (*Continued*)
 disposable, 379f
 fitting of, 379f
 indications for continuous positive airway pressure via, 450b
 meeting criteria for, 421
 problems with, 384
- Nasal minimask, 379
 headgear and, 380f
- Nasal passages, damage to, 341b
- Nasal pillows, 379
 headgear and, 380f
 use of, 385
- Nasal prongs
 fit of, 452
 indications for continuous positive airway pressure via, 450b
 infant flow and, 452f
 use of, 453b
- Nasal “sigh” positive airway pressure, in neonates, 453f, 455
- Nasopharyngeal injury, from long-term ventilation, 430b
- Nasopharyngeal tube
 indications for continuous positive airway pressure via, 450b
 use of, 453b
- Nebulization, provided by ventilator, 231, 231f
- Nebulizers
 impairment, 362–363
 during NPPV, use of, 231–232
 small-volume, during mechanical ventilation, 230, 230b
- NEEP. *See* Negative end-expiratory pressure
- Negative end-expiratory pressure (NEEP), 40, 41f
- Negative inspiratory force (NIF), 51–52, 401–402
- Negative pressure ventilation (NPV), 3–4, 430–431
 airtight garments for, 432f
 cuirass shell for, 431f
 lung mechanics after, 10f
 use of, 10, 369
- Negative pressure ventilators, 19
- Neonatal ventilator
 advancement in, 460
 circuit, schematic for, 459f
 features of, 460b
- Neonates, 448–449
 assessment and treatment of, case study on, 456b
 continuous positive airway pressure in, indications of, 450b
 cuffless ETs in, use of, 465
 determining effective oxygenation and ventilation in, 449
 extubation in, 451
 graphic waveform, 461f
 heart rates for, 200
 invasive mechanical ventilation in, clinical indications for, 457b
 lung disorders, lung-protective ventilation strategies for, 473t

Neonates (*Continued*)

- nasal continuous positive airway pressure
 - in, 450–454, 450b
 - applications of, 451–453, 452b
 - indications and contraindications for, 450b
 - nasal intermittent mandatory ventilation
 - in, 454–455
 - nasal “sigh” positive airway pressure in, 453f, 455
 - noninvasive nasal high-frequency ventilation in, 455
 - noninvasive positive pressure ventilation
 - in, 454–455
 - patient-triggered pressure-controlled intermittent mandatory in, 461f
 - pediatric ventilatory support, goals of, 450
 - physical examination, abnormalities on, 450b
 - respiratory distress in, 448–449
 - magnitude of, Silverman-Anderson score for, 449f
 - TCPL/IMV, asynchrony during, 459
 - transient tachypnea of, 450
 - ventilators for, features of, 458b
 - ventilatory support of, indications for, 457–458
- Neural control, review of, 510
- Neurally adjusted ventilatory assist, 472
- alarms and safety features in, 515–516
 - electrical activity, monitoring, 510
 - evaluating, 516
 - monitoring of, 509–510
 - use of, 514–515
 - ventilation, results of initiating, 516
 - weaning from, 516
- Neurally adjusted ventilatory assist (NAVA), 35
- Neuroleptics, 302, 302b
- usage, in mechanically ventilated patients, 304b
- Neurologic factors, in respiratory failure, 400b
- Neuromuscular blocking agents (NMBAs), 304b
- case study on, 306b
 - classes of, availability of, 304
 - monitoring, 305
 - withdrawal, prolonged paralysis (reasons), 408
- Neuromuscular disorders, 48b, 50, 114–115
- clinical scenario, 115b
 - drugs and, 50
 - guidelines for, 115
 - initial ventilator settings, 115b
 - long-term mechanical ventilation and, 421b
 - ventilation in, case study on, 50b
- Newborn. *See* Neonates
- Nitric oxide, exhaled
- factors affecting levels of, 177b
 - monitoring of, 177–178
- NIV. *See* Noninvasive ventilation

- Nocturnal hypoventilation, 373, 373b
- Nonbronchoscopic techniques, description of, 291
- Nondependent lung, ventilation to, 327, 327f
- Nondepolarizing agents, 305–306
- Nonexistent cuff pressure, 138–139
- Noninvasive devices, 431–433
- Noninvasive nasal continuous positive airway pressure, in neonates, 450–454
- Noninvasive neurally adjusted ventilatory assist (NAVA), 455
- Noninvasive positive pressure ventilation (NPPV), 46–47, 55–56, 63–64, 430
- adjustment of, 382–384
 - case study on, 383b–384b
 - advantages and disadvantages of, 64b
 - aerosol delivery in, 384
 - factors affecting, 384b
 - after extubation, 405
 - basic concepts of, 368–390
 - bilevel PAP and, 99
 - changed to invasive ventilation, 56b
 - clinical benefits of, 370b
 - complications of, 384–386
 - case study on, 384b
 - contraindications for, 56b
 - discontinuation of, 386
 - disorders managed with, 64b
 - equipment selection for, 375–382
 - exclusion criteria for, 374b
 - expiratory positive airway pressure, levels of, 493
 - goals of, 370–373
 - heliox and, 493
 - humidification issues during, 378
 - indications for, 56b, 370–373
 - in acute respiratory failure, 373t
 - in chronic disorders, 375t
 - initiation of, steps for, 382b
 - instituting, criteria for, 406b
 - interfaces in, advantages and disadvantages of, 378t
 - monitoring of, 382–384
 - case study on, 383b
 - nasal mask in, meeting criteria for, 421
 - nebulizers during, 231–232
 - in neonates, 454–455
 - patient selection for, case study on, 383b
 - preparation for, 382
 - selecting the patient interface in, 63–64
 - selection criteria for, list of, 373t, 375t
 - setup for, 382
 - success predictors of, 383b
 - symptoms for, list of, 373t, 375t
 - termination of, criteria for, 384b
 - therapy with, complications associated with, 386t, 434t
 - types of, 370
 - weaning from, 386
- Noninvasive respiratory support, 450–457
- Noninvasive ventilation (NIV), 294
- clinical benefits of, 370b
 - definition of, 369

Noninvasive ventilation (NIV) (*Continued*)

- face or nasal mask, fitting, 110
 - indications for, 373
 - techniques of, 369–370
- Nosocomial pneumonia
- pathogenic organisms from, 287b
 - risk, reduction methods of, 293b
- NPV. *See* Negative pressure ventilation
- Numeric intensity scale, 238f
- Nurse-driven protocols, 410
- Nutrition, adequate, 424
- Nutritional status, 408–409
- O**
- Obstructed expiratory valve, 361–362
- Obstructive sleep apnea (OSA), 370
- continuous positive airway pressure (CPAP) for, 433–434
 - therapy for, 373
- Occlusion pressure measurements, 188
- Occult PEEP, 330
- Oliguria, 316
- Open-circuit technique, 221
- Open-heart surgery, hemodynamic monitoring after, 207b
- Open-loop system, 19–20, 20b, 21f
- Open reservoir, use of, 395f
- Operational verification procedure (OVP), 125
- Operator settings, incompatible with machine parameters, 356
- Operator's manuals, 364
- Opioids, 303
- pharmacologic action of, 303
 - side effects of, 303, 303b
 - reversal of, 303
 - usage, in mechanically ventilated patients, 304b
- Optical shunting, 169
- Optimal PEEP, 251
- establishment of, 246–248
 - selection of, 251–257
 - case study on, 257b
 - study of, 252–257
 - performing, 254
- Oral cavity, examination of, 349
- Oral interfaces, 382
- Oral mouthpiece, 382f
- Oronasal mask, 381f
- Oropharyngeal decontamination, 295
- Oropharynx, damage to, 341b
- OSA. *See* Obstructive sleep apnea
- Oscillators
- drive mechanism for, 477f
 - sinusoidal waveform generated by, 498f
- Overdistention, 321
- lung injury from, 323–324
- PEEP and, 260b
- pressure-volume curve for, 324f
 - pressure-volume loop and, 256f
 - protection from, chest-wall compliance and, 323b

- Overinflation, 96, 359
- OVP. *See* Operational verification procedure
- Oxygen
- administration equipment for, 427b
 - analyzers, 128
 - concentration of, inspired, 466–467
 - delivery, 205, 205b
 - open reservoir to enhance, 395f
 - to tissues, basics of, 246–248
 - desaturation of, 372
 - flow rates of, higher, 376
 - toxicity of, 333
 - pulmonary changes associated with, 333b
- Oxygenation, 114
- adequacy of, 403
 - adjusting, 496–497
 - basics of, 246–248
 - calculation of, equations for, 247b
 - continuous monitoring of, 48
 - data, 255f
 - determination of, 449
 - evaluation of, measures and values in, 246t
 - failure of, 54, 54b
 - goal for, 502–503
 - during HFOV, 502
 - inadequate, 352
 - in prone positioning, potential mechanisms of, 275–279
- Oxygen consumption ($\dot{V}O_2$), 204
- Oxygen content, calculation of, 204
- Oxygen saturation measured by pulse oximetry (S_pO_2)
- assessment of, 112b–113b
 - in ventilator patients, evaluation of, 246–247
- Oxygen saturation of arterial blood (S_aO_2), 204
- Oxygen therapy, hazards of, mechanical ventilation and, 333
- Oxyhemoglobin (O_2Hb), 167f, 168
- dissociation curve
 - for arterial blood, 169f
 - right shift, acidosis and, 328
- P**
- P_aCO_2 . *See* Arterial partial pressure of carbon dioxide
- Palv. *See* Alveolar pressure
- P_aO_2 . *See* Arterial partial pressure of oxygen
- PAOP. *See* Pulmonary artery occlusion pressure
- Paradoxical breathing, 51, 135
- Paralytic disorders, 48b
- Paralytic drugs, 48b
- Paralytics, 299–308, 299b, 304b
- Partial ventilatory support, 64
- Passive humidifiers, placement of, 107b
- Passy-Muir valve, 438, 438f
- patient's experience with, clinical scenario on, 439b
- Patent airway, maintenance of, 48
- Patent ductus arteriosus, 451
- Patient care team, concerns of, 386
- Patient-centered mechanical ventilation, 238
- Patient circuit, 21
- additional components of, 24f
 - adjuncts used with, 24b
 - basic elements of, 23b, 24f
- Patient-circuit leaks, during PSV, 362
- Patients
- agitation, case study on, 304b
 - appearance of, PEEP and, 254
 - assessment, case study on, 136b
 - changing position, 279b
 - circuit, accidental disconnections, 340b
 - clinical stability of, 420–421
 - closed head injury guidelines, 116–117
 - comfort, improvement in, 383b
 - comfort of, 237–238
 - confusion and delirium in, 237
 - effort, control of, 34
 - evaluation of, clinical factors in, 400b
 - information of, 125
 - initial assessment, 112b–113b
 - initial ventilator settings for, 111
 - interfaces, 378
 - management techniques in, 235
 - neuromuscular disorder guidelines, 115
 - preparation of, 110
 - problems related to, 349–351
 - protecting, 347–348
 - respiratory distress in, 47
 - safety of, 237
 - selection of, 420–422
 - criteria for, 373–375
 - size, suction levels and, 222t
 - sudden distress
 - causes of, 348b
 - identification of, 348–349, 348b
 - temperature, 135
 - variability among, 273
 - ventilatory performance of, 401–402
- Patient-triggered ventilation, 460
- Patient triggering, 34–35, 35f, 36b
- case study on, 35b
 - inadequate sensitivity setting for, 359
- Patient-ventilator asynchrony, 348, 349b, 360, 363f
- assessment of, 157–158, 157f, 157b, 158f
 - detecting, using Edi catheter, 512–513
 - examples of, 352–353, 353b
- Patient-ventilator management, methods to improve ventilation in, 213–243
- Patient-ventilator synchrony, 335–338
- improved, 459f
- Patient-ventilator system, documentation of, 125–128
- PC-CMV. *See* Pressure-controlled continuous mandatory ventilation
- PC-IMV. *See* Pressure-controlled intermittent mandatory ventilation
- PC-IRV. *See* Pressure-controlled inverse ratio ventilation
- Peak expiratory flow, 52–53, 53f
- rate (PEFR), defined, 151
- Peak inspiratory pressure (PIP), 12f, 13, 131, 185, 185b
- adjustment in, 455
 - changes, examples of, 141t
 - concerns with, 93
 - evaluation of, case study on, 355b
- Peak pressure, 13
- alarm activating, case study on, 322b
 - pneumothorax and, 322
- Pediatric infant ventilators, features for, 460b
- Pediatric patient. *See* Children
- Pediatric ventilator, 458–461
- advancement of, 460
 - features of, 458b
- Pediatric ventilatory support, goals of, 450
- PEEP. *See* Positive end-expiratory pressure
- Pendelluft, 478–479
- Percent leak, 465
- Perfusion states, low, 168
- Perfusion without ventilation, 205
- Periodic hyperinflation, 109–110, 109b
- Perivascular, 321–322
- Permissive hypercapnia, 114, 220
- circulatory effects of, 220–221
 - clinical scenario, 221b
 - contraindications of, 220–221, 221b
 - procedures for managing, 220, 220b
- Phase variables, breath phases and, 33–43, 34b
- Philips Respironics Healthcare V60 ventilator, 376f
- Phrenic nerve, severed, 511–512
- Physical appearance, assessment of, 112b–113b
- Physiological dead space, increased, 218–219
- Physiological positive end-expiratory pressure, 96–100, 97b
- Physiological shunt, determination of, 205
- Pilot tube
- cut in, 139–140, 140f
 - repair kit, 140f
- PIP. *See* Peak inspiratory pressure
- Piston-driven ventilator, internal pneumatic circuit, example of, 37f
- Pitt speaking tracheostomy tube, 436–437, 437f
- Plasma renin activity (PRA), 316, 317b
- Plateau pressure (P_{plat}), 3, 13, 13f, 40, 131, 131b, 183, 185b
- changes, examples of, 141t
 - evaluation of, case study on, 355b
 - measurement of, 13, 95b, 130f
- Pleural space, airway pressure to, transmission of, 260
- Pleura-occupying lesions, 48b
- Pneumatically powered ventilators, 18–19, 19b
- Bird Mark, 18, 19f
- Pneumatic circuit, 21–23
- external, 23

Pneumatic circuit (*Continued*)

- internal, 21–23
- Pneumatic flow control valve, digital on/off valve, 27f
- Pneumobelt, 432–433
 - with positive pressure generator, 433f
- Pneumomediastinum, 322
- Pneumoperitoneum, 323
- Pneumotachometer, 52
- Pneumothorax, 322–323, 350
 - tension, 322
 - work of breathing and, 51
- Polymicrobial infections, 287–288
- Polyneuritis, 311
- Portable homecare ventilators, 377
- Portable pressure-targeted ventilators, 375
 - limitations of, 375
- Portex speaking tracheostomy tube, 436–437, 436f
- Posey Cufflator device, 136f
- Positive end-expiratory pressure (PEEP), 12–13, 12f, 314, 314f, 462–467, 463f
 - airway suctioning with, 261
 - applications of, 249–250, 253t
 - physiological factors for, 258f
 - applied or inadvertent, 202
 - ARDS vertical gradient and, 267
 - asynchrony, 338
 - baseline pressure level and, 40
 - congestive heart failure and, 260
 - continuous positive airway pressure (CPAP) and, 42–43, 42f
 - contraindications for, 259
 - during controlled ventilation, 42f
 - definitions of, 12–13, 104b
 - devices, technical aspects of, 249
 - establishment of, 246–248
 - excessive, 338, 362
 - flowsheet of, example, 255f
 - goals of, 249
 - increased, effects of, 258t–259t, 463f
 - indications for, 251, 251b
 - initiating, 251
 - introduction to, 248–250
 - left ventricular dysfunction, effects in, 119b
 - levels of
 - high, 255f
 - selection of, 251–257
 - minimum/low loop, 250
 - optimal, 251
 - physiological effects of, 259–261
 - positive-pressure ventilation and, 310
 - pulmonary effects of, 259–260
 - ranges, 250–251
 - setting, pressure-volume loops in, 268–275
 - study of
 - in experimental model involving oleic acid injury, 257t
 - parameters measured and monitored during, 253b
 - terminology, 249
 - therapeutic, 251
 - titration of, 159, 159f
 - varying levels of, 203f

Positive end-expiratory pressure (PEEP) (*Continued*)

- weaning from, 261, 262t, 262b–263b
- withdrawal, 262b
- Positive pressure breath
 - upper airway pressure graph, 12f
 - volume from, 118f
- Positive pressure ventilation (PPV), 4, 10–11, 128b
 - beneficial effects on heart function in patients with left ventricular dysfunction, 312, 312b
 - body position during, 275–279
 - cardiovascular effects of
 - adverse, 310–311
 - factors influencing, 311–312
 - coronary blood flow with, 311
 - duration and magnitude of, 312
 - effects on pulmonary system, 320–345
 - endocrine effects of, on renal function, 316
 - fluid balance and, 236
 - inflation hold with, 40f
 - and lungs, intrapleural pressures and, 310, 310f
 - mechanics and pressure waves associated with, 11f–12f
 - oxygenation in, mechanisms of, 275–279
 - positive end-expiratory pressure (PEEP) and, 310
 - selection of, 114
 - thoracic pump mechanism during, 310
 - usage of, 370
- Positive pressure ventilators, 19, 21f
- Postextubation
 - difficulties in, 404–405
 - laryngospasm, occurrence of, 404
 - stridor, 505
- Postmyocardial infarction, ventilatory support, 95b
- Postoperative pulmonary complications, 48b
- Postpolio syndrome, 434
- Postural drainage, 232–233
- Power input alarm, 356
- Power transmission, 23–26
- PPV. *See* Positive pressure ventilation
- Preload, 193
- Premature breath cycling, case study on, 38b
- Premature pressure support termination (PPST), 467–468
- Pressure
 - baseline, 12–13
 - calculation of, 6b
 - definition of, 3–4, 4t
 - in positive-pressure ventilation, 10–11
 - determining, 86b
 - driving, 132
 - at end of exhalation, 13, 13f
 - equivalents of, 3b
 - flow, volume, and time relationship, 148, 148b
 - gradients, 3, 3f
 - limit, 133
 - peak pressure, 13

Pressure (*Continued*)

- percentage, change in, 465f
- scalars, 149f, 151f–153f
- triggering, sensitivity level for, 34, 35f
- units of, 3
- waves
 - negative pressure ventilation and, 10f
 - positive pressure ventilation, impact of, 11f–12f
- Pressure augmentation, 76–77
- Pressure broadening, 171
- Pressure-control inverse ratio ventilation, pressure-time curves for, 493f
- Pressure-controlled breathing, 32
- Pressure-controlled continuous mandatory ventilation (PC-CMV), 70–72, 71f, 74t, 471f
 - advantage of, 99
 - in children, 461f
 - for COPD, 112
 - descending ramp waveform and, 99
 - with high PEEP level, 274
 - with increased PEEP, 274
 - in patient with respiratory acidosis, adjustment, 215b
 - scalars, 150, 151f
 - tidal volume during, 97b
- Pressure-controlled intermittent mandatory ventilation (PC-IMV)
 - advantages, risks, and advantages of, 74t
 - scalars, 150, 152f
- Pressure-controlled inverse ratio ventilation (PC-IRV), 71–72
- Pressure-controlled ventilation, 31, 31b, 33f, 39, 69b
 - with airflow limitation, 464f
 - assessing overdistention during, 160–161, 160f–161f
 - descending waveform, 68f
 - volume-controlled ventilation *versus*, 150, 150b
 - volume, decrease (clinical scenario), 216b
- Pressure control mode, 461–462
- Pressure control ventilation, 86b
 - initial settings for, 98–99
 - PIP and volume evaluation in, case study on, 355b
- Pressure-cycled inspiration, 75b
- Pressure cycling, pressure limiting *versus*, 37–38
- Pressure limiting, 36, 37f
 - pressure cycling *versus*, 37–38
- Pressure manometer, 51–52, 52f
- Pressure-regulated volume control (PRVC), 77, 77f, 99–100
 - case study on, 100b
 - inspiratory phase of, 469f
 - names for, 100t
- Pressure support, 36
 - flow asynchrony, 468f
 - flow synchrony, 468f
- Pressure-supported breath, triggering of nebulizer impairment of, 362–363

- Pressure support ventilation (PSV), 73–75, 75f–76f, 86b, 394–395, 467–468, 468f
 additional settings in, 74–75, 76f
 flow cycling during, 161–162, 161f, 162b
 initial settings for, 98, 98f
 inspiratory flow termination in, 99b
 patient-circuit leaks during, 362
 time-cycled and pressure-cycled inspiration with, 75b
- Pressure-targeted ventilation (PTV), clinical scenario, 216b
- Pressure-targeted ventilators (PTV), 375–377, 376b
- Pressure-time curve, fluctuations in, 363f
- Pressure-time product, 187–188, 189f
- Pressure-time waveforms, 36, 37f, 42f
 with continuous positive airway pressure (CPAP) and, 42f
 mean airway pressure and, 248f
- Pressure tracing
 of arterial pressure, 201f
 evaluation of, 204b
 of pulmonary artery, baseline, 202
- Pressure ventilation
 changes, 214–216, 215f
 initial ventilator settings during, 96
 inspiratory time, inadequacy of, 359
 modes, with volume targeting, initial settings for, 99
 required setting selection and variables during, 96t
 tidal volume delivery in, 97–98, 97b
- Pressure-volume (P-V) curves
 bedside measurement of, 142–144, 142f, 144f
 data correlation of, 143t
 obtaining, techniques for, 143b
 for PEEP, 246–248
- Pressure-volume (P-V) loops, 157f, 272f, 362f, 462f
 components of, 151, 153f–154f
 PEEP, 159f
 slope, positive end-expiratory pressure (PEEP), effect of increasing, 463f
 spontaneous breaths and, 151, 154f
- Pressure waveforms, 98f
 for airway pressure release ventilation, 79f
 various forms of, 148f
- Pressurized metered dose inhalers (pMDIs), during mechanical ventilation, 229–230
- Problem, definition of, 347
- Prone positioning, 268, 276–278, 277f
 contraindications to, 277b
 oxygenation in, mechanisms of, 275–279
 protocol for, 278b
 for respiratory support, 484
 technical aspects of, 277–278
- Prophylactic antibiotics, 296
- Prophylactic therapy, 483
- Propofol (Diprivan), 302, 302b
 hemodynamic effects of, 302
 onset and duration of, 302
- Proportional assist ventilation (PAV), 79–80, 79b
- Proportional solenoid valve, type of flow, control valve, 26, 26f
- Proximal airway pressure, 3
- PRVC. *See* Pressure-regulated volume control
- Pseudomonas aeruginosa*, 287–289
- Pseudooscillators, 476
- PSV. *See* Pressure support ventilation
- Psychological factors
 in respiratory failure, 400b
 in weaning, 409
- Psychological status, 236–237
- Pulmonary angiogram, 351
- Pulmonary artery (PA)
 bedside catheterization of, 197
 catheterization, 197–200, 197f
 pressure, 202–204
 pressures of, 135, 201–204
 response to ventilation of, 202f
 tracing, baseline of, 202
 waveform, systemic arterial waveform and, 202
- Pulmonary artery (PA) catheter, 197
 complications associated with, 199t
 insertion sites of, 198, 198t
 placement of, 197–198
 position of, West's zone relationship in, 199f
 rupture associated from, risk factors of, 200, 200b
 in zone 3 position, 199, 199b
- Pulmonary artery occlusion pressure (PAOP), 193, 201–202, 201b
 abnormal values/patterns in, causes of, 202b
 important role of, 201–202
 increased, effects of, 259t
 wedged position and, 198–199
- Pulmonary blood flow
 detection, capnography in, 175
 effects of mechanical ventilation on, 327–328
 redistribution of, 327–328
- Pulmonary condition, clinical findings of, 143t
- Pulmonary disorders
 initial ventilator settings, 121t
 physical and radiologic findings in, 136t
- Pulmonary edema, 350
- Pulmonary embolism (PE), 351
 as emergency, 351
- Pulmonary infiltrates, presence of, 289
- Pulmonary injury sequence (PIS), 474
- Pulmonary interstitial emphysema, clinical scenario, 477b
- Pulmonary mechanics, monitoring, ventilator graphics for, 154–156, 154f–155f, 155b, 156f
- Pulmonary overdistention, from CPAP, 454, 454f
- Pulmonary shunt, 248b
- Pulmonary specialty wards, 420
- Pulmonary vascular pressure monitoring, with PEEP, 257–258
- Pulmonary vascular problems, 48b
- Pulmonary vascular resistance (PVR), 193
 calculation of, 193
 positive pressure and, effects on, 328, 328f
 positive pressure ventilation and, 310–311, 311f
- Pulse oximeter, 167f
 ambient light and, 169
 capability, description of, 168–169
 case study on, 120b
 nail polish and, 169
 pulsatile and nonpulsatile components of, 168f
 skin pigmentation and, 169
- Pulse oximetry, 48, 167–170, 167f–168f
 clinical applications of, 169–170
 clinical practice guideline for, 170b
 physiological and technical concerns for, 168–169
- Pulse pressure, 200–201
- Pulse rate, determination of, 167
- Puritan Bennett 840 ventilator, 74–75
- Puritan Bennett 7200 ventilator, fixed flow, 336
- Pursed-lip breathing, 41–42, 97b
- PVR. *See* Pulmonary vascular resistance
- ## R
- Radford's nomogram, 89f
- Rales, 135
- Ramp, 376
- Ramsay Sedation Scale, 300t
- Random access memory (RAM), usage, 18–19
- Rapid shallow breathing index (RSBI)
 calculation of, case study on, 401b
 for weaning status, 401
- Rate control, 34
- Rat lungs, macroscopic aspect of, 326f
- Readiness, assessment of, 399b
- Read-only memory (ROM), 18–19
- Rebreathing circuit, by Respironics NICO capnometer, 205f
- Recruitment-derecruitment, 321
- Recruitment maneuvers, 271–275, 271b–272b
 hazards of, 273
 summary of, 275, 275b
 theoretical model of, 273f
 types of, 274–275
 use of, 500b
- Reflectance oximetry, 205
- Rehabilitation hospital, 420
- Reintubation, 404, 404b
- Relative humidity, changes in, 106–107, 106b
- Renal effects, impaired, 317
- Renal failure/malfunction, 236
- Renal insufficiency, fentanyl (usage), 303
- Rescue therapy, 483
- Residual volume, 52
- Resistance, 6–8

- Resistance (*Continued*)
 - increased, 8f
 - values for, 8b
 - Respiration, 2
 - Respiratory acidosis
 - adjusting PC-CMV in patient with (clinical scenario), 215b
 - clinical and ECG changes and, 328b
 - increasing rate (clinical scenario), 215b
 - increasing tidal volume, 215b
 - metabolic alkalosis, combined, 218b
 - volume and pressure ventilation changes, 214–216, 215f
 - Respiratory alkalosis
 - clinical and ECG changes associated with, 329b
 - decreasing rate (clinical scenario), 216b
 - metabolic acidosis, combined, 218b
 - during spontaneous efforts, 217b
 - VC-CMV and PC-CMV changes, 216–217
 - ventilator-induced, 408t
 - volume decrease in pressure-controlled ventilation, 217b
 - Respiratory alternans, 394
 - Respiratory capabilities, and demands, balance between, 392f
 - Respiratory care plan, long-term mechanical ventilation and, 427b
 - Respiratory diseases, hemodynamic changes in, 209t
 - Respiratory disorders, long-term mechanical ventilation and, 421b
 - Respiratory distress
 - causes of, 348b
 - management of, in mechanically ventilated patient, 349b
 - physical signs of, 348f
 - recognition of, 47
 - severe, evaluation of, in a ventilated patient, case study on, 351b
 - sudden, clinical scenario for, 350b
 - Respiratory disturbance, clinical scenario, 218b
 - Respiratory drive
 - abnormalities in, 351
 - decreased, central nervous system disorders and, 48
 - Respiratory factors, in respiratory failure, 400b
 - Respiratory failure
 - acute, 47–48
 - case study on, 49b
 - definition of, 47–48
 - indications of, 50t
 - patient history and diagnosis of, 48–51
 - physiological measurements, 51–54
 - cause of, treatment of, 110
 - clinical indications for, 448–449
 - definition of, 448
 - disorders and agents associated with, 48b
 - etiology of, determining, 400b
 - Respiratory fluctuations, PA catheter placements during, 198
 - Respiratory frequency, determining, 86b
 - Respiratory function, assessment of, 166–191
 - Respiratory muscles
 - inactivity, 31
 - strengthening of, 409
 - weakness, 114
 - Respiratory quotient, variations in, 180b
 - Respiratory rate
 - calculation of, 91
 - case study on, 90b
 - minute ventilation and, 53
 - tidal volume and, interrelation of, 91b
 - Respiratory special care units, 420
 - Respiratory status, in mechanical ventilation, 328–330
 - Respiratory support, adjunctive forms of, 483–484
 - Respiratory system
 - mechanics
 - assessment of, 183
 - clinical applications of, 185–188
 - derived variables in, 185–186
 - measured variables in, 185
 - pressure gradients, 3f
 - Respiratory therapy, equipment of, 289
 - Respiratory zone, of comfort, 398
 - Respirometer, 52
 - Respironics NICO capnometer, rebreathing circuit by, 205f
 - Respite care, 422
 - Resting heart rate, 200
 - Restrictive thoracic disorders, 372, 372b
 - Resuscitation bag, 348
 - Reticular pattern, 266b
 - Retrograde pressures, 193
 - Reverse Trendelenburg position, 432
 - Reynold's number, 504b
 - Right atrial pressure (RAP), 193, 197, 201–204
 - abnormal values/patterns in, causes of, 202b
 - continuous monitoring of, 201
 - normal ranges in, 201
 - Right atrium
 - catheter advancement in, waveforms from, 198f
 - indwelling venous catheter placement, 135
 - Right ventricular (RV) afterload, increase in, 310–311
 - Right ventricular (RV) dilation, 311
 - Right ventricular end-diastolic pressure (RVEDP), 193
 - Right ventricular (RV) function, altered, 310–311, 311f
 - Right ventricular pressure (RVP), 197
 - direct measurements of, 201
 - Right ventricular stroke work, calculation of, 206
 - Right ventricular stroke work index (RVSWI), 206
 - Rise time, 74
 - Rise-time control, 376
 - Rising exponential curve, 150
 - Rocking bed, 431–432, 432f
 - caution with, 432b
 - Rotary drive piston, 25b–26b
- ## S
- Saline instillation, normal, 225
 - Scalars, 148–150, 149f–152f
 - normal, 153–154
 - term, usage, 147–148
 - SCCM. *See* Society of Critical Care Medicine
 - Secretions, 350, 350b
 - clearance, 221–226, 434–435
 - removal, 223
 - Sedation
 - levels of, 300b
 - Joint Commission definitions of, 300
 - monitoring of, 300–301, 300t, 300b
 - practices of, 300
 - strategies and protocols for, 399b, 410
 - Sedatives, 299–308, 299b
 - usage of
 - for mechanically ventilated patients, 304b
 - Selective digestive tract decontamination, 296
 - Semirecumbent patient positioning, 294
 - Sensitivity setting, in final ventilator setup, 104–107, 104b, 105f, 106b
 - Sensor Medics 3100A, 477, 477f
 - Servo-i ventilator
 - main screen in, 513f–514f, 514
 - during NAVA ventilation, 515f
 - “volume control”, 513f
 - VS of, 338
 - Set pressure, 131
 - Set volume, actual delivered volume and, 38
 - Severe asthma, clinical scenario, 505b
 - Severe inspiratory airflow limitation, pressure-controlled ventilation with, 464f
 - Severe respiratory distress
 - causes of, 349b
 - evaluation of, case study on, 351b
 - management of, 349b
 - signs of, 348f
 - Shadow triggering, 335
 - Shallow breathing, 51
 - Shape signal, 335, 335f
 - Shear stress, 324, 324f, 324b
 - Shell ventilator, 369
 - Shikani, 437
 - Short binasal prongs, use of, 454
 - Shunt
 - clinical, calculation of, 253b
 - definition of, 205
 - fraction, 205–206
 - pulmonary, 248b
 - Sidestream sampling devices, 171
 - Sigh/sighing, 109–110, 109b
 - history of, 109b
 - techniques, 274–275
 - Silent aspiration, 224

- Silverman-Anderson respiratory scoring system, 448–449, 449f
 - Simethicone agents, 385
 - SIMV. *See* Synchronized intermittent mandatory ventilation
 - Sine flow, 93
 - Sine wave pressure curve, 37f
 - Single-breath CO₂ (SBCO₂) curve
 - description of, 175–176, 176f
 - of inspiration and exhalation, 176–177, 177f
 - Single-circuit ventilator, 21, 22f
 - Skeletal disorders, long-term mechanical ventilation and, 421b
 - Skilled nursing facilities, 420
 - Skin pigmentation, pulse oximeter and, 169
 - Sleep
 - metabolic rate reduction, associated with, 182
 - status, 236–237
 - Sleep apnea
 - PEEP and, 261
 - syndrome, 48b
 - Sliding Venturi, design of, 476f
 - Slope control, 161
 - Small airways, laminar flow in, 504
 - Small-volume nebulizers (SVNs), 228, 295
 - during mechanical ventilation, 230, 230b
 - position of, 385f
 - Smoke exposure, 168b
 - Society of Critical Care Medicine (SCCM)
 - NMBA administration recommendation, 305
 - recommendations from, 399b
 - Speaking tracheostomy tubes, 436–437
 - concerns with, 439
 - Speaking valves, 435–440
 - concerns with, 439
 - Specialized continuous suction endotracheal tubes, 295f
 - Specific dynamic action, 182
 - Speech
 - loss of, 436
 - tracheostomy tube and, 435–440
 - Spontaneous breathing, 2, 73
 - airway pressure during, 495
 - device for delivering heliox in, 505–506, 505b
 - prolonged, 334
 - thoracic pump mechanism during, 310
 - Spontaneous breathing trial (SBT), 73, 400, 401b
 - assessment during, 403, 403b
 - failure, 399b
 - recommendation in, 405, 405b
 - problems during, clinical signs and symptoms indicating, 403b
 - ventilation maintenance in, 409–410
 - Spontaneous breaths, 43, 65
 - pressure-volume loops and, 151, 154f
 - Spontaneous CPAP, circuitry for, 250
 - Spontaneous inspiration, intrapleural pressure and, 310f
 - Spontaneous modes, 73–75
 - Spontaneous ventilation
 - mechanics of, 2–4
 - example of, 5f
 - preserving, 494–495
 - Spring-loaded bellows, 25b–26b
 - Sputum
 - color, 235t
 - upper airway infections and, 235
 - Stable chronic lung diseases, 421
 - Static compliance (C_S), 6, 6b, 140, 186
 - calculation of, 6b
 - case study on, 8b
 - measurement of, auto PEEP and, 332
 - PEEP and, 256
 - Static pressure, 183
 - head, 196
 - Static pressure-volume (SPV)
 - curve, 142, 142f
 - loop, features of, 270–271
 - Stiff lungs, 254f
 - Stoma, maintenance of, 439–440
 - Strain gauge pressure transducer, 183, 195–196, 195f
 - Straw-sipping problem, 105
 - Streaming, 479, 479f
 - Stress ulcer prophylaxis, 295, 296b
 - Stroke index (SI)
 - calculation of, 204
 - case study on, 204b
 - Stroke victim, case study on, 49b
 - Stroke volume (SV), 206
 - Stroke work, 206, 207b
 - Subacute care units, 420
 - Subatmospheric pressure, decrease in, 435
 - Subglottic secretions, aspiration of, 224–225
 - Substrate utilization pattern, 182–183, 182b
 - Succinylcholine, 305
 - inactivation of, 305
 - side effects of, 305
 - usage of, 305
 - Suction catheters
 - flexible, 222f
 - reuse of, procedure in, 441b
 - size (estimation), based on endotracheal tube size, 222b
 - Suctioning
 - assessment after, 225–226, 225b
 - duration of, 222–223
 - hazards and complications of, 223, 223b
 - Sudden distress, identification of patient
 - in, 348–349, 348b
 - causes of, 348b
 - Sudden respiratory distress
 - causes of, 349b
 - clinical scenario, 350b
 - management of, 349b
 - Superior vena cava, indwelling venous catheter placement, 135
 - Super-syringe technique, 144f, 269–270, 269f
 - Supplemental oxygen therapy, 48
 - Surfactant
 - alteration of, 324–325
 - artificial, 480
 - deficiency syndromes, 462
 - replacement therapy, 483–484
 - Survanta, 483
 - Sustained inflation, 274
 - Swan-Ganz catheter, 197
 - Synchronized intermittent mandatory ventilation (SIMV), 73b, 393
 - flow, volume, airway pressure and esophageal pressure measurements in, 394f
 - System compressibility, 89
 - Systemic arterial blood pressure, 135
 - Systemic arterial pressure, 200–201
 - direct measurement of, 196
 - Systemic artery catheterization, 196–197
 - Systemic hypotension, 200, 311b
 - Systemic vascular resistance (SVR), 193
 - calculation of, 206
 - normal ranges of, 206
 - System-imposed work of breathing, 333
 - System leaks, 38
- ## T
- Tachycardia, 48b, 200
 - hypoxemia and, 223
 - Tachypnea, 48b
 - “Talking” tracheostomy tube, 437f
 - Tank ventilators, 430–431
 - Targeting volume, as control variable, 65, 65b, 66f, 66b
 - Taylor-type dispersion, 479
 - Temperature, 135
 - Tension pneumothorax, 322
 - Termination asynchrony, 337
 - Therapeutic PEEP, 251
 - Therapist-driven protocols (TDPs), 410
 - Thermal flow meters, 184–185
 - Thermodilution catheters, 197
 - Thoracic pressure-volume relations,
 - patterns of alteration in, 354t
 - Thoracic pump mechanism, 310
 - Thorax
 - computed tomographs of, 265f
 - positive-pressure ventilation and, 310, 310b
 - Threshold resistors, 250, 251b
 - Thrombolytic therapy, 351
 - Tidal flow-volume loops, based on mechanical breaths, 232f
 - Tidal volume (V_T), 465
 - case study on, 90b
 - changes, examples of, 141t
 - delivery
 - capability of, 111
 - in pressure ventilation, 97–98
 - display, 129
 - flow delivery, dependence on, 495

- Tidal volume (V_T) (*Continued*)
 flow, total cycle time, and inspiratory-to expiratory ratio, relationship, 91–92, 91b
 increasing (clinical scenario), 215b
 measurement, respirometer technique for, 129f, 129b
 during PC-CMV, 97b
 positive end-expiratory pressure, effect of, 463f
 rate and, 88–91
 settings, 90b
 in ARDS, 267–268
 usage, 109b
- Time constants, 8–9, 8b
 calculation of, 8b, 463b
 concept of, 465
 passive exhalation and inhalation and, 9f
 percentage change in pressure in, 464–465, 465f
- Time-controlled breathing, 32
- Time controller, 31
- Time-cycled breath, pressure-limited, 36
- Time-cycled inspiration, 75b
- Time-cycled, pressure-limited, intermittent mandatory ventilation (TCPL/IMV), 458–459
- Time-cycled ventilator
 effects of changing flow pattern in, 94–95
 examples of, 39, 94t
 inspiratory flow in, 92b
- Time, flow, pressure, volume (relationship), 148, 148b
- Time-triggered, pressure-limited, time-cycled ventilation (TPTV), 459f
- Time triggering, 34
- Tissues, oxygen delivery to, basics of, 246–248
- Titrating ventilator, methods of, 393–395
- Total cycle time (TCT), 34
 calculation of, 91–92
 tidal volume and, relationship, 91–92
- Total face mask, 379–382, 381f
- Total oxygen consumption ($\dot{V}O_2$), 86
- Total resistance, 141
- Total respiratory cycle, pressure readings in, 313f
- Total shunt fraction, 206
- T-piece weaning, 395
- Trachea, damage to, 341b
- Tracheal buttons, 435–440, 440f
 decannulation and, 439–440
- Tracheal dilation, 138f
- Tracheal injury, from long-term ventilation, 430b
- Tracheal intubation, capnography in, 175b
- Tracheal necrosis, 137–138
- Tracheal pressure curve, using inspiratory pressure support, 396f
- Tracheoesophageal fistula, 451
- Tracheomalacia, 456
- Tracheostomy
 complications associated with, 341b
 consideration for, 410–411
- Tracheostomy (*Continued*)
 role of, in weaning, 399b, 410–411
 speaking valves, 437–439
- Tracheostomy tubes, 250, 426, 435–440
 care of, 294–295
 child with, 438b
 complications, 341b
 connector for, 437–438
 cuffs, management of, 136–140
 early placement of, 435–436
 selection and benefits of, 435–436
 speaking, 436–437
 during ventilation, speaking with, 436
- Train-of-four (TOF), assessment of, 305, 305b
- Transairway pressure (P_{TA}), 3, 131, 151
 airway resistance measurement and, 7
- Transcutaneous electrodes, 179f
- Transcutaneous monitoring, 178–180
 clinical practice guideline for, 178b
 pulse oximeters and, 466
 technical considerations in, 179–180
- Transcutaneous partial pressure of O_2 ($P_{tc}O_2$), 178–179, 179f
- Transcutaneous PCO_2 , 179, 179f
- Transcutaneous PO_2 , 178–179, 179f
- Transdiaphragmatic pressure, 187, 189f
- Transport ventilators, 427b
 examples of, 427–428
- Transpulmonary pressure (P_L or P_{TP}), 3–4, 266b
 breathing and, 30–31
 changes in, 5t
 chest-wall and, 323b
 components of, 4
- Transrespiratory pressure (P_{TR}), 4
- Transthoracic pressure (P_W), 3
- Trigger asynchrony, 157, 157f, 335–336, 335f–336f
- Triggering
 case study on, 106b
 mechanism (trigger variable), 34
- Trigger sensitivity, 352
- Trigger variable, 34–35, 34b
- Tris-hydroxymethyl-aminomethane (THAM), 220
- Tubing compliance, 88–90
 calculating volume lost to, 90b
 correction of, 130
- Tubing compressibility, 38
- Turbine flow meters, 185
- U**
- Ultrasonic flow transducers, 184f
- Ultrasonic nebulizers, 228
- Unilateral lung disease, patient position in, 278–279
- Unintubated patient, resistance values for, 7b
- Unseated expiratory valve, 361–362
- Upper airway
 infections, sputum and, 235
 pressure, 3
 graph of, 12f
- Upper airway (*Continued*)
 topical anesthesia to, 235
- Upper inflection point, 267
- User interface (control panel), 18, 20–21, 22f
- V**
- VAIs. *See* Ventilator-assisted individuals
- VALI. *See* Ventilator-associated lung injury
- VAP. *See* Ventilator-associated pneumonia
- VAPS. *See* Volume-assured pressure support
- Variable capacitance, 183
- Variable orifice pneumotachometers, 184–185, 184f
- Variable pressure support/control, 397
- Vascular endothelial injury, 325–326
- Vascular reflexes, blocked, 311
- Vascular resistance, 206
- Vascular tone, changes in, 200
- VC-CMV. *See* Volume-controlled continuous mandatory ventilation
- VC-IMV. *See* Volume-controlled intermittent mandatory ventilation
- VDR-4, 476
- Vecuronium, 306
 effectiveness of, data on, 306
- Vecuronium bromide (Norcuron), 306
- Venous return
 changes in, 95–96
 reduction, positive pressure ventilation and, 128b
- Ventilated patients
 administering aerosols to, 226, 227f, 227b
 management techniques and therapies in, 235
 P_aO_2 , S_pO_2 , F_iO_2 evaluation in, 246–247
 severe respiratory distress, evaluation of case study on, 351b
 transport of, support equipment and monitoring equipment for, 238b
- Ventilation, 2
 abnormalities, correction of, 214
 adequacy of, indicator of, 52b
 adjusting, 496–497
 backup mode of, 356
 basic model of, 30–31
 changes, methods of, based on P_aCO_2 and pH, 214–221
 dead space, 176b
 depression of, 333
 determination of, 449, 496
 failure of, 53
 flow-cycled, 39, 39f
 gas flow during, 2
 intubation without, 56
 maintenance of, 502
 manual, 110
 mode of, 64–67, 128
 determination of, 150, 151b, 152f–153f
 selection of, 30
 neural control of, 510
 in neuromuscular disorders, case study, 50b

- Ventilation (*Continued*)
 to nondependent lung, 327
 parameters, case study on, 142b
 perfusion without, 205, 248b
 pressure-cycled, 39–40
 pressure gradients during, 2
 prolongation of, in long-term care facilities, 399b, 412
 review of neural control of, 510
 solving problems in, 347
 strategy, improving, 496
 time-cycled, 38–39
 tracheostomy tubes during, speaking with, 436
 types of, 10
 volume-cycled, 38
- Ventilation-to-lung periphery, 327
- Ventilation-to-perfusion (\dot{V}/\dot{Q}), 95
 mismatching in, 47, 253–254
 relationships, 172f
- Ventilator alarms, 107, 108b
 inoperative, technical error message and, 356
 situations, action during, 109
- Ventilator-assisted individuals (VAIs), 419
 cuff deflation of, 436
 discharge of, preparation for, 422–424
 psychological problems in, 430
- Ventilator-associated lung injury (VALI),
 ventilator-induced lung injury *versus*, 321, 321b
- Ventilator-associated pneumonia (VAP),
 286–298, 287b
 algorithm of, 291, 292f
 bacteriologic (quantitative) diagnosis of, 291
 causes and risk factors of, 287–289, 287b–288b
 CDC surveillance paradigm for, 289, 290t
 clinical diagnosis of, 289–291
 diagnosis of, 289–291
 clinical criteria used in, 290t
 endotracheal tube and, 294
 epidemiology of, 287–289
 handwashing and, 293–294, 293b
 incidence of, 287
 management of
 antibiotic regimens used for, 292f
 noninvasive ventilation and, 294
 nonpharmacological interventions for, 293–295
 pathogenesis of, 289
 patient case of, 291b
 pharmacological interventions for, 295–296
 positioning and enteral feeding and, 294
 prevention of, strategies for, 291–296, 293b
 treatment of, 291, 293b
- Ventilator circuits
 disinfection of, 440–441
 leaks, checking for, 133–134, 133f, 133b
 management strategies for, 295, 295b
- Ventilator control
 panel, user interface, 20–21, 22f
 systems and circuits, 19–23
- Ventilator CPAP, 452–453
- Ventilator-dependent patients
 early tracheostomy tube placement in,
 advantages of, 435b
 at home site, respiratory care plan
 equipment checklist for, 427b
 sites for, 420
- Ventilator graphics, 147–165
 problem solving using, case study on, 358b
 for pulmonary mechanics monitoring, 154–156, 154f–155f, 155b, 156f
 scalars, 148–150, 149f
 troubleshooting for, 347b
- Ventilator-induced diaphragm dysfunction, 512
- Ventilator-induced lung injury (VILI), ven-
 tilator-associated lung injury *versus*, 321, 321b
- Ventilator-induced respiratory alkalosis, 408t
- Ventilator-induced respiratory muscle weakness, 326–327
- Ventilator management protocol (VMP), 411f
- Ventilator-related problems, 351–353
- Ventilators, 17–28, 62–84
 additional modes of ventilation in, 76–80
 artificial intelligence system for, 395
 asynchrony, resolution for, 353b
 bilevel positive airway pressure in, 75–76, 76b
 breath delivery in, 64–65
 changes in, case study on, 329b
 classification, historical perspective on, 17–18
 components of, 18b
 compressors (blowers), 23–24
 control systems and circuits of, 19–23
 conversion system and, 23–26
 cost of purchasing of, 111
 dependence, pathology of, 398, 399b
 discontinuation of, closed-loop control
 modes for, 395–398
 double-circuit, 21–23, 23f
 drive mechanisms in, 23
 electrically powered, 18b
 equipment setup, final considerations in, 110
 flow sheet, 125, 126f
 comment section of, 144
 fluid logic (fluidic) pneumatic
 mechanisms, components of, 20f
 full and partial ventilatory support in, 64
 function of, 494b
 with heliox, 508b
 worksheet for reviewing, 81f
 input power of, 18–19
 inspiratory waveform maintenance, 32f
 internal function of, 18
 mechanical and operational hazards of, 339, 339b–340b
 methods of, comparison of, 395
 minute ventilation, display, 129
- Ventilators (*Continued*)
 modes, 31, 62–84
 spontaneous, 73–75
 worksheet for reviewing, 81f
 needs, 110
 noninvasive and invasive positive pressure
 ventilation, 63–64
 operation, verification of, 125b
 parameters, PEEP and, 255–256
 patient performance with, 401–402
 performance, evaluation of, 111
 pneumatically powered, 18–19, 19b
 pneumatic circuit, 21–23
 power source of, 18–19
 power transmission and, 23–26
 problems in, 351–353
 evaluation of, 361b
 identification of, use of graphics in, 356–360, 358b
 procedures, 252t
 PRVC names on, 100t
 rate, display, 129
 requirement, clinical scenario, 95b
 selection of, 110–111, 426–428
 case study on, 19b
 sensitivity setting in, 104–107, 104b, 105f, 106b, 129
 setup
 final considerations in, 103–123
 parameters, 103–104
 single-circuit, 21, 22f
 synchrony, using waveform, 513–514
 technical error message and, 356
 tidal volume, display, 129
 troubleshooting, 357b
 types of, 375–378
 unexpected responses to, 361–364
 user interface (control panel), 18, 20–21, 22f
 volume displacement designs, 24–26
 volume flow-control valves, 26
- Ventilator settings, recommending changes in, 468b
- Ventilatory assist, neurally adjusted, 514–516
- Ventilatory management, and discontinuation, components of, 392b
- Ventilatory mechanics
 adult and critical range values of, 51t
 bedside measurement of, 51–53
- Ventilatory muscle function, 400b
- Ventilatory support
 discontinuation of, 373
 establishment of, 374
 inadequate, 352
 indications for
 in neonates, 457–458
 in pediatric patients, 458
 methods of titrating, 393–395
 newborn and pediatric, 450
 postmyocardial infarction, 95b
 withholding and withdrawing, ethical dilemma on, 412
- Ventricular rate, decreased, 204

- Vest Airway Clearance System, 233f
- Vibrating mesh nebulizers, 228
- Viscous resistance, 7
- Visual alarms, 107
- activation of, 133
- Visual analog scale, 238f
- Vital capacity (VC), 50, 52
- bedside measurement of, 53b
- Vital signs, 134–135
- assessment of, 112b–113b
- Voice tracheostomy tube (VTT), 436–437
- Volume
- control mode, 467
 - pressure-regulated, 469, 469f - delivery
 - delayed in, 463f
 - graphs, 94f - device (bellows), usage, 6f
 - evaluation of, case study on, 355b
 - expiratory portion of, 347f
 - flow, pressure, time relationship, 148, 148b
 - guarantee, 469–472, 470f
 - loss, calculation of, to tubing compliance, 90b
 - pressure-regulated, 469, 469f
 - scalars, 152f–154f
 - targeting, pressure ventilation modes with, 99
- Volume-assured pressure support (VAPS), 76, 112
- Volume-controlled breathing, 32
- Volume-controlled continuous mandatory ventilation (VC-CMV), 70
- advantages, risks, and advantages of, 74t
 - goal of, 86
 - graphs of, 70f
 - inspiratory pause, setting of, 133f
 - scalars, 148
 - volume-time waveform during, 133f
- Volume-controlled inspiration, 33b
- Volume-controlled intermittent mandatory ventilation (VC-IMV)
- advantages, risks, and advantages of, 74t
 - scalars, 149–150, 150f, 153f–154f
- Volume-controlled ventilation, 31b, 33f, 69b, 86b
- airway pressure waveform during, 130f
 - flow constancy and, 336
 - initial settings during, 86–95
 - peak inspiratory pressure (PIP) and plateau pressure (P_{plat}), evaluation of, 355b
 - pressure-controlled ventilation *versus*, 150, 150b
- Volume-cycled breath, inspiratory phase of, 38
- Volume-cycled ventilation, 38
- Volume-cycled ventilators, 38
- effects of changing flow pattern in, 94–95
 - example of, 94t
 - flow and volume delivery during, 94f
 - flow patterns in, 94f
- Volume displacement designs, 24–26
- Volume displacement designs (*Continued*)
- example of, 25b–26b
 - linear drive piston, 25b–26b
 - rotary drive piston, 25b–26b
 - spring-loaded bellows, 25b–26b
- Volume flow-control valves, 26
- Volume limiting, 37
- Volume support
- initial settings of, 100
 - names for, 100t
 - Servo-i, 112
 - test breath, 78f
 - time-cycled and pressure-cycled
 - inspiration with, 75b
- Volume support ventilation (VSV), 77, 78f, 472
- Volume-targeted continuous mandatory ventilation, 70
- Volume-targeted pressure support ventilation, 397
- Volume-targeted ventilation
- advantage of, 96
 - V_T and, 467
- Volume-time curve, 347f
- below baseline, expiratory portion of, 360
 - problem, 362f
- Volume-time waveforms, 36, 37f, 133f
- Volumetric capnometry, 175–177, 176f
- Volume triggering, 34
- Volume ventilation, 507
- initial ventilator settings for, 86b
 - inspiratory pause during, 95–96, 95b
- Volume waveforms, flow pressure and, 471f
- Volutrauma, barotrauma and, 323–324
- Vortex ultrasonic flow meters, 184, 184f
- Vyair 3100B
- control panel of, 499f
 - schematic of, 498f
- W**
- Wall attachment phenomenon, 20f
- Water traps, emptying, 107
- Waveforms (curves), 147–148, 148b
- abnormal, ventilator response to, 357b
 - ringing, 359–360, 363f
- Weaning, 482–483
- acid-base factors in, 408
 - anesthesia strategies and protocols for, 410
 - APRV settings, example of, 497t
 - attempt
 - evaluation of, case study on, 394b
 - failed, case study on, 408b - cardiac factors in, 406
 - clinical criteria for, evaluation of, 398–405
 - clinical scenario on, 409b
 - complication of, nonrespiratory factors in, 405–410
 - criteria for, 400–401
 - difficulty in, case study on, 422b
 - evidence-based, 398
- Weaning (*Continued*)
- exercise and, 408–409
 - goals for, 412
 - hyperventilation and, 329
 - index, requirements of, 401b
 - in long-term ventilation units, 399b
 - metabolic factors in, 408
 - nonrespiratory factors in, 407t
 - nutritional status and, 408–409
 - parameters of, 401t
 - patient's ability for, 403
 - pharmacologic agents on, effect of, 408
 - physiological parameters for, 401t
 - protocols for, 399b, 410, 410b
 - efficiency and effectiveness of, 410b
 - example of, 411f - psychological factors in, 409
 - disease-related issues and, 409
 - manifestations of, 409 - psychological fears on, 409
 - readiness assessment for, evaluation
 - criteria for, 403 - sedation strategies and protocols for, 410
 - techniques, 392–393
 - term, use of, 392, 392b
 - titrating ventilator support during, 393–395
 - T-piece, 395
 - tracheostomy in, role of, 399b
 - work of breathing during, 333–334
- Weaning failure
- clinical scenario on, 410b
 - criteria for, 406b
 - factors in, 405
- Webb and Tierney study, 326
- Wheatstone bridge, 195–196, 195f
- Wiggers diagram, 193
- illustration of, 194f
- WOB. *See* Work of breathing
- Women, ideal body weight for, calculating, 88b
- Work of breathing (WOB), 48b, 186, 402, 402b
- chest trauma and, 51
 - during continuous positive airway pressure, 188f
 - defined, 186
 - graphic representation of, 186–187, 187f–188f
 - increased, 50–51, 333–339
 - measurement of, 334
 - physical signs and measurements of, 402b
 - reduction of, steps for, 334–339
 - ventilator, performed by, 334b
 - during weaning, 333–334, 334b
- Y**
- Y-connector, 90–91, 437–438
- Z**
- ZEEP. *See* Zero end-expiratory pressure
- Zero end-expiratory pressure (ZEEP), 40