CURRENT PHYSICAL THERAPY

PEAT

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1988
B.C. Decker Inc • Toronto • Philadelphia

Publisher

B.C. Decker Inc
3228 South Service Road
Burlington, Ontario L7N 3H8

B.C. Decker Inc
320 Walnut Street
Suite 400
Philadelphia, Pennsylvania 19106

Sales and Distribution

United States and Possessions	**The C.V. Mosby Company** 11830 Westline Industrial Drive Saint Louis, Missouri 63146
Canada	**The C.V. Mosby Company, Ltd.** 5240 Finch Avenue East, Unit No. 1 Scarborough, Ontario M1S 5P2
United Kingdom, Europe and the Middle East	**Blackwell Scientific Publications, Ltd.** Osney Mead, Oxford OX2 OEL, England
Australia	**Harcourt Brace Jovanovich** 30–52 Smidmore Street Marrickville, N.S.W. 2204 Australia
Japan	**Igaku-Shoin Ltd.** Tokyo International P.O. Box 5063 1–28–36 Hongo, Bunkyo-ku, Tokyo 113, Japan
Asia	**Info-Med Ltd.** 802–3 Ruttonjee House 11 Duddell Street Central Hong Kong
South Africa	**Libriger Book Distributors** Warehouse Number 8 "Die Ou Looiery" Tannery Road Hamilton, Bloemfontein 9300
South America (non-stock list representative only)	**Inter-Book Marketing Services** Rua das Palmeiras, 32 Apto. 701 222–70 Rio de Janeiro RJ, Brazil

Current Physical Therapy

ISBN 1–55664–025–0

Library of Congress catalog card number: 87–72381

10 9 8 7 6 5 4 3 2 1

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PREFACE

The intent of *Current Physical Therapy* is to provide a description of management strategy for a variety of disorders currently treated by physical therapists. The text does not attempt to review etiology and pathophysiology, but concentrates on the more practical matters of treatment.

In recent years the scope of practice in physical therapy has expanded considerably, and advances in the basic and clinical sciences have stimulated the continuing development of the profession. A view of current practice, however, cannot describe fixed or static situations in clinical management, so that here only a circumscribed view of a developing science and its clinical application is given. *Current Physical Therapy* includes sections dealing with major aspects of clinical practice: cardiopulmonary, musculoskeletal, and neurologic, and two sections that concentrate on pain management and the application of selected electrophysiologic agents. The final section, Developing Practice, is an indication of some new directions in physical therapy.

Current Physical Therapy draws on the individual clinical experience of physical therapists, each of whom describes his or her particular methodology in one aspect of practice. Each chapter is a personal, current, and clinical point of view, not a summary of alternative techniques. The authors are all involved in the area of therapy they describe.

I am grateful to the contributors who have produced uniformly interesting up-to-date articles. Special appreciation is offered to Mary Mansor of B.C. Decker, Inc. for her guidance and unfailing support. Finally, I would like to express my special thanks to Enid Peat for advice and comment and for many hours of invaluable assistance.

Malcolm Peat, Ph.D.

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CARDIOPULMONARY PHYSICAL THERAPY

ASSESSMENT: THE BASIS OF CHEST PHYSICAL THERAPY

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As in all other areas of physical therapy when dealing with the cardiopulmonary patient assess is of paramount importance. Assessment should include an appropriate history, an accurate and complete physical examination, and knowledgeable use of diagnostic test results. Each stage of the assessment should be directed to formulating a probable diagnosis and to determining the amount of detail required at further stages of the assessment.

HISTORY

A baseline knowledge of the patient's overall medical condition and history, in addition to specific information regarding cardiac and pulmonary problems, should be obtained from the medical chart and from patient questioning. Important areas to include in the history taking are as follows:

1. Relevant medical history and current complaint
2. Social history
3. Family history
4. History of respiratory and cardiac problems
5. Shortness of breath (SOB)—dyspnea
6. Cough and sputum production
7. Smoking history
8. Occupational history
9. Chest pain
10. Previous surgery.

Relevant medical history and the complaint that has led the patient to seek medical help can be obtained from the medical chart, and patient questioning should focus only on areas that need clarification. It is important to note particulars that may affect treatment selection or the patient's ability to carry out treatment requirements. These include chronic illnesses, previous or current neurologic conditions, and reasons for and type of surgery if a surgical patient. Social history can also be obtained from the chart and should take into account marital status and physical home situation, which could affect the patient's ability to cope at home. Family history can also be important, especially in regard to cancer or cardiac disease.

Any specific history relating to the patient's cardiopulmonary status should be obtained by direct patient questioning, as it is interesting how often the information received may vary, depending on which member of the health care team is asking the questions. When asking about history of cardiac or pulmonary problems, it is helpful to be specific and to inform the patient about some of the conditions in which you are interested. For instance, a chronic chest patient may not perceive his or her condition as a "problem," but does indicate that he or she has had emphysema for 20 years and has had pneumonia six times in the last 10 years. Thus, a more helpful approach is to ask if the patient has had asthma, bronchitis, emphysema, or pneumonia, or to ask if they ever had a heart attack, high blood pressure, or heart failure. If history of any of these is reported, it is important to determine when the condition occurred and whether medical treatment was received.

Questions about dyspnea should determine whether it occurs at rest or with exertion, if with exertion at what level, and what provides relief. The patient should also be asked about orthopnea (inability to lie flat without SOB) and paroxysmal nocturnal dyspnea (SOB that wakes them from sleep), which may indicate cardiac disease.

History of cough should determine frequency and timing of cough (e.g., only in the morning, throughout the day, after a cigarette) and production of sputum. Sputum should be described by amount, color, consistency, and absence or presence of hemoptysis. Recent changes in amount or color are also important for the chronic chest patient.

Smoking history should determine both the number of cigarettes smoked each day and the number of years the patient has smoked; this allows determination of pack years (packs per day times years smoked), which is a more objective measure of smoking history. If the patient has quit smoking it should be determined when they quit and why. The latter may provide some information about patient attitudes towards health teaching and potential compliance with it.

Occupational history can provide useful information if the patient has had prolonged exposure to coal dust, silica dust, asbestos fibers, solvent fumes, grain dust, or other irritants that may have led to chronic chest changes. Questioning about chest pain should include the type of pain, what brings it on or causes it to exacerbate, and what provides relief. Other pain, such as back or shoulder pain, may also provide helpful clues. If the patient has had previous thoracic or major abdominal surgery, it is useful to know the type of surgery and whether any postoperative respiratory complications occurred. With the information obtained from the chart and from patient questioning one can begin to formulate an idea of what diagnosis and what problems to expect, and what amount of assessment is necessary.

CURRENT SUBJECTIVE STATUS

Each time a patient is seen, whether on initial assessment or on subsequent visits, it is important to formulate a picture of their current status, based on the patient's subjective reports. It is helpful to ask a general question such as, "how are you feeling?", to begin this process. Questions should be asked about dyspnea (i.e., "how is your breathing?"), about cough and sputum production, and about pain and its relief, particularly with surgical patients. This information gives an indication of the patient's status and helps determine the direction of the assessment.

PHYSICAL EXAMINATION

The traditional and most useful organization of the cardiopulmonary system comprises, in order, inspection, palpation, percussion, and auscultation (IPPA). Within the IPPA format, there are other assessment techniques within each part of the basic assessment, and these should be addressed dependent on whether the assessment is initial or secondary and on the particular patient. Figure 1 illustrates this principle, showing basic elements in the center and additional elements on either side.

Inspection

The essential elements in the inspection are respiratory rate, rhythm, depth and pattern of breathing. A general observation of the patient and his or her environment precedes inspection, taking into consideration ventilatory assistance, supplemental oxygen and its means of delivery, chest tubes, nasogastric tubes, intravenous lines, monitoring devices, dressings, and bedside documentation of the patient's vital signs and fluid balance; each may affect or give information regarding the patient's cardiopulmonary system.

Resting respiratory rate should be observed without the patient's awareness, for example, while making preliminary introductions or while reviewing the bedside information. Respiratory rate should be taken over 10 to 15 seconds unless it is very slow or irregular, in which case it should be taken for a full minute. Normal rates should range from 12 to 18 breaths per minute.

Rhythm can be regular or irregular. Irregular rhythm should be described and length of apneic periods noted. The irregularity may be Cheyne-Stokes breathing that may be associated with congestive heart failure, increased intracranial pressure and drug overdoses—where rate and depth follow a repeated pattern of gradual increase to a maximum and subsequent decrease to an apneic period. Alternatively, Biot's respirations are "irregularly irregular" and are usually seen with neurologic abnormalities. It is often more helpful simply to describe the rhythm than to attempt to label it.

Depth should be described using a continuum of terms such as shallow, moderately shallow, moderate, normal, or increased. Depth of breathing can be altered by pain, neurological status, hypoxia, fever, and metabolic abnormalities. Breathing pattern should be described as primarily upper chest, lower chest, abdominal excursion, or a combination of these.

Chest wall shape should also be evaluated on initial assessment. Normal chest shape is elliptical with the lateral diameter greater than the anteroposterior diameter. Variations from this should be noted.

Beyond these basic areas, further areas of inspection may be addressed, depending on the history and subjective findings. Alterations in chest shape, such as increased anteroposterior diameter, barrel chest (a generalized rounding of the chest cage with prominence of the sternum), pectus excavatum (depressed sternum), and pectus carinatum (protruding sternum), should be observed. Also to be noted are abnormalities in spinal curvature, such as kyphoscoliosis, asymmetry in levels of scapulae, and flaring of the lower ribs.

Use of accessory muscles of respiration such as the sternocleidomastoids, trapezius, latissimus dorsi, and paravertebrals should be noted; use should be described as mild, moderate, or marked in degree. Indrawing of intercostal spaces, the suprasternal notch, supraclavicular areas, or the lower chest wall should be noted. It should be observed whether indrawing occurs on inspiration or expiration, the location of the indrawing, and the degree whether minimal, moderate, or marked.

Cyanosis, a bluish discoloration of the skin, may be best observed in the mucous membranes of the lips or nares or on the underside of the tongue. This dis-

coloration may not always be an accurate indication of hypoxia as adequate hemoglobin levels are necessary for cyanosis to be present. Cyanosis of nailbeds and digits is not usually helpful as it is often caused by peripheral arteriolar vasoconstriction. Pursed lip breathing, flaring of the nares, finger clubbing, and paradoxical abdominal breathing should also be noted if present.

An assessment of the patient's cough, obtained by asking them to cough or by observing any spontaneous coughs that occur, can be included here. The cough should be described by its depth (shallow, moderate, deep) or its strength (weak, moderate, strong) and its productiveness. Sputum, if produced, should be observed and described by color and consistency. Audible wheezes or secretions may also be heard, as well as stridor—a crowing sound produced by laryngeal spasm or edema, or by tracheal stenosis.

Palpation

Two basic items should always be included in palpation: expansion and flexibility. Expansion is the movement of the chest wall that the patient can produce. Lateral costal expansion should be assessed in all patients as this is most likely to be altered. Assessment is done by placing the hands on the chest wall with the thumbs at the xiphoid notch and the fingers resting along the anterolateral chest just below the nipples or breasts. Amount and symmetry of movement is noted. Upper and lower (posterior) chest movement can also be palpated using other hand positions.

Flexibility describes the compressibility of the chest wall by external force. The hands are placed on the chest wall in varying positions and gentle compression is applied. Flexibility should be described using a continuum of terms such as slightly decreased, decreased, moderate, moderately rigid, and rigid.

Other areas of palpation if indicated by preceding assessment findings may be included. Tracheal position can be palpated in the suprasternal area to indicate mediastinal shifts. This indication is not usually found unless a marked shift is present, such as with massive pleural effusion or intrathoracic tumor. Amount of abdominal tone may provide useful information as it affects both inspiratory and expiratory abilities. Abdominal tone can be described as flaccid, decreased, normal, or increased. If present, subcutaneous emphysema can be palpated and produces a crackling, bubbly feeling under the skin. It is usually present over the lateral or anterior chest wall and the neck, but may extend to the face, upper arms, abdominal wall, and upper thighs in severe cases.

In some patients, tactile fremitus should also be assessed. The ulnar border of the dominant hand is placed horizontally against the chest wall, and the patient is asked to say "ninety-nine" or a similar phrase. The vibration transmitted through to the hand is felt and described as being decreased, normal, or increased. For comparison the hand is moved from side to side and moved over the chest wall to assess all areas. Alterations in density of the underlying lung tissue or in amount of fluid or presence of air in the pleural space lead to changes in tactile fremitus. Increased density of underlying tissue, such as with consolidation, causes increased fremitus, whereas fluid or air in the pleural space, as in pleural effusion or pneumothorax, causes decreased fremitus.

Percussion

As indicated in Figure 1, percussion is not necessary in every assessment. It is an assessment technique that may be used to help develop a diagnosis, particularly when other assessment techniques have not provided sufficient information. Percussion is carried out by placing the middle phalanx of the second digit of the nondominant hand in firm contact with the chest wall parallel to the ribs and by striking the phalanx with the tip of the second digit of the dominant hand. The resonance produced by this action is described as normal, decreased or dull, or increased or hyperresonant. Percussion note should be compared side to side and all areas of the chest should be covered. Alterations in underlying lung tissue or fluid or air in the pleural space causes changes in the percussion note. A decrease or dullness in the percussion note is found with pleural effusion, consolidation, large areas of atelectasis, or fibrosis. An increased or hyperresonant percussion note is found over a pneumothorax, areas of emphysema, or a large cavity.

Auscultation

Auscultation should be the last part of the assessment, not the first and only as happens if assessment is quick and cursory. Based on previous parts of the assessment, auscultation should clarify diagnosis and problems being identified. Auscultation should be carried out with the stethoscope in firm contact with the chest wall. Three basic locations should always be auscultated: anterior upper lobes over the mid-anterior chest wall; right middle lobe and lingula anterolateral to the nipple line; and lower lobes posterolateral or posterior. Auscultation should be done on both resting respiration and deep breaths, but this is usually only feasible with chronic chest patients since with most postoperative or acute medical patients resting respirations do not provide useful findings.

Breath sounds and adventitia are the two things that should be assessed during auscultation. Breath

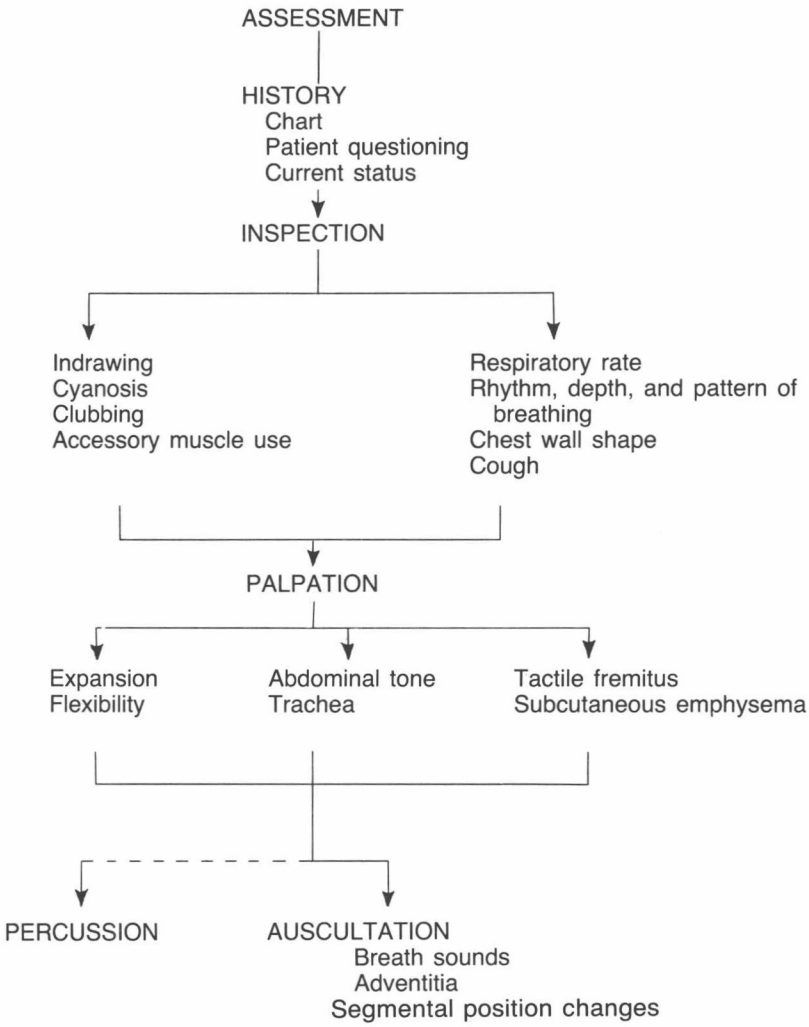

Figure 1 Assessment of the patient presenting with cardiopulmonary problems.

sounds are produced by turbulent air flow through the first few generations of bronchi and are transmitted to the chest wall by the lung tissue. Changes in air flow, in density of the transmitting lung tissue, or in fluid or air in the pleural space cause alterations in breath sounds. Breath sounds should be described by quality, and intensity or quantity.

Quality refers to whether breath sounds are normal (vesicular), bronchial, or of some intermediate type (bronchovesicular). In normal breath sounds, all of inspiration and up to the first third of expiration are heard as a soft rustling sound. In bronchial breath sounds, all of inspiration and all of expiration are heard, with a silent gap between them. They are of a hollow, echo-like type as if one were listening down a pipe. Bronchial breath sounds are produced when lung tissue density is increased, such as with consolidation or large areas of atelectasis. They are also found at the upper limit of a large pleural effusion. These are normally found over the trachea and may be found in the normal patient over the right anteromedial chest or in the auscultatory triangles between the scapulae because of decreased chest wall impedance or proximity of the large bronchi to the chest wall. Intermediate or bronchovesicular breath sounds are those where expiration is increased but not of true bronchial quality; they represent intermediate degrees of pathology.

Quantity or intensity of breath sounds describes the loudness of the breath sounds. They should be described as decreased, normal, or increased. Decreased breath sounds may be found with pleural effusion or pneumothorax, where the sound transmission is blocked, with atelectasis, or occasionally with

early stages of consolidation where air flow is decreased. Increased breath sounds may be found in consolidation or other pathologies that may produce bronchial breath sounds.

Adventitia should be described as crackles or wheezes. Crackles are discontinuous, explosive, nonmusical sounds. They should be classified by timing in the ventilatory cycle, quality (fine, medium, coarse), and number (few, diffuse). It is postulated that fine to medium crackles may be produced by rapid equalization of gas pressures when airways suddenly become patent. Medium to coarse crackles are thought to be produced by the action of air flow through or by secretions. Crackles may indicate a number of different sources including pulmonary edema, atelectasis, pulmonary fibrosis, secretions, and upper airway secretions.

Fine end-inspiratory crackles can be found in the dependent zones in pulmonary edema and shift with position changes. They may also be found in atelectasis, particularly following treatment. Fine inspiratory and expiratory crackles, which do not change with position or treatment, are found in pulmonary fibrosis. Medium to coarse crackles are those found with secretions—the most coarse crackles or upper airway sounds indicating secretions in the largest airways.

Wheezes are continuous musical sounds that may be monophonic or polyphonic. They should be described in terms of timing and pitch. Current theory states that wheezes are produced by vibration or by airway walls, and a partial obstruction by a similar mechanism to that which produces notes in a reed instrument. Wheezes may also be created by a number of situations including bronchospasm, pulmonary edema, secretions, or incomplete airway occlusion.

Coarse, monophonic wheezes indicate secretions in a large airway and usually clear with coughing. A coarse monophonic wheeze that does not clear may be due to a tumor or another obstruction. Scattered, polyphonic wheezes on expiration usually indicate bronchospasm. Scattered monophonic wheezes may also be found in pulmonary edema. It is important to note that absence of wheezing in an asthmatic attack may indicate severe bronchospasm such that almost no air is flowing. Another adventitious sound is a pleural rub—a creaking, squeaky sound caused by the movement of the two layers of pleurae on each other when they are roughened by inflammation or developing adhesions.

If obvious abnormalities are noted, or previous assessment findings indicate potential problem areas, a more detailed auscultation can be carried out over each lung segment, and differences with position change can be noted. Voice sounds can also be assessed during auscultation if it is necessary to clarify the diagnosis further. Speech is normally transmitted as a low-pitched mumble. Alterations in density increase or decrease the transmission of voice sounds. Voice sounds decrease with pleural effusion or pneumothorax, except at the upper limit of an effusion, where the phenomenon of egophony is heard. Here the higher-pitch vowels are transmitted more clearly, but with a change in character to a nasal bleating sound where "a" sounds like "ee." Voice sounds increase (bronchophony) over consolidation or large areas of atelectasis. Whispering pectoriloquy, where usually nontransmitted whispered sounds are audible, also occurs with the same pathologies.

OTHER DATA

After obtaining all of the information from the history and physical examination, the therapist has other available sources of data. These sources include; arterial or capillary blood gas tests, pulmonary function tests, and chest x-ray examinations. Interpreted reports of pulmonary function tests and x-ray examinations are available, although if they are unavailable the therapist should be able to interpret them on a basic level. These interpretations are beyond the scope of our discussion and resources are available to assist with this. The analysis of blood gas tests is discussed in a separate chapter.

The final stage of the assessment should be a review of all of the information obtained, from which a working diagnosis and a problem list is developed and then used to determine treatment techniques and frequency. Assessment should continue during each treatment and at each subsequent visit. This should eventually lead to the decision to discharge the patient from treatment either because the problem has been resolved, the patient is able to manage alone, or a problem has been identified in which physical therapy has no role.

SUGGESTED READING

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BLOOD GAS ANALYSIS

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In clinical practice, arterial or capillary blood gas results are often available, but are also often misused or ignored. These values can provide important information in guiding treatment decisions and perhaps most importantly in helping to define those patients for whom physical therapy intervention is not indicated and for whom consequences could be serious.

Analysis of blood gas results should not focus solely on oxygen levels and is really an assessment of the acid-base balance of the body. In order to understand what these values mean, it is necessary to review some basic chemistry and physiology.

CHEMISTRY

Beginning with some definitions, recall that an acid is any substance that can release hydrogen ions (H^+), whereas an alkali or base is any substance that can accept hydrogen ions. The acidity or alkalinity of a solution is determined by its H^+ concentration. Hydrogen ion concentration is very small (0.000001 mol per liter) and so is expressed as pH, the negative logarithm of the actual concentration.

Also, recall that any gas exerts a pressure, whether it is free in the atmosphere, confined in a container (e.g., the lungs), or dissolved in a liquid (e.g., plasma). When two or more gases are mixed together, each gas exerts a pressure as if it were the only gas present. This is known as its partial pressure and is usually measured in millimeters of mercury (mm Hg). Oxygen and carbon dioxide concentrations in the blood are expressed as their partial pressures (P_{O_2} and P_{CO_2}).

The values of pH, P_{O_2}, and P_{CO_2} are normally measured by a blood gas analyzer from a sample of arterial or "arterialized" capillary blood. Other values that make up a complete set of blood gases include the bicarbonate (HCO_3^-) level, which is usually a calculated value and is expressed in milliequivalents per liter, and sometimes base excess (BE) or base deficit. This is a standardized measure of deviation from normal standard HCO_3^-, i.e., the HCO_3^- concentration measured in equilibrium with a gas with a P_{CO_2} of 40 mm Hg at 37° C, which is expressed as a positive or negative numerical value.

PHYSIOLOGY

Acid-Base

Normal acid-base balance in the body maintains a pH of between 7.35 and 7.45, which is the extracellular pH at which cells can function. This level is attained by balancing the generation of hydrogen ions with their elimination or buffering. Hydrogen ions are released by acids produced by tissue breakdown and normal metabolism. Hydrogen ions are also yielded from carbonic acid that results from the chemical reaction of metabolically produced CO_2 with water ($H_2O + CO_2 \leftrightharpoons H_2CO_3 \leftrightharpoons H^+ + HCO_3^-$). Bicarbonate ions are also produced in this reaction.

Elimination of volatile CO_2 from the lungs is the primary mechanism for maintaining normal pH. Changes in ventilation alter the amount of CO_2 that is eliminated. The renal system also plays an important part in acid-base balance through selective excretion or retention of H^+ and HCO_3^-. Various buffers that remove hydrogen ions from solution are found throughout the body. Phosphate and ammonia levels in the urine are controlled by the kidneys. Hemoglobin and other proteins also act as buffers.

Whenever an imbalance in acid-base status occurs, the pH shifts from normal, and the body is in a state of acidosis ($pH \leq 7.35$) or alkalosis ($pH \geq 7.45$). This can be caused by metabolic or respiratory disturbances. Normal arterial blood gas values are shown in Table 1. Elevations in HCO_3^- lead to an increase in pH, whereas elevations in P_{CO_2} lead to a decrease in pH. Disturbances come from a variety of sources: some metabolic causes are listed in Table 2; respiratory causes are listed in Table 3. Respiratory disturbances are ultimately a result of either alveolar hypoventilation with retention of CO_2 or alveolar hyperventilation with increased elimination of CO_2. Compensation for a particular disturbance occurs in the other systems involved in acid-base balance. In respiratory abnormality, compensation occurs via changes in renal and other buffering systems, and takes 24 to 48 hours. In metabolic disturbance, compensation occurs in minutes to hours via the respiratory system, and then gradually by other buffer systems. Compensation brings pH back to within normal limits, and is reflected in changes in HCO_3^- and P_{CO_2}.

Oxygenation

Arterial oxygenation is determined by numerous factors including ventilation, perfusion, and diffu-