

Acute Respiratory Failure in Chronic Obstructive Pulmonary Disease

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Classification of Severity of Respiratory Disease

| SEVERITY OF THE DISEASE | PERTINENT FINDINGS |
|---------------------------|--|
| Respiratory Impairment | Asymptomatic or mild symptoms. Objective evidence of airway obstruction: increased R_a , normal or mildly reduced FVC, $FEV_{1.0}$ and MBC to 70% of predicted. Pao_2 normal or reduced to 65–80 mm Hg. $Paco_2$ normal or decreased. Arterial pH normal, or mild respiratory alkalosis. |
| Respiratory Insufficiency | Moderate symptoms, physical limitation and exertional dyspnea. Spirometric data: FVC, $FEV_{1.0}$ and MBC to 50% of predicted. Pao_2 50–65 mm Hg. $Paco_2$ 40–50 mm Hg, intensified with exercise. Arterial pH 7.32–7.40. |
| Respiratory Failure | Advanced symptoms, dyspnea at rest. Spirometric findings: FVC, $FEV_{1.0}$ and MBC < 50% predicted. Pao_2 < 50 mm Hg, $Paco_2$ > 50 mm Hg, and pH < 7.32. May be acute or chronic. |

See opposite page for normal values and other definitions.

Disorders Leading to Respiratory Failure

- I. *Generalized or global alveolar hypoventilation*
 - A. Respiratory center destruction or depression: cerebral trauma or ischemia, morphine, barbiturates, anesthesia, high flow uncontrolled oxygen, metabolic alkalosis, idiopathic.
 - B. Neuromuscular abnormalities: poliomyelitis, myasthenia gravis, Guillain-Barré syndrome, multiple sclerosis, muscular dystrophy, botulinus or tetanus toxins, drugs (curare, polymyxin, neomycin, etc.) or acute porphyria.
 - C. Skeletal or thoracic defects: spinal arthritis, kyphoscoliosis, thoracic surgery, rib fractures.
- II. *Restrictive disorders with decreased distensibility of lung or reduced tissue mass with impaired gas exchange and diffusion*
 - A. Parenchymal: pulmonary fibrosis, granulomatosis, pneumoconiosis, edema, infiltrating tumor, atelectasis, pneumonia, pneumonectomy.
 - B. Extraparenchymal: pleural effusion, pneumothorax, fibrothorax, obesity, abnormal surgery, ascites.
- III. *Pulmonary vascular diseases*: thromboembolism, vasculitis, vasoconstriction due to hypoxemia or acidosis, parenchymal destruction (emphysema).
- IV. *Obstructive airways disease*
 - A. Upper airway disease: tumor, laryngeal obstruction.
 - B. Lower airway disease: acute and chronic bronchitis, pulmonary emphysema, bronchial asthma, bronchiectasis, bronchiolitis, cystic fibrosis.

Precipitating Factors

1. Infection: viral, bacterial, fungal, tuberculous—infections producing bronchial, bronchiolar or parenchymal disease
2. Allergic: extrinsic or intrinsic with bronchospasm, bronchial edema
3. Irritative or chemical: dust, fumes, smoke, air pollutants, cough, aspiration, respiratory burn
4. Drugs: oxygen, anesthesia, narcotics, sedatives, tranquilizers, atropine-like agents, Dornavac, Mucomyst, certain antibiotics (Polymyxin, Neomycin, Kanamycin)
5. Cardiovascular: pulmonary emboli, pulmonary vascular thrombosis, cardiac failure, arrhythmias
6. Mechanical: abdominal distention, obesity, pneumothorax, pleural effusions, empyema, chest trauma, atelectasis, ascites, postoperative pain
7. Secretions: (mucoïd or purulent), increased adhesiveness, viscosity, volume, dehydration and inspissation
8. Neuromuscular
9. Contributory factors: a. Hypermetabolic states (viz., fever); b. Shock; c. Bacteremia; d. Metabolic acidosis

Selected Pulmonary Function Tests and Normal Values

| TEST | SYMBOL | NORMAL VALUE (ADULTS) |
|---|----------------------|---|
| <i>LUNG VOLUMES (BTPS)</i> | | |
| Slow vital capacity | SVC | 4.8 L.* |
| Residual volume | RV | 1.2 L.* |
| Total lung capacity | TLC | 6.0 L.* |
| Residual volume/total lung capacity | RV/TLC | <30% |
| <i>VENTILATORY PERFORMANCE AND AIRFLOW PARAMETERS</i> | | |
| Forced vital capacity | FVC | 4.8 L.* |
| Forced expiratory volume in 1 second | | |
| as % predicted | FEV _{1.0} | >80%* |
| as % observed FVC | FEV _{1.0} % | >75-80% |
| Forced expiratory volume in 3 seconds | | |
| as % observed FVC | FEV _{3.0} % | >95% |
| Maximum breathing capacity (maximum voluntary ventilation) | MBC (MVV) | >150 L./min.* |
| Maximal expiratory flow rate | MEFR | >300 L./min.* |
| Peak expiratory flow rate | PEFR | >350 L./min. |
| <i>ALVEOLAR GAS</i> | | |
| Alveolar oxygen tension | PAO ₂ | 95-105 mm. Hg |
| Alveolar carbon dioxide tension | PACO ₂ | 38-42 mm. Hg |
| Alveolar-arterial oxygen gradient | A-a O ₂ | 5-15 |
| <i>GAS DISTRIBUTION</i> | | |
| Single breath N ₂ test | SBN ₂ | <2.5% N ₂ (between 750-1,250 ml. expired) |
| <i>ARTERIAL BLOOD</i> | | |
| Arterial oxygen tension | PaO ₂ | 85-95 mm. Hg |
| Arterial carbon dioxide tension | Paco ₂ | 38-42 mm. Hg |
| Oxygen saturation, rest | SaO ₂ | 95-98% |
| Arterial pH | pH _a | 7.38-7.42 |
| Hydrogen ion concentration (activity) | (H ⁺) | 40.0 ± 2.0 nM./L. |
| Bicarbonate concentration | (HCO ₃) | 22-27 mM./L. |
| Oxygen content | CaO ₂ | 19.5 vols. % |
| Oxygen capacity | Cap | 20.0 vols. % |
| <i>VENTILATION/VENTILATION-PERFUSION†/GAS EXCHANGE</i> | | |
| Alveolar ventilation | VA | 4.0-7.5 L./min. |
| Physiologic dead space | VD | 100-200 ml. |
| Minute ventilation | VE | 6.0-10.0 L./min. |
| Tidal volume | V _t | 0.5-0.8 L./breath |
| Physiologic dead space/tidal volume ratio | VD/V _t | <0.33 |
| Venous admixture/cardiac output × 100 | Qs/Qt | <2-4% |
| CO ₂ evolution | VCO ₂ | 200-240 ml./min. |
| O ₂ consumption | VO ₂ | 250-300 ml./min. |
| Respiratory quotient VCO ₂ /VO ₂ | R.Q. | 0.8 |
| Diffusion capacity of lung (STPD) | | |
| for carbon monoxide | DLco (steady state) | 15-20 ml./min./mm. Hg |
| for oxygen | DLO ₂ | >15 ml./min./mm. Hg |
| <i>MECHANICS OF BREATHING</i> | | |
| Compliance of lungs | CL | 0.2 L./cm. H ₂ O |
| Total (lungs + thorax) | CT | 0.1 L./cm. H ₂ O |
| Airway resistance | R _a | 1.5-2.5 cm. H ₂ O/L./sec. (Lung volume specified) |
| Work of breathing (rest) | | 0.5 kg. M./min. |

*Illustrative value only for a normal young male at rest. Observed normal values should be at least 80% of predicted.

†Approximate values for a normal male at rest.