

Index

- abbreviated injury score 74
 abdominal aortic cross-clamp 220
 abdominal aortic surgery 245
 acclimatization 117, 119
 acetazolamide
 high-altitude complications 120
 respiratory effects 288
 acetyl-CoA 239
 acetylene tracer 209
 acid–base balance 250, 295–310
 chemical buffering 295
 normal 295
 acid–base disorders
 approach to 298–99
 compensation equations 299
 diagnosis 297
 mixed 300
 simple 299
 acids 295
 acinar airway reduction factor 349
 acute lung injury 170, 177
 acute mountain sickness 120
 acute respiratory distress syndrome
 153, 160, 318
 alveolar deadspace 177
 mechanical ventilation 169
 ventilation/perfusion mismatch 322
 adults
 normal respiratory values 5
 air
 constituents of 116
 air embolism 4, 204, 444
 air travel 116
 airway
 anesthesia 48
 difficult 34
 establishment of 48
 integrity 56
 neonates 91
 airway devices
 out-of-hospital setting 20
 airway maintenance 34
 airway management
 hospital setting 32–35
 operating room 37–41
 out-of-hospital setting 19–29
 airway obstruction
 conscious sedation 108–09
 monitoring 13
 airway–alveolar interface 340
 alanine 239
 alarm systems 378
 alcoholic ketoacidosis 302
 aliasing 410
 altitude exposure 115
 alveolar pressure changes 117
 and pressure 116
 capnometry 124
 human physiology 116
 hypocapnia 256
 lung volume 119
 altitude mountain sickness 117
 alveolar CO₂ *See* PaCO₂
 alveolar deadspace 4, 83, 170, 196,
 200, 226, 315
 acute respiratory distress syndrome
 177
 causes of 177
 increased 196
 gas embolism 205
 pulmonary embolism 201
 alveolar deadspace fraction 200
 alveolar ejection volume *See* VA_e
 alveolar gas equation 122, 226
 alveolar hyperventilation 117
 alveolar hypoventilation 15
 alveolar minute ventilation 150, 152,
 233
 alveolar O₂ *See* PAO₂
 alveolar plateau 85, 329
 missing 92
 alveolar recruitment 161
 alveolar ventilation 165
 monitoring 12
 neonates 83
 relationship to PaCO₂ 39
 American Heart Association 20, 64,
 192
 American Society for Testing and
 Materials (ASTM) 373
 American Society of
 Anesthesiologists 43, 64
 American Society of Anesthesiology
 Closed Claims Study 37
 American Society of Gastrointestinal
 Endoscopy
 Clinical Outcomes Research
 Initiative (CORI) 105
 amino acids 240
 anatomic deadspace 83, 196
 anesthesia 43
 airway establishment 48
 and CO₂ production 242
 atalectasis 166
 breathing circuit 45
 capnography 320
 equipment 44
 cardiovascular surgery 50
 general 103
 intraoperative events
 cardiopulmonary bypass 246
 laparoscopy 244
 temperature 246
 tourniquet release 245
 vascular cross-clamping 245
 laparoscopy 49
 morbidity 104
 neurosurgical 49
 one-lung ventilation 49
 position-related problems 48
 ventilation during 43
 anion gap *See* metabolic acidosis
 antacids
 false-positive CO₂ estimates
 39
 anthropogenic effect 262
 antisialagogues 41
 anxiety 103, 108
 anxiolytics 43
 aortic body 117, 360
 aortic pulse pressure 66
 aortic surgery 51
 APACHE 63
 apnea 16, 26, 34, 58
 central sleep 256
 conscious sedation 108–09
 apnea test for brain death 290
 ARDS *See* acute respiratory distress
 syndrome
 arterial blood gases 297
 analysis 12
 arterial carbon dioxide partial
 pressure *See* PaCO₂
 arterial CO₂ tension *See* PaCO₂
 arterial gas embolism 122–23
 arterial–alveolar gradient 56
 arterial-to-alveolar PCO₂ gap 235

Index

- asthma 5, 48, 196, 330, 332
arterial–alveolar gradient
56
biofeedback 131
rationale 131
results 131
CO₂ monitoring 58
hypocapnia 127
waveforms 465
- atelectasis 145
anesthesia-induced 166
- atmospheric gases 261
atmospheric monitoring 261–69
closed ecosystems 265
mines 263
saturation diving 265
SEALAB experiments 265
- atmospheric pressure 115
changes in 68
- ATP 239
- Australian Incident Monitoring Study
(AIMS) 39
- Avogadro's law 289
- Badische Anilin und Soda Fabrik
(BASF) 418
- bag-valve mask 19
- Bartter syndrome 306
- bases 295
- Beckman metabolic measurement
cart 424
- Beer–Lambert law *See* Lambert–Beer
law
- bicarbonate 240
during cardiopulmonary
resuscitation 187
regulation 296
- bicarbonate buffers 295
- bicarbonate infusion 288
- bicarbonate–carbonic acid equation
295
- bi-level ventilation 141
- biofeedback 127–33
asthma 127, 131
epilepsy 128
hyperventilation syndrome 128
panic disorder 127, 129
principles and perspectives 132
- Bios-3 265
- Biosphere 2 266
- birds, capnography 276
- Black, Andrew 459
- blackdamp 263
- Bland–Altman plot 212, 215
- blood transfusion
decision hemodynamics 219
- Bohr equation 59, 65, 83, 198
- Bohr, Christian 417, 421
- Bohr–Enghoff equation 84, 165
- Bouguer, Pierre 416
- Boyle, Robert 415
- Boyle's Law of Pressure and Volume
121
- brain
CO₂ effects 252
- brain death
apnea testing 290
- brain injury, traumatic 66, 72
- breath detection 392
- breath sounds
auscultation 22
patients in transit 63
- breathing circuit 45
integrity 56
during transit 64
- breathing, control of 360–68
dynamic end-tidal forcing 363
frequency response of respiratory
controller 363
hypercapnic ventilatory response 362
physiology 360
pseudorandom binary forcing 364
response to transient CO₂
inhalation 362
- British Standards Institute (BSI) 373
- bronchiolitis 58
- bronchodilators 174
- bronchopleural fistula 34
- bronchospasm 26, 330
- Buteyko breathing technique 128
- calcium metabolism 246
- calibration 380
- calorimetry
direct 241
indirect 241
- capacitance equation 215
- capnogram
analysis of 432
church-steeple appearance 47
origins of 432
- capnography 1, 27, 226, 329–37
advances in 148
alpha angle 13
applications 432
beta angle 13, 319
cardiopulmonary resuscitation
185–92
clinical uses 12
conscious sedation 105
definition 23
endotracheal tube placement 64
history 455
monitoring
air embolism 444
circulation 437
medical errors 442
metabolism 432
technical defects 441
ventilation 433
- neonate
devices 80
emergency medicine and
transport 85
intensive care 86
mainstream and sidestream
measures 81
operating room 84
response time 90
safety 86
sampling rate 91
small airways 91
technical limitations 89
- out-of-hospital setting 24–27
- patients in transit 63–68
- pulmonary embolism 195–205
- sleep disorders 96–100
- time-based *See* time-based
capnography
veterinary medicine 272–79
- volume-based *See* volume-based
capnography
waveforms
biphasic 40
use of 76
- capnography head-up tilt test
(CHUTT) 16
- capnometry 27
at altitude 124
colorimetric 75
conscious sedation
modified nasal cannula 106
definition 23
endotracheal tube placement 64
quantitative 75
semiquantitative 75
sleep disorders 97
- capnometry-assisted respiratory
training *See* biofeedback
- carbohydrate metabolism 239
- carbon dioxide 239–47, 415
absorbers 151
balance 151, 240
elimination 151
embolism 663, 922
exhaled 11, 226
increased partial pressures 288
apnea testing for brain death
290
bicarbonate infusion 288
inhalation test 362
measurement 381–93, 417
algorithms 392
chemical 417
colorimetric detectors 385
early clinical applications 420
infrared absorption 382
mainstream/sidestream
capnography 388
mass spectroscopy 386

- photoacoustic spectroscopy 385
physical 418
- metabolic changes affecting 54
cardiovascular function 54
respiratory function 55
- monitoring 226
and ambient pressure 124
asthma 58
neonates 58
non-invasive 149
spontaneously breathing patients 58
tissue levels 235
- pathophysiology 283–86
physical properties 381
production 60, 239–40
anesthesia 242
biochemistry/physiology 239
calorimetry 241
intraoperative events 244
- reduced partial pressures
carbonic anhydrase disorders 286
mitochondrial disorders 283
- regulation 295
respiratory stimulation 118
- stores 240
- tissue/organ effects 250–56
central nervous system and brain 252
central sleep apnea 256
circulatory system and heart 254
oxygen delivery 252
respiratory system 253
splanchnic perfusion 252
vascular effects 255
- transport 162, 225
volume 407, 417
- carbon monoxide 263
- carbonated beverages
false-positive CO₂ estimates 39, 64
- carbonic acid 295, 416
- carbonic anhydrase disorders 286
acquired 288
inherited 287
- cardiac arrest 54, 438
out-of-hospital 185, 191
patients in transit 66
PETCO₂ 185–92
and prognosis 188
- cardiac arrhythmias 119
- cardiac compression 444
- cardiac output 65, 208–23, 331
animal models 347–53
capnodynamic monitoring 215
complete rebreathing CO₂ Fick Qc
method 208
determination of 336
partial rebreathing CO₂ Fick Qc
method 210
findings 211
- patients in transit 66
thermal dilution 210
- cardiogenic oscillations 3, 7, 437, 465
- cardiopulmonary bypass 51, 246
weaning from 146
- cardiopulmonary resuscitation 33,
185–92, 465
bicarbonate and epinephrine 187
coronary and cerebral perfusion 187
- cardiopulmonary system
high-altitude changes 119
- cardiovascular function
and CO₂ 54
- cardiovascular surgery
anesthesia 50
- carnitine palmitoyltransferase II
deficiency 283
- carotid body 117
carotid pulse 186
- cassava, cyanide in 285
- cats, capnography 273
- cattle, capnography 274
- Centers for Disease Control (CDC) 262
- central atmosphere monitor 269
- central nervous system
CO₂ effects 252
high-altitude changes 120
- central sleep apnea 256
- central venous pressure 208
- cerebral edema
high altitude 120
- cerebral perfusion pressure 187
- Charles, Jacques Alexander César 415
- Charles' Law of Temperature 121
- chemical buffering 295
- chemoreceptors 360
- chemoresponsiveness
measurement of 363
spontaneous variations in
ventilation 366
ventilatory stability 366
- chest wall disorders 99
- children
conscious sedation 105
sedation 15
seizures
respiratory monitoring 16
- chokedamp 263
- chokes 123
- chronic fatigue syndrome
occult hyperventilation 15
- chronic obstructive pulmonary disease
48, 196, 201, 319, 330, 356
- circulation, monitoring of 437
- citric acid cycle 240
- Clapeyron, Émile 415
- climate
extremes of 116
- clonidine
and response to anesthesia 243
- closed ecosystems 265
Bios-3 265
Biosphere 2 266
International Space Station 267
Space Shuttle 266
submarines/submersibles 268
- Cobra Perilaryngeal Air 19
- colorimetric capnometers 11, 32
- colorimetric capnometry 75
- colorimetric CO₂ detector 16, 385
semi-quantitative 24
- Comité Européen pour Normalisation
(CEN) 373
- compensation equations 299–300
- complete rebreathing 208
- compliance, pulmonary 11
- computed tomography 162
- congestive heart failure 222
- conscious sedation 103
airway obstruction 108–09
apnea 108–09
capnography 102–11
acceptance by providers 110
acceptance by regulatory agencies 110
vs. observation 110
- children 105
definition of 103
guidelines 102
history 104
hypercarbia 110
hypoventilation 108
hypoxemia 109
pulse oximetry 107
sampling devices 107
ventilatory compromise 108–09
ventilatory depression 105
- constant current anemometer 403
- constant temperature anemometer 403
- continuity equations 215
- continuous “waveform” capnography 25
- convection 162, 340
- coronary artery bypass graft 212, 245
- coronary perfusion pressure 187
- Cumming, Gordon 458
- curare cleft 3, 55, 464
- Cushing syndrome 306
- cyanide 284
biochemistry 284
poisoning 285
sources of 285
- cytochrome *c* 285
- Dalton's Law of Partial Pressure 121
- Davenport diagram 299
- Davy Safety Lamp 264
- D-dimer test 200

Index

- deadspace 89, 195, 421
 alveolar *See* alveolar deadspace
 anatomic *See* anatomic deadspace
 dynamic apparatus 137
 evaluation of 335
 Fletcher's calculation 92
 physiological *See* physiological
 deadspace ventilation 6, 56,
 314
 decompression sickness 122
 deep sedation 103
 dexamethasone
 high-altitude complications 120
 diabetic ketoacidosis 58, 250, 296
 diaphragmatic hernia 87
 difficult airway 34
 diffusion 162, 340
 diving 122
 saturation 265
 dogs, capnography 273
 dolphins, capnography 279
 double-lumen tube ventilation 40
 Douglas bag 80, 421
 Duchenne muscular dystrophy 284
 dynamic end-tidal forcing 363
 dysoxia 231, 235
 dyspnea 127
- echocardiography
 transesophageal 186, 205
 electrical impedance tomography 162
 electroencephalography 96
 electromagnetic interference 379
 electromagnetic radiation 379
 electromyography 96
 emphysema 330, 356
 endobronchial mainstem intubation
 33
 endobronchial tube
 confirmation of placement 39
 endoscopy 16
 endotoxin-induced lung injury 253
 endotracheal intubation 19
 blind placement 40
 confirmation of 32, 37–38
 out-of-hospital setting 20–21
 patients in transit 63
 positioning
 false-negative CO₂ assessment 33
 false-positive CO₂ assessment 33
 monitoring of 56
 endotracheal tube
 kinking of 56
 leaks 65
 occlusion of 56, 65
 placement 148
 Endotrol® tube 38
 end-tidal CO₂ *See* PETCO₂
 energy expenditure 242
 energy production 240
- enteral feeding tubes
 placement 16
 enteric tubes
 avoidance of airway intubation 34
 epidural anesthesia 243
 epilepsy 433
 hypocapnia 128
 epinephrine
 and cardiopulmonary resuscitation
 187
 and gas exchange 244
 equal area method 340
 erythropoietin
 high-altitude changes 119
 esophageal CO₂ detection 38
 esophageal detector device 22, 27
 esophageal gastric airway 19–20
 esophageal intubation 64
 unrecognized 21–22, 37
 auscultation of breath sounds 22
 chest rise and fall 22
 direct visualization 21
 pulse oximetry 22
 esophageal obturator airway 19
 esophageal–tracheal combitube 19
 ethylene glycol poisoning 303
 etomidate 49
 Euler–Lagrange equation 355
 exercise 241
 expiration
 incomplete 93
 expiratory positive airway pressure
 (EPAP) limit 139
 expiratory time-constant 164
 expiratory valve incompetence 46
 extubation 155
 unplanned 64
 neonates 86
- face masks 137, 139
 selection of 138
 use of 138
 fiberoptic bronchoscope 34
 fibrecapnic intubation 41
 Fick principle 208
 Fick's law of diffusion 162
 firedamp 263
 Food and Drug Administration (FDA)
 44, 373
 functional residual capacity 48,
 330–31
- gas analyzer
 improper calibration 2
 gas diffusive resistance 353–57
 gas embolism 204
 gas exchange 11, 163
 anesthesia effects 243
 gas flow 397–404
 calibration 410
- clinical issues 397
 differential pressure flow sensors
 400
 fixed orifice type 402
 Fleisch type 400
 hot-wire flow sensors 402
 Silverman and Whittenberg/Lilly
 modification 401
 turbulent flowmeters 402
 variable orifice type 401
 distal
 and proximal gas measurement 410
 factors affecting readings 398
 gas conditions 398
 humidity 399
 inlet conditions 399
 operating range of flow sensor 400
 resistance 400
 sensor location 398
 temperature 399
 mainstream 410
 measurement site conditions 408
 measurement technologies 400
 proximal
 and gas measurement 409–10
 signal processing 410
 ultrasonic sensors 404
 volume 397
 gas laws 121, 415
 Boyle's Law of Pressure and Volume
 121
 Charles' Law of Temperature 121
 Dalton's Law of Partial Pressure
 121
 General Gas Law 121
 Henry's Law of Solubility 121
 Gay-Lussac, Joseph Louis 415
 general anesthesia 103
 General Gas Law 121
 Gitelman syndrome 306
 glucose oxidation 239
 glutamine, catabolism 241
 glycerol 239
 glycogen 239
 greenhouse gases 261
 Guericke, Otto von 415
- Haldane, John Scott 417
 halothane 49
 Hamberger effect 295
 harp seals, capnography 279
 head injury 66
 heart
 CO₂ effects 254
 heliox 265
 hemodynamic preconditioning 161
 Henderson–Hasselbalch equation 296,
 385
 Henry's Law of Solubility 121, 265
 Herschel, William 416

- high altitude 116
 acute mountain sickness 120
 cardiopulmonary changes 119
 early hypoxia response 117
 hematologic changes 119
 hypoxic respiratory stimulation 117
 lung volume increase 118
 neurologic changes 120
- high-frequency oscillation 173
 high-frequency ventilation 173
 jet 52, 173
 percussive 174
 positive pressure 173
- high-pressure environments 115–25
 history 424–26
 clinical capnography 430–55
 volume-based capnography 457–60
- Hooke, Robert 415
 horses, capnography 274
 hospital setting
 airway management 32–35
 hot-wire anemometers 400, 403
 constant current 403
 constant temperature 403
- Hutchinson, John 420
 hydrogen sulfide 263
 hyperaldosteronism 306
 hyperbaric chambers 123, 125
 hyperbaric exposure 120
 pulmonary effects 122
- hypercapnia 11, 250–51, 296
 and brain injury 252
 and cardiac performance 255
 and lung injury 253
 endotoxin-induced 253
 cerebral blood flow 253
 ischemia–reperfusion injury 254
 myocardial effects 254
 nocturnal 58
- hypercapnic acidosis 253
 hypercarbia 99
 conscious sedation 110
- hyperkalemia 306
 hyperpyrexia *See* hyperthermia
 hyperthermia 246
 malignant 8, 246, 459
- hyperventilation 7, 66, 118, 229, 241
 alveolar 117
 avoidance of 72
 PETCO₂ role in 73
 hypercapnic 252
 occult 15
 waveforms 463
- hyperventilation syndrome 128, 309
 hypocapnia 11, 66, 74, 127, 250, 296, 308
 altitude exposure 256
 and brain injury 252
 and lung injury 253
 asthma 127
 epilepsy 128
 myocardial effects 254
 panic disorder 127
- hypocapnic alkalosis 252–53
 hypokalemic acidosis 305
 hypoplastic left heart syndrome 58
 hypotension 54, 437
 dangers of 446
 vasodilation-induced 216
- hypothermia 246
 hypoventilation 45, 66, 99, 226, 241, 296
 alveolar 15
 and sedation 66
 conscious sedation 108
 nocturnal 100
 waveforms 462
- hypovolemia 54, 65, 217, 251
 hypoxemia 16, 74
 conscious sedation 109
 in children 15
- hypoxic pulmonary vasoconstriction
 reflex 162
- ice core analysis 262
 inferior vena cava compression
 445
- infrared absorption spectroscopy
See infrared detectors 384
 double-beam-in-space 384
 double-beam-in-time 384
 Luft design 384
 non-dispersive 384
 Veingerov design 384
- infrared radiation 382
 absorption 382
 chopper 385
 pressure broadening 383
 sources 384
- infrared spectrography 80
 inspiration
 decreased CO₂ at start of 85
 inspiratory baseline 85
 inspiratory valve incompetence 46
 intensive care
 neonates 86
- International Electrotechnical
 Commission (IEC) 373
 International Liaison Committee on
 Resuscitation 192
 International Organization for
 Standardization (ISO) 124, 373
 International Space Station 267
 intracranial pressure, raised 250
- ischemia 231, 235
 ischemia–reperfusion injury 250, 254
- isopropanol
 as contaminant 377
- Jonson, Björn 457
- Kearns–Sayre disease 283
 ketoacidosis 302
 alcoholic 302
 diabetic 193
- Konzo 285
 Krebs cycle 285
 Krogh, August 417
 Krogh, Marie 417
 Kussmaul respirations 301
 Kyoto Protocol 262
 kyphoscoliosis 40
- lactate 231, 239
 lactic acidosis 302
 lactulose 241
 Lambert, Johann Heinrich 416
 Lambert–Beer law 384, 416
 laparoscopy 244
 anesthesia 49
 laryngeal mask airway 19
 laryngeal tube airway 19
 late deadspace fraction
 pulmonary embolism 201
- Lavoisier, Antoine-Laurent de 415
 leaks
 minimization of 142–43
- Leber optic neuropathy 283
 Lesch–Nyhan syndrome 288
 Levenberg–Marquardt algorithm
 341
- licorice intake, metabolic alkalosis
 306
- lipogenesis 240
 lipolysis 243
 Liston, Max 423
 Liston-Becker Company 423
 loop gain 367
- low-pressure environments 115–25
 lower body negative pressure 235
 Luer connectors 378
 Luft, Karl Friedrich 418
- lung
 gas transport in 166
 lung CO₂ capacitance
 compensation for 216
 lung collapse 160
 lung function testing
 neonates 87
 lung growth 92
 lung injury
 endotoxin-induced 253
 hypercapnia 253
 hypocapnia 253
 unilateral 172
- Lung Injury Score 171
 lung perfusion 163
 lung recruitment 340–45
 and CO₂ kinetics 162
 monitoring of 162
 lung resection 323

Index

- lung transplantation 323
lung volumes 12
- magnesium deficiency 306
hypokalemic alkalosis 305
- mainstream capnography 1, 11, 47,
388–89
analyzers 390
neonates 81, 91
non-invasive positive pressure
ventilation 138, 463
sleep disorders 97
- Mainz Emergency Evaluation Scoring
System 192
- malignant hyperthermia 8, 52, 246, 459
- mass balance equation 351
- mass spectroscopy 386
magnetic sector-fixed detector
387
quadrupole mass filter 387
technical challenges 388
- measurement accuracy 374
measurement drift 376
- mechanical ventilation 169–78
acute respiratory distress syndrome
169
capnography in treatment
evaluation 174
disconnection 45
extubation 155
high-frequency/percussive 173
leaks 46
lung collapse 160
minimization of 148–56
monitoring during 54–61
optimization 148–56
patient transport 56
phases of 149
tracheal gas insufflation 172
unilateral lung injury 172
waveforms 464
weaning from 57, 60, 154
failure of 153
importance of 153
neonates 87
- medical errors 442
cardiac compression 444
nearly fatal pain stimulus 442
- metabolic acidosis 299, 301
anion gap 301
causes 303
chloride-resistant 305
chloride-sensitive
drug-induced 305
high anion gap 302
decreased renal function 304
ketoacidosis 302
lactic acidosis 302
non-anion gap (hyperchloremic)
304
- acid infusion 304
drug-induced 304
gastrointestinal 304
renal disease 304
signs and symptoms 301
- metabolic alkalosis 299, 304
alkali administration 305
causes 303
chloride-sensitive 305
gastrointestinal disorders 305
diagnosis 305
metabolic demand 241
- metabolism 239
capnographic monitoring 432
- methane 263–64
- methanol poisoning 303
- mice, capnography 275
- microcapnometry 276
- microstream capnography 15, 81, 106
- midazolam
premedication 243
- mill-wheel murmur 444
- mines 263
- mining accidents 263
- minute ventilation 4–5, 52, 60
alveolar 150, 152
loss of 65
- minute volume
anesthesia 242
- mitochondrial disorders 283
acquired 284
inherited 283
- monoethanolamine scrubbers 269
- morbidity
anesthesia-related 104
- multiple inert gas elimination
technique 229, 315–16
- muscle relaxants 464
effects of 435
onset time 216
- NADH 231
- narcotics 43
- nasal cannula 106
- nasal pressure monitoring 96
- National Association of Emergency
Medical Services Physicians 64
- National Institute of Occupational
Safety and Health (NIOSH) 263
- neonates
alveolar ventilation 83
incomplete expiration 93
lung function testing 87
monitoring 80–93
normal respiratory values 5
PaCO₂ 83
PETCO₂ 83
sleep laboratory 88
therapeutic CO₂ administration
58
- weaning from mechanical
ventilation 87
- neuroleptic malignant syndrome 246
- neuromuscular blockade 43, 244
- neuromuscular disease 58, 99
- neurosurgical anesthesia 49
- NICO monitor 212–13, 216
- nifedipine
high-altitude pulmonary edema
120
- nitric oxide 116, 253
- nitrogen dioxide 263
- nitrogen narcosis 122
- nitrogen washout 12
- nitrous oxide 7
- nitrous oxide tracer 209
- non-invasive positive pressure
ventilation 135–43
acute respiratory failure 136
patient interfaces 137
patient selection 137
PETCO₂ monitoring 139
rebreathing 142
short-term vs. long-term use 142
sidestream vs. mainstream sampling
138
time-based capnography 135
volume-based capnography 135
- Nordström, Lars 457
- NPPV *See* non-invasive positive
pressure ventilation
- nutrient metabolism 239
- obesity hypoventilation syndrome
99
- Observer's Assessment of Alertness/
Sedation scale (OAA/S) 15
- obstructive lung disease 320
- obstructive sleep apnea 58, 98, 135
- Occupational Safety and Health
Administration (OSHA) 262
- one-lung ventilation 49, 323
- operating room
airway management 37–41
neonatal monitoring 84
- osmolar gap 303
- out-of-hospital setting
airway devices 19–20
airway management 19–29
endotracheal intubation 20–21
- overventilation 66
- oxidation 239
- oxidative phosphorylation 239
- oxygen 239
oxygen consumption 231, 239
biochemistry/physiology 239
oxygen delivery 231
tissues 252
- oxygen saturation 14
- oxygen toxicity 122

- PACO₂ 11, 38, 72, 118, 136, 225–29, 250
 at altitude 118
 changes during transport 65
 measurement challenges 138
 neonates 83
 pulmonary embolism 198
 relationship to alveolar ventilation 39
 sleep disorders 96
 ventilatory adequacy 145
 PaCO₂–PETCO₂ gradient 318
 panic disorder 127
 biofeedback 129
 methodology 129
 results 130
 PAO₂ 115
 Parkinson–Cowan dry gas meter 421
 partial rebreathing method 210
 findings 211
 PCO₂
 mixed venous 347–53
 peak expiratory flow rate 332
 PECO₂ determination 392
 PEEP 56, 65, 75, 169, 211
 management 153
 titration 340–45
 percussive ventilation 173
 perfluorocarbons, ventilation with 175
 performance measures 374
 PerforMax™ face mask 137
 perfusion
 in relation to ventilation 315
 PETCO₂ 5, 11, 23, 27, 32, 136, 169, 225–29, 232, 318, 329
 and cardiac arrest 185–92
 as predictor of PaCO₂ 14, 58
 avoidance of hyperventilation 73
 clinical applications 54
 critically ill patients 146
 dilution effects 139
 field uses
 guidance of ventilation 76
 troubleshooting 77
 high 52
 low 52
 monitoring with ventilators 77
 neonates 83
 normal 52
 NPPV monitoring 139
 optimization of 216
 out-of-hospital monitoring 22, 72
 justification for 72
 panic disorder 127
 pulmonary embolism 198
 ventilatory weaning
 postoperative 145–46
 Pfund, August Herman 418
 pH
 changes during transport 65
 Phasitron® 174
 Philips V60 non-invasive ventilator 135
 phosphodiesterase inhibitors
 high-altitude complications 120
 photoacoustic spectroscopy 385
 physiological deadspace 65, 155, 169
 anesthetized patients 170
 pulmonary embolism 198
 Pieler lamp 264
 Planck's constant 381
 pneumonia 34
 pneumoperitoneum 244
 pneumotachometry 96, 150
 pneumothorax 34
 PO₂
 at altitude 118
 pocket mask 19
 polycythemia 119
 polysomnography 96, 100
 positive end-expiratory pressure
 See PEEP
 positive pressure ventilation 74
 prehospital situation 15
 capnography as guide to ventilation 72–77
 pressure
 and altitude 116
 and depth 121
 pressure broadening 383
 pulmonary artery wedge pressure 208
 pulmonary blood flow 208–23
 abdominal aortic cross-clamp 220
 assessment shortcuts 214
 congestive heart failure 222
 hypotension due to vasodilation 216
 hypovolemia 217
 muscle relaxant onset time 216
 radical prostatectomy 217–18
 thready pulse 216
 pulmonary capillary blood flow *See* Qc
 pulmonary edema 145
 high altitude 120
 pulmonary embolism 7, 176, 195–205
 alterations associated with 197
 detection
 alveolar deadspace 201
 late deadspace fraction 201
 limitations of capnography 202
 physiological deadspace 198
 time-based capnography 198
 thrombolytic therapy 203
 ventilation/perfusion mismatch 324
 pulmonary fibrosis 323
 pulmonary hypertension 54
 pulse
 thready 216
 pulse oximetry 14–15, 44
 conscious sedation 107
 unrecognized esophageal intubation 22
 pulseless electrical activity 66
 PvCO₂ 209
 Collier equilibrium method 209
 Defares exponential method 209
 pyruvate 239
 Qc 208
 calibration equation 215
 complete rebreathing method 208
 partial rebreathing method 210
 QT *See* cardiac output

 radical prostatectomy 217–18
 Raman scattering 419, 424
 RAmAn SCattering AnaLyzer (RASCAL) monitor 424
 rapid respiration
 damping 2
 Rayleigh scattering 419
 reactive airway disease 13
 rebreathing 142, 393
 waveforms 463
 receiver operating characteristics (ROC) curve 191
 red blood cell transfusion
 rapid 212
 repressurization 123
 reptiles, capnography 277
 respiration
 central neurologic disturbances 448
 respiratory acidosis 251, 299, 306, 309
 causes 306–07
 airway factors 308
 central factors 306
 neuromuscular factors 308
 parenchymal factors 308
 diagnosis 306
 respiratory alkalosis 7, 251, 299, 308–09
 causes 309
 inciting factors 308
 CNS stimulation 309
 drugs and hormones 309
 hyperventilation syndrome 309
 hypoxemia/tissue hypoxia 309
 stimulation of chest receptors 310
 signs and symptoms 308
 respiratory assessment
 outside operating room 11–17
 respiratory deadspace *See* deadspace
 respiratory gas monitors
 calibration 380
 definition of 374
 interfering gas/vapor effects 377
 ISO 21647 standard 373
 performance measures 374
 accuracy 374
 drift 376

Index

- respiratory gas monitors (*cont.*)
 range 375
 response time 376
 types of 374
 respiratory quotient 232
 respiratory rate 5, 52
 respiratory system resistance 332
 response time 376
 resuscitation 438
 Rhan sampler 80
 Röntgen, Wilhelm 418
 rotating vane spirometers 400
 rotational energy transitions 383
- salicylate overdose 303
 San Diego Paramedic Rapid Sequence Intubation (RSI) Trial 72
 saturation diving 265
 SEALAB 265
 sedation
 conscious 102–11
 definitions of 103
 patients in transit 66
 procedural 102
 sedatives 43
 seizures
 respiratory monitoring 16
 shivering 246
 shock 231–36
 capnometric monitoring 231
 tissue CO₂ monitoring and perfusion 235
 tissue-specific monitoring 234
 shunt perfusion 56
 sidebands 383
 sidestream capnography 1–2, 47, 388–89
 analyzers 390
 neonates 81, 89
 non-invasive positive pressure ventilation 138
 sleep disorders 97
 sidestream gas sampling 410
 S_{III} 166
 single-breath capnography 12
 single-path model 353
 sleep
 non-rapid eye movement (NREM) 98
 rapid eye movement (REM) 98
 ventilation during 97
 sleep disorders 13
 capnography 96–100
 obesity hypoventilation syndrome 99
 obstructive sleep apnea 58, 98, 135
 snoring 98
 sleep laboratory 98
 neonates 88
 snoring 98
 sodium bicarbonate 241
 sodium nitroprusside 285
 Space Shuttle 266
 spirometry 11
 splanchnic perfusion 252
 spontaneous breathing trial 155
 spontaneous circulation, return of 186, 188
 spontaneous ventilation
 disconnection 46
 leaks 46
 standard temperature and pressure dry (STPD) conditions 407
 standards development organizations 373
 stinkdamp 263
 Stow–Severinghaus PaCO₂ electrode 386
 strong ion theory 297
 subarachnoid block 43
 submarines/submersibles 268
 succinylcholine 244
 sudden cardiac death 185
 sulfur dioxide 263
 sulfuric acid 295
 syncope
 occult hyperventilation 15
 systemic vascular resistance 208
- Tau*-CO₂ 164
 technical defects 441
 technical specifications 373–80
 alarm systems 378
 calibration 380
 Luer connectors 378
 performance measures 374
 units 378
 technical standards 373, 379
 temporal mismatching 331
 tension pneumothorax 76
 thermistors 96
 thermogenesis, diet-induced 242
 thermoneutrality 241
 thiopental 49
 Thomson, William 416
 thrombolytic therapy 203
 Thumper® device 186
 tidal volume 5, 52
 at endotracheal tube 150
 delivery 150
 size of 141
 small 139
 time-based capnography 1–4, 11, 148, 329
 artifacts 2
 cardiovascular status 149
 history 423
 interpretation 4–6
 cardiovascular issues 4
 pulmonary issues 4
 neonates 82
- non-invasive positive pressure ventilation 135
 pathologic 330
 altered inspiratory phase 332
 phase I 330
 phases II and III 330–31
 patterns of 461–65
 pulmonary embolism 198
 uses 12–16
 airway obstruction monitoring 13
 alveolar ventilation monitoring 12
 deadspace ventilation monitoring 13
 endoscopy 16
 enteral feeding tube placement 16
 evaluation of non-intubated patients 14
 occult hyperventilation 15
 pediatric sedation 15
 pediatric seizure monitoring 16
 prehospital 15
 sleep disorders 13
 ventilated patients 149
 Tissot spirometer 421
 tissue buffering 250
 tissue hypoxia 309
 tissue oxygen delivery 252
 tissue oxygenation/perfusion 251
 Tobin index 146
 tourniquet release 51, 245
 tracheal gas insufflation 172
 transesophageal echocardiography 186, 205
 transport of patients
 capnography during 63–68
 complications 67
 mechanical ventilation 56
 monitoring of respiration
 circuit integrity 64
 neonates 85
 procedural sedation 66
 sources of measurement error 67
 transpulmonary pressure 160
 trauma
 ventilation/perfusion mismatch 324
 triglycerides 239
 Tyndall effect 419
 Tyndall, John 416, 418
- units 378
 unrecognized misplaced intubation
 See esophageal intubation, unrecognized
 upper airways resistance syndrome 98
 uric acid 295
- VA_e/VT 336
 van der Waals, Johannes 416
 Van Helmont, Jan Baptista 415
 Van Slyke apparatus 418

Cambridge University Press

978-0-521-51478-1 - Capnography, Second Edition

Edited by J. S. Gravenstein, Michael B. Jaffe, Nikolaus Gravenstein and David A. Paulus

Index

[More information](#)

Index

- vascular cross-clamping 245
- VCO₂
 age variation 243
 anesthesia effects 242
- VD shunt 165
- ventilation 165
 adequacy of 145
 consistency of 65
 deadspace 314
 in relation to perfusion 313
 PETCO₂-guided 72, 76
 prehospital
 capnography as guide to 72–77
 step changes 227
 weaning from
 postoperative 145–46
- ventilation/perfusion matching 136
- ventilation/perfusion mismatch 11, 55, 232, 313–25
 acute respiratory distress syndrome 322
 capnography 317
 clinical correlation 319
 low cardiac output state 324
 obstructive lung disease 320
 one-lung ventilation, lung resection and lung transplantation 323
 pulmonary embolism 324
 pulmonary fibrosis 323
 trauma 324
- ventilation/perfusion ratio 11, 40, 160, 169, 226, 330
 acute increase 227
 global increase. *See* hyperventilation
- regional increase 227
 decreased pulmonary blood flow 228
- ventilator-associated lung injury 253
- ventilator disconnection 64
- ventilator-induced lung injury 154
- ventilatory failure 123
- ventilatory maldistribution 166
- ventilatory requirements, prediction of 60
- veterinary capnography 272–79
 acid–base values 275
 birds 276
 blood gases 275
 dogs and cats 273
 dolphins 279
 harp seals 279
 horses and cattle 274
 limitations of 272
 lung volumes 276
 reptiles 277
 respiratory parameters 274
 small laboratory animals 275
 species differences 273
- volume-based capnography 6–7, 11, 38, 148, 151, 333
 analysis 340–45
 clinical implications 344
 Fowler's method 340
 cardiac output estimation 336, 347
 clinical uses 59
 deadspace evaluation 335
 history of 423, 457–60
 lung recruitment 340–45
- neonates 82
- non-invasive positive pressure ventilation 135
- PEEP titration 340–45
- phase II deformation 334
- phase III deformation 334
- variables 342–43
 S_{III} 344
- veterinary medicine 272
- volutrauma 150
- wasted ventilation 195
- water trap 89
 artifacts 2–3
- waveforms
 normal 462
 real time and trend 462
 asthma 465
 cardiogenic oscillations 465
 cardiopulmonary resuscitation 465
 faulty ventilatory circuit valve 464
 hyperventilation 463
 hypoventilation 462
 mechanical ventilation 464
 muscle relaxants 464
 non-diagnostic 463
 rebreathing 463
 sudden loss of expiratory CO₂ 464
- Wheatstone bridge 403
- Zuntz, Nathan 420