

# Index

- 1:1:1 transfusion strategy, 248, 249
- abdominal edema  
and ventilatory support, 97
- abdominal surgery  
adverse effects of fluid overload,  
157–8  
basic fluid and electrolyte needs,  
156  
effects of different fluids, 156  
evaporative loss, 157  
fluid loss during laparoscopic  
surgery, 157  
fluid loss to the third space, 157–8  
fluid therapy during preoperative  
fasting, 156–7  
functional loss of extracellular fluid,  
157–8  
goal-directed fluid therapy (GDT),  
158  
insensible perspiration losses, 156  
normal fluid and electrolyte losses,  
156  
perioperative fluid therapy  
goals of, 155–6  
in major surgery, 157–8  
in outpatient surgery, 158–63  
perspiration loss from the open  
abdomen, 157  
postoperative edema formation,  
156  
postoperative fluid therapy, 163  
restricted fluid therapy, 157  
sensible perspiration losses, 156  
urinary losses, 156  
use of epidurals, 158  
zero-balance fluid therapy, 157
- absorption of irrigating fluid  
clinical presentation, 254–5  
electrocautery procedures, 253–4  
glycine, 255  
incidence, 254–5  
irrigating solutions, 255–6  
isotonic saline, 256  
mannitol, 255  
measuring fluid absorption, 256–8  
mechanisms, 254  
operating procedures with this risk,  
253–4
- pathophysiology of TUR syndrome,  
256  
prevention of TUR syndrome, 258–9  
sorbitol, 255  
sterile water, 255–6  
transurethral resection (TUR)  
syndrome, 253–4  
treatment of, 259–60
- acid–base assessment methods, 52–3  
clinical relevance of balanced  
solutions, 56–7  
decision to use balanced solutions,  
57  
effects of colloid solutions, 54  
impact of fluids on, 53–6  
relevance of fluid bicarbonate  
content, 56  
relevance of fluid pH, 56  
role of crystalloid [SID], 53–4  
Stewart approach, 52–3  
treatment of metabolic alkalosis,  
56
- acquired von Willebrand syndrome,  
60–1
- acute cardiogenic shock, 207
- acute normovolemic hemodilution  
(ANH), 127  
and hemostasis, 130–1  
and the cardiac patient, 130  
effects of anesthesia, 128  
efficacy, 131  
increase in cardiac output, 127–8  
increase in tissue oxygen extraction,  
128  
limits of hemodilution, 128–31  
physiological compensation  
mechanisms, 127–8  
results from the literature, 131  
role in surgical procedures, 131  
theoretical aspects, 131
- acute respiratory distress syndrome  
(ARDS), 27
- adrenaline, 220
- adverse effects of infusion fluids,  
262  
colloid fluids (general), 265  
colloid fluids (specific), 265–6  
crystalloid fluids (general), 263–4  
crystalloid fluids (specific), 264–5
- hemostatic effects, 263  
osmolality effects, 262–3  
peripheral edema, 266–7  
temperature effects, 262–3
- Aesculon system, 115
- albumin, 11  
as plasma volume expander, 70  
clinical use, 11–12  
debate over use, 12  
pharmacokinetics, 11
- anemia  
in critically ill patients, 219
- anemia tolerance, 34  
critical DO<sub>2</sub> (DO<sub>2crit</sub>) concept, 34–6  
limits, 34–6  
therapeutic increase, 36–7
- anesthesia induction  
check for preoperative fluid deficit,  
2  
fluid therapy, 1
- anthropometry, 44
- anti-platelet effects of colloid fluids,  
61
- arterial pressure waveform analysis  
use in GDT, 113–14
- arterial waveform analysis, 103–7  
calibrated devices, 103–4  
dynamic markers of preload status,  
106  
heart–lung interactions, 106–7  
limitations, 107  
predicting fluid responsiveness,  
105–7  
static markers of preload status,  
105–6  
transient increase of cardiac  
preload, 107  
uncalibrated devices, 104–5
- Assessment of Blood Consumption  
(ABC), 250
- atrial natriuretic peptide (ANP), 12,  
166, 167, 225
- balanced solutions, 170  
clinical relevance of, 56–7  
decision to use, 57
- betametasone, 151
- Bezold–Jarisch reflex, 225
- bioimpedance (BIA), 44

- BioZ system, 115
- bleeding control guidelines, 60–2
- blood hemoglobin  
before and after infusion, 45
- blood loss  
accounting for in volume measurement, 45–6  
coagulation management, 37–8  
dilutional anemia tolerance, 34  
intraoperative replacement, 1  
limits of anemia tolerance, 34–6  
management of intraoperative blood loss, 34  
risks associated with transfusion, 33–4  
therapeutic increase of anemia tolerance, 36–7  
*See also* trauma; uncontrolled hemorrhage
- blood transfusion. *See* transfusion; trauma
- blood–brain barrier (BBB), 69
- body fluid spaces (compartments), 41
- body fluid volume measurement, 41  
accounting for blood loss, 45–6  
anthropometry, 44  
bioimpedance (BIA), 44  
blood hemoglobin, 45  
central blood volume, 44  
double-tracer technique, 43  
fluid efficiency, 44–5  
indocyanine green (ICG), 42–3  
sodium method, 44  
tracers, 41–3
- bradykinin, 239
- brain  
blood–brain barrier (BBB), 69  
microvascular fluid exchange, 69  
traumatic brain injury, 204  
volume regulation, 69
- British Consensus Guidelines on Intravenous Fluid Therapy for Adult Surgical Patients (GIFTASUP), 136, 138
- bromide tracer, 41
- burns  
administration of colloids, 239  
burns that need very large fluid volumes, 241  
determining fluid requirements, 236–7  
developments in modern burn care, 237  
early tangential excision of the burn wound, 242  
electrical injuries, 241  
endpoints for fluid treatment, 240–1  
fluid balance pathophysiology, 237–40  
fluid loss over time, 239  
fluid treatment practical guidelines, 240–1  
future prospects for fluid treatment, 242  
impact on body fluid balance, 236–7  
in children, 242  
incidence of burn injuries, 237  
inhalation injuries, 241  
mediators of fluid losses, 239–40  
negative imbibition pressure, 237–8  
Parkland crystalloid resuscitation strategy, 240–1  
permeability effects, 238–9  
serum albumin level, 239  
situations requiring modified Parkland strategy, 241–2  
timing of fluid resuscitation, 239  
treatment outcome, 237  
very extensive burns, 241, 242
- capillaries  
microvascular fluid exchange, 67
- capillary membrane, 3
- carbon monoxide tracer, 42
- cardiac output (CO) monitoring  
approach to use in the perioperative period, 107  
assessing a CO monitor, 101  
evidence for perioperative benefits, 100–1  
pulmonary artery catheter (PAC), 101–3  
role in hemodynamic optimization, 100–1  
role of echocardiography, 101  
using indices in clinical practice, 107
- cardiac surgery  
choice of colloid or crystalloid fluid, 167  
controversial RCTs comparing colloids vs. crystalloids, 170–2  
effects of fluid therapy on the glycocalyx layer, 167  
effects of fluid volume overload, 166  
effects of perioperative fluid therapy, 166  
glycocalyx shedding, 166–7  
implications of the glycocalyx model, 167  
implications of the revised Starling equation, 167  
intravascular colloid osmotic pressure (COP), 167  
no-reabsorption rule with colloid resuscitation, 167  
physiologically balanced and unbalanced fluids, 170
- resuscitation fluids  
colloids, 167–9  
crystalloids, 169–70  
dextrans, 169  
gelatins, 169  
human albumin solutions (HAS), 167  
hydroxyethyl starches (HES), 169  
hypertonic saline, 169–70  
normal saline, 169  
semi-synthetic colloids, 169  
review of outcome studies, 172–3  
vascular endothelial alterations, 166–7
- cardiac tamponade, 208
- cardiogenic shock, 207
- cell membrane  
regulation of solute distribution, 3–4
- central blood volume (CBV)  
measurement, 44  
*See also* hypovolemic shock
- chromium radioactive tracer, 42
- circulatory shock  
pathophysiology, 207–8  
resuscitative management, 206–7
- ClearSight system, 115
- clotting  
effects of fluid therapy, 61
- coagulation and fluids  
anti-platelet effects, 61  
clinical relevance of colloid-induced coagulopathy, 63–4  
decrease in fibrinogen levels, 61–2  
different effects of crystalloids and colloids, 60  
dilutional coagulopathy, 60–3  
effects of HES on blood coagulation, 60–2  
effects of hyperchloremic metabolic acidosis, 61  
effects on acceleration of clotting, 61  
effects on factor VIII and von Willebrand factor, 60–1  
effects on fibrinolysis, 61  
FIBTEM decrease, 62  
first signs of coagulopathy, 62  
impaired fibrin polymerization, 61–2  
perioperative acquired coagulopathy, 59  
reversal of colloid-induced coagulopathy, 63  
severe coagulopathy, 62  
targeted bleeding control strategies, 60–2  
coagulation management, 37–8  
coagulopathic bleeding, 59

## Index

- colloid fluids, 10–11  
 adverse effects, 265–7  
 and metabolic acidosis, 61  
 anticoagulant side effects, 60  
 anti-platelet effects, 61  
 clinical relevance of colloid-induced coagulopathy, 63–4  
 comparison with crystalloid fluids, 15–16  
 decrease in fibrinogen levels, 61–2  
 dilutional coagulopathy, 60–3  
 first signs of, 62  
 effects as plasma volume expanders, 70–1  
 effects on fibrinolysis, 61  
 FIBTEM decrease, 62  
 impaired fibrin polymerization, 61–2  
 influence on acid–base status, 54  
 miscellaneous effects, 15  
 net result of antithrombotic effects, 62–3  
 reversal of colloid-induced coagulopathy, 63  
 severe coagulopathy, 62  
 therapeutic window, 16–17  
 volume equivalent of crystalloid fluids, 17–18  
*See also* specific fluids
- colloid osmotic pressure (COP), 10, 167
- complement cascade system, 239
- complement factor C3, 239
- complement factor H (CFH), 77
- complement system  
 influence of the glycocalyx layer, 77
- Co-ordination group for Mutual Recognition and Decentralized Procedures – Human (CMDh)  
 statement on the use of HES, 60–2
- critical  $DO_2$  ( $DO_{2crit}$ ) concept, 34–6
- crystalloid fluids  
 adverse effects, 263–5, 266–7  
 anticoagulant side effects, 60  
 comparison with colloid fluids, 15–16  
 definition of, 3  
 distribution of, 3–4  
 distribution of solutes, 3–4  
 effects as plasma volume expanders, 69–70  
 effects on ECF volume, 3–4  
 effects on ICF volume, 3–4  
 hyperchloremic acidosis, 70  
 influence on acid–base status, 53–4  
 osmolality, 3  
 tissue edema caused by, 69–70  
 tonicity, 3  
 types of, 3
- uses in the perioperative period, 4  
 volume equivalent of colloid fluids, 17–18  
 volume kinetics, 142  
*See also* specific fluids
- cytokines, 239
- damage control resuscitation (DCR)  
 approach, 248
- day surgery  
 adjunct medications with impact on fluid balance, 151–2  
 anesthesia and analgesia protocols, 148–9  
 anesthesia and fluid therapy, 150  
 assessment and preparation, 148–9  
 features of, 152  
 increasing number of elderly patients, 149  
 increasing proportion of, 148  
 outcome studies, 149, 152  
 pain management, 148–9, 151–2  
 perioperative cardiovascular events in the elderly, 149  
 perioperative fluid therapy, 150  
 postoperative adverse events, 152  
 postoperative fatigue, 152  
 postoperative fluids, 150–1  
 postoperative nausea and vomiting (PONV), 152  
 postoperative urinary retention, 152  
 preoperative carbohydrate loading, 150  
 preoperative correction of nutritional deficits, 149–50  
 preoperative fasting routines, 149  
 preoperative nutritive fluid intake, 150  
 recovery from, 152  
 use of steroid medications, 151–2
- desmopressin, 38
- deuterium, 42
- dexamethasone, 151
- dextrans, 14–15  
 as plasma volume expander, 70  
 clinical use, 15
- diabetes insipidus (DI)  
 complication of pituitary surgery, 203–4
- diarrhea  
 preoperative fluid therapy, 2
- dilutional anemia tolerance, 34
- dilutional coagulopathy, 37, 60–3  
 and metabolic acidosis, 61  
 anti-platelet effects, 61  
 decrease in fibrinogen levels, 61–2  
 different effects of crystalloids and colloids, 60  
 effect on acceleration of clotting, 61
- effects on factor VIII and von Willebrand factor, 60–1  
 effects on fibrinolysis, 61  
 first signs of, 62  
 impaired fibrin polymerization, 61–2  
 net result of antithrombotic effects, 62–3
- distributive shock, 208
- dobutamine, 220
- dopamine, 220
- early, aggressive goal-directed therapy (EGDT), 216–17
- echocardiography, 220  
 role in hemodynamic monitoring, 101
- edema  
 abdominal, 97  
 caused by crystalloid fluids, 69–70  
 formation in surgical patients, 156  
 related to fluid therapy, 83–4  
*See also* pulmonary edema
- eicosanoids, 239
- elderly patients  
 day surgery, 149  
*See also* geriatric surgery
- electrocautery procedures  
 absorption of irrigating fluid, 253–4
- electrolytes, 23
- Enhanced Recovery After Surgery (ERAS) programs  
 aims, 138–9  
 choice of fluid, 137–8  
 guidelines, 134  
 incorporation of GDT, 115–16, 135–6  
 intraoperative fluid management, 135–6  
 optimizing perioperative fluid management, 134  
 postoperative fluid management, 137  
 preoperative fluid management, 135
- enteric lavage  
 preoperative fluid therapy, 2
- epidurals, 158
- esophageal Doppler monitor (EDM), 112–13
- ethanol  
 as a tracer, 42  
 tonicity, 3
- European Medicines Agency (EMA)  
 statement on the use of HES, 60
- European Society of Anesthesiology (ESA)  
 guidelines for control of severe bleeding, 60

- European Surgical Outcomes Study (EuSOS), 110
- European Trauma guidelines, 60
- Evans blue dye, 42
- EXTEM test, 61
- extracellular fluid (ECF)  
 functional loss of, 157–8
- extracellular fluid (ECF) space  
 distribution of crystalloid fluids, 3
- extracellular fluid (ECF) volume  
 effects of crystalloid fluids, 3–4
- factor VIII  
 effects of hydroxyethyl starch (HES), 60–1
- fasting. *See* perioperative fasting; preoperative fasting
- fast-track surgery, 185
- fatigue  
 postoperative, 149, 152
- fibrin polymerization  
 effects of colloid fluids, 61–2
- fibrinogen levels  
 effects of colloid fluids, 61–2
- fibrinolysis  
 effects of colloid fluids, 61
- FIBTEM decrease, 62
- FIBTEM test, 61
- fluid therapy  
 back at the surgical ward, 2
- enteric lavage, 2
- fluid efficiency, 44–5
- fluid requirement, 1
- general guidelines, 2
- hypertonic dehydration, 2
- hypotonic dehydration, 2
- ileus, 2
- induction of anesthesia, 1
- intraoperative blood loss  
 replacement, 1
- intraoperative fluid, 1
- maintenance therapy, 1
- patient blood management (PBM), 33–4
- patient with inability to drink, 2
- patient with vomiting or diarrhea, 2
- postoperative care unit, 1
- preoperative fasting regime, 1
- preoperative fluid deficit, 2
- Frank–Starling fluid challenge, 112
- Frank–Starling relationship, 122
- functional hemodynamic monitoring  
 and clinical outcomes, 124
- future developments, 124–5
- functional hemodynamic parameters, 121, 122–3
- pleth variability index (PVI), 123–4
- using the pulse oximeter to optimize fluid status, 123
- functional microcirculatory  
 hemodynamics (FMH), 87
- gelatin, 14  
 as plasma volume expander, 70, 71
- concerns over virus disease risk, 14
- Gelofusine, 14
- geriatric surgery  
 controversial issues in fluid management, 185
- intraoperative fluid management, 185–6
- issues in elderly surgical patient care, 185
- postoperative fluid management, 186
- preoperative fluid management, 185  
*See also* elderly patients
- glucose intolerance  
 postoperative, 149
- glucose solutions  
 avoiding hyperglycemia, 21
- clinical use, 21–2
- dosing, 22–3
- electrolytes, 23
- hyponatremia, 23
- mannitol, 24
- pharmacokinetics, 20–1
- purpose of infusion, 20
- rebound hypoglycemia, 23–4
- volume kinetics, 49
- glycine  
 absorption of irrigating fluid, 255
- glycocalyx layer  
 alterations during cardiac surgery, 166–7
- and inflammation, 76–8
- as a storage system, 76
- effects of disease, 80
- effects of fluid therapy, 167
- effects of sepsis, 80
- effects of surgery, 80
- how to assess in patients, 78–9
- influence on the complement system, 77
- influence on vascular permeability, 75–6
- location and description, 73–5
- mechanotransduction function, 76
- shedding of, 77–8
- structure, 73–5
- glycocalyx model  
 implications for cardiac surgery, 167
- goal-directed fluid therapy (GDT)  
 abdominal surgery, 158
- Aesculon system, 115
- aims, 110
- arterial pressure waveform analysis, 113–14
- BioZ system, 115
- choice of fluid, 116
- ClearSight system, 115
- esophageal Doppler monitor (EDM), 112–13
- implementation challenges, 116
- incorporation into ERAS programs, 115–16, 135–6
- individualized volume optimization, 111–12
- monitor technologies, 112–15
- NICOM system, 115
- non-obstetric spinal anesthesia, 142
- pleth variability index (PVI), 115
- potential benefits for high-risk surgical patients, 116
- goal-directed therapy (GDT)  
 early approach, 111
- early, aggressive goal-directed therapy (EGDT), 216–17
- for high-risk surgical patients, 110
- optimization of DO<sub>2</sub> or CO, 101
- purpose of, 110
- studies of perioperative outcomes, 100–1
- studies of supranormal oxygen delivery, 111
- use in intensive care, 210–11
- Haemaccel, 14
- Hartmann's solution, 5
- hemodilution. *See* acute normovolemic hemodilution (ANH)
- hemodynamic monitoring. *See* functional hemodynamic monitoring; invasive hemodynamic monitoring; non-invasive hemodynamic monitoring
- hemorrhage. *See* blood loss; trauma; uncontrolled hemorrhage
- hemorrhagic shock  
 use of hypertonic fluids, 27–8
- hemostatic strategies for severe bleeding, 60–2
- hetastarch, 12
- histamine, 238, 239
- human plasma, 15
- hydroxyethyl starch (HES)  
 anticoagulant side effects, 60
- anti-platelet effects, 61
- as plasma volume expander, 70
- clinical relevance of colloid-induced coagulopathy, 63–4
- clinical use, 13
- contraindications in coagulopathy, 62
- debate over use, 13–14
- effects on acceleration of clotting, 61

## Index

- hydroxyethyl starch (HES) (*cont.*)  
 effects on blood coagulation, 60–2  
 effects on factor VIII, 60–1  
 effects on fibrinolysis, 61  
 effects on von Willebrand factor, 60–1  
 first signs of dilutional coagulopathy, 62  
 hypercoagulability induced by, 61  
 impaired fibrin polymerization, 61–2  
 medico-legal considerations, 60–2  
 net result of antithrombotic effects, 62–3  
 pharmacokinetics, 13  
 preparations, 12–13  
 reversal of colloid-induced coagulopathy, 63  
 hyperchloremia, 194  
 hyperchloremic acidosis, 70  
 hyperchloremic dilutional acidosis, 85–6  
 hyperchloremic metabolic acidosis, 61, 191–3  
 hyperdynamic shock, 220  
 hyperlactatemia, 193  
 hypertonic dehydration, 2  
 hypertonic fluids, 26  
 clinical trials experience, 27–30  
 intraoperative and postoperative studies, 29–30  
 management of hemorrhagic shock, 27–8  
 mechanism of action, 26–7  
 use in traumatic brain injury, 28–9  
 hypertonic saline  
 volume kinetics, 49  
 hypoalbuminemia, 12  
 hypoglycemia  
 rebound hypoglycemia, 23–4  
 hyponatremia  
 related to glucose infusions, 23  
 hypotonic dehydration, 2  
 hypovolemic shock, 207–8  
 Bezold–Jarisch reflex, 225  
 bradycardic response to hypovolemia, 224  
 cardiovascular response to reduced CBV, 223  
 ceased sympathetic activity, 224–5  
 central vascular pressures during, 225–7  
 choice of volume treatment, 227  
 clinical outcome, 228  
 defining normovolemia, 225–6  
 pale skin, 224–5  
 pre-shock stage, 223  
 reduced central blood volume (CBV), 222–3  
 stage II, 223–5  
 stage III, 225  
 surgical patients, 226  
 tachycardia in stage III, 225  
 tilt table experiments, 226  
 titration to establish normovolemia, 226–7
- ileus  
 preoperative fluid deficit, 2  
 indocyanine green (ICG), 41, 42–3  
 inflammation  
 and the glycocalyx layer, 76–8  
 inotropic agents, 220  
 insensible fluid loss, 206  
 insensible perspiration losses, 156  
 INTEM test, 61  
 intensive care  
 choice of resuscitation fluids, 208–10  
 colloid fluids, 208–10  
 crystalloid fluids, 208–10  
 goal-directed therapy (GDT), 210–11  
 insensible fluid loss, 206  
 pathophysiology of cardiovascular insufficiency, 207–8  
 pathophysiology of circulatory shock, 207–8  
 resuscitative management of circulatory shock, 206–7  
 role of fluid infusions, 206  
 interstitial fluid, 41  
 interstitial fluid volume, 3  
 intracellular fluid (ICF), 41  
 intracellular fluid (ICF) space  
 effects of tonicity of infusion fluid, 3  
 intracellular fluid (ICF) volume  
 effects of crystalloid fluids, 3–4  
 intraoperative blood loss replacement, 1  
 intraoperative fluid, 1  
 intrathoracic blood volume measurement, 44  
 invasive hemodynamic monitoring  
 arterial waveform analysis, 103–7  
 evidence for patient care benefits, 100–1  
 pulmonary artery catheter (PAC), 101–3  
 use of cardiac output (CO) monitoring, 100–1  
 iohexol tracer, 41  
 irrigating fluid. *See* absorption of irrigating fluid  
 iso-osmotic infusion fluid, 3  
 isotonic infusion fluid, 3–4  
 isotonic saline, 4–5  
 absorption of irrigating fluid, 256  
 Jehovah's Witness patients, 36, 128  
 ketorolac, 152  
 laparoscopic surgery  
 fluid loss, 157  
 LiDCOrapid system™, 105  
 LiDCO™ system, 104  
 liver transplantation, 188  
 approach to fluid prescription and intervention, 198  
 biochemical derangements, 189  
 coagulopathy management, 189–91  
 effects of massive blood transfusion, 189  
 factors influencing volume and type of fluid intervention, 189–91  
 fluid intervention at each surgical stage, 188–9  
 goal of optimum fluid intervention, 188–9  
 hemodynamic changes, 189  
 hyperchloremia, 194  
 hyperlactatemia, 193  
 inorganic anions, 193–4  
 metabolic acidosis, 191–3  
 physicochemical considerations for fluid choice, 191  
 plasma osmolality, 194  
 potential for massive bleeding, 189  
 renal dysfunction, 191  
 reperfusion syndrome, 189  
 use of colloids, 194–6  
 use of crystalloids, 196  
 lymphatic system  
 role in microvascular fluid exchange, 67, 69  
 maintenance therapy, 1  
 mannitol, 24  
 absorption of irrigating fluid, 255  
 mass balance equation, 44  
 maximum clot firmness (MCF) test, 61  
 medications  
 adjuncts which affect fluid balance, 151–2  
 medico-legal considerations  
 use of hydroxyethyl starch (HES), 60–2  
 metabolic acidosis, 61, 191–3  
 metabolic alkalosis, 56  
 microcirculation monitoring  
 aim of fluid therapy, 82–3  
 choice between balanced and unbalanced solutions, 86  
 choice of solution for fluid therapy, 85–6  
 comparison with systemic hemodynamic measures, 82–3



- components of the microcirculation, 84
- debate on perioperative fluid management, 82
- detrimental effects of fluid therapy, 83–4
- effects of amount of fluid administered, 86–7
- functional microcirculatory hemodynamics (FMH), 87
- hyperchloremic dilutional acidosis, 85–6
- methods, 84–5
- microcirculatory fluid responsiveness, 87–8
- promoting tissue oxygen perfusion, 82–3
- requirement for, 84
- tissue edema related to fluid therapy, 83–4
- to guide fluid resuscitation, 87
- microvascular fluid exchange
- advantages and disadvantages of plasma volume expanders, 69–71
  - blood–brain barrier (BBB), 69
  - effects of colloid plasma volume expanders, 70–1
  - effects of crystalloid plasma volume expanders, 69–70
  - in the brain, 69
  - normal circulation, 67
  - outside the brain, 67–9
  - reducing the need for colloids, 71
  - regulatory mechanisms, 67
  - role of the lymphatic system, 67, 69
- Starling fluid equation, 67–8
- transcapillary escape rate (TER), 67
- two-pore theory, 68–9
- MostCare system<sup>TM</sup>
- pressure recording analytical method (PRAM), 105
- Multion Gastrique<sup>®</sup>, 56
- neuropeptides, 239
- neurosurgery
- approach to fluid management, 204–5
  - diabetes insipidus (DI)
    - complication, 203–4
  - fluid administration challenges, 202
  - general principles of fluid therapy, 202–3
  - pituitary surgery, 203–4
  - SIADH complication, 203–4
  - spine surgery, 204
  - subarachnoid hemorrhage (SAH), 203
  - supratentorial tumor surgery, 203
  - traumatic brain injury, 204
- NICOM system, 115
- nitric oxide (NO), 238, 239
- no-reabsorption rule
- colloid resuscitation in cardiac surgery, 167
- non-functional fluid spaces, 48–9
- non-invasive hemodynamic monitoring, 120–1
- functional hemodynamic parameters, 122–3
  - preload dependence, 121–2
- non-steroidal anti-inflammatory drugs (NSAIDs), 148, 151–2
- noradrenaline, 220
- obstetric spinal anesthesia, 142–3
- colloids, 143–4
  - crystalloid coload, 143
  - fluid options, 145
  - fluids and vasopressors, 144–5
  - phenylephrine, 144–5
- obstetric surgery
- debate on fluid management, 186
- obstetrics
- controversial issues in fluid management, 185
- obstructive shock, 208
- OPTIMISE trial, 101
- osmolality
- definition, 3
  - of body fluids, 3
  - of crystalloid fluids, 3
- oxygen free radicals, 238, 239, 240
- paracetamol, 148
- Parkland crystalloid resuscitation strategy, 240–1
- modifications for special situations, 241–2
- patient blood management (PBM), 33–4, 63
- patient with inability to drink
- hypertonic dehydration, 2
- pediatrics
- approach to fluid therapy, 177
  - blood pressure monitoring, 180–1
  - burns in children, 242
  - clinical recommendations for fluid therapy, 181
  - effects of anesthesia, 180–1
  - fluid replacement therapy, 179
  - maintenance infusion, 178–9
  - monitoring, 180–1
  - perioperative fasting, 178
  - physiology, 177–8
  - volume replacement therapy, 179–80
  - volume status and tissue perfusion monitoring, 180–1
- pentastarch, 12
- perioperative acquired coagulopathy, 59
- perioperative fasting
- pediatric patients, 178
- perioperative fluid management
- current controversial issues, 184–5
  - debate on, 82
  - fast-track surgery, 185
- peripheral edema, 266–7
- phenylephrine, 144–5
- PICCO<sup>TM</sup> devices, 103, 104
- pituitary surgery, 203–4
- Plasma-Lyte, 7–8
- plasma volume, 3, 41
- platelet activating factor (PAF), 239
- pleth variability index (PVI), 115, 123–4
- postoperative fluid therapy
- back at the surgical ward, 2
  - postoperative care unit, 1
  - postoperative nausea and vomiting (PONV), 137, 149, 152, 158
  - postoperative urinary retention, 152
  - preload dependence, 121–2
  - preoperative carbohydrate loading, 22, 150
- preoperative fasting, 1
- fluid therapy, 156–7
  - for day surgery, 149
- preoperative fluid deficit, 2
- preoperative fluid management, 135
- preoperative nutritional status, 149–50
- propranolol, 22
- prostaglandins, 238, 239
- proteases, 239
- pulmonary artery catheter (PAC), 101–3
- complications, 102–3
  - conflicting outcome studies, 103
  - indications for use, 101–2
  - limitations, 103
  - validation, 103
- pulmonary edema, 7
- and ventilator-induced lung injury (VILI), 95–7
  - clearance of, 95
  - clinical aspects, 92–3
  - contributory factors, 95
  - experimental studies, 94
  - high-permeability (non-cardiac) pulmonary edema (HPPE), 92
  - hydrostatic (cardiac) pulmonary edema (HPE), 92
  - increase in extravascular lung water (EVLW), 92

## Index

- pulmonary edema (*cont.*)  
 maintenance of spontaneous breathing, 93  
 theoretical aspects, 93–4  
 treatment of HPE, 92–3  
 treatment of HPPE, 93  
 types of, 92  
 unusual causes, 93
- pulmonary embolism, 208
- pulmonary surgery  
 complications related to fluid management, 186  
 controversial issues in fluid management, 185
- pulse oximeter  
 use in optimizing fluid status, 123
- Pulsioflex™ system (PICCO™ device), 104–5
- radioactive iodated albumin, 42
- radioactive tracers, 42
- radioiodated albumin, 41
- rapid thromboelastography (r-TEG), 249
- rebound hypoglycemia, 23–4
- renal injury  
 hyperchloremia, 194
- renal transplantation, 188  
 approach to fluid prescription and intervention, 198  
 use of colloids, 197  
 use of crystalloids, 196–7
- restricted fluid therapy  
 abdominal surgery, 157
- resuscitative endovascular balloon  
 occlusion of the aorta (REBOA), 249
- Ringer's solutions, 5  
 acetate, 5  
 clinical use, 6–7  
 distribution, 5–6  
 dosing, 7  
 elimination, 6  
 lactate, 5  
 pharmacokinetics, 5–6
- rotational thromboelastometry (ROTEM), 60, 248
- Saline versus Albumin Fluid Evaluation (SAFE), 204
- sensible perspiration losses, 156
- sepsis  
 definition, 215  
 effects on the glycocalyx layer, 80  
 later course of, 217–18
- septic shock (severe sepsis), 208  
 anemia, 219  
 anesthesia, 216  
 blood transfusions, 219
- characteristics of critically ill patients, 215–16
- crystalloids vs. colloids, 218–19  
 definition, 215
- early, aggressive goal-directed therapy (EGDT), 216–17
- early fluid resuscitation, 216–17
- early vs. late septic shock, 216
- fluid responsiveness, 219–20
- key messages, 220
- mortality rate, 215
- serotonin, 238, 239
- treatment with inotropic agents, 220
- treatment with vasopressors, 220
- shock. *See* hypovolemic shock;  
 intensive care; septic shock
- sodium method of volume measurement, 44
- solute in crystalloid fluids  
 distribution of, 3–4
- sorbitol  
 absorption of irrigating fluid, 255
- spinal anesthesia  
 colloids, 143–4  
 crystalloid fluid volume kinetics, 142
- crystalloid coload, 143
- fluid options, 145  
 for different types of patient, 145
- fluids and vasopressors, 144–5  
 phenylephrine, 144–5
- goal-directed fluid therapy (GDT), 142
- hypotensive response, 141–2
- non-obstetric, 142
- obstetric, 142–3
- spine surgery, 204
- starch  
 forms of, 12–13
- Starling equation, 238–9  
 implications of the revised Starling equation, 167
- Starling formula for transcapillary fluid exchange, 67–8
- sterile water  
 absorption of irrigating fluid, 255–6
- steroid medications  
 use in day surgery, 151–2
- Stewart approach to acid–base assessment, 52–3
- strong ion difference [SID], 53
- subarachnoid hemorrhage (SAH), 203
- substance P, 239
- supratentorial tumor surgery, 203
- surgery  
 effects on the glycocalyx layer, 80
- surgical bleeding, 59
- Surviving Sepsis Campaign, 210, 218–19, 220
- syndrome of inappropriate antidiuretic hormone secretion (SIADH)  
 complication of pituitary surgery, 203–4
- systemic inflammatory response syndrome (SIRS), 215, 239
- targeted bleeding control, 60–2
- technetium radioactive tracer, 42
- third space  
 concept, 49, 245  
 fluid loss to, 157–8
- thoracic epidural analgesia (TEA), 137
- thromboelastography (TEG), 60, 248
- thrombomodulin (TM), 77
- tonicity  
 definition, 3  
 of crystalloid fluids, 3
- tranexamic acid, 38
- transcapillary escape rate (TER), 67
- transcervical resection of the endometrium (TCRE)  
 absorption of irrigating fluid, 253–4
- trans-esophageal echocardiography, 101
- transfusion  
 anemia tolerance of the human body, 34  
 limits of, 34–6  
 therapeutic increase of, 36–7
- coagulation management, 37–8
- critical DO<sub>2</sub> (DO<sub>2crit</sub>) concept, 34–6
- in critically ill patients, 219
- management of intraoperative blood losses, 34
- risks associated with, 33–4
- See also* trauma
- transfusion-related acute lung injury (TRALI), 15
- transfusion-related cardiac overload (TACO), 37
- transfusion-related immunomodulation (TRIM), 33
- transplantations. *See* liver transplantation; renal transplantation
- trans-thoracic echocardiography, 101
- transurethral resection (TUR)  
 syndrome, 253–4  
 measuring fluid absorption, 256–8  
 pathophysiology, 256  
 prevention, 258–9  
 treatment, 259–60
- transurethral resection of the prostate (TURP)  
 absorption of irrigating fluid, 253–4
- trauma  
 1:1:1 transfusion strategy, 248, 249

- damage control resuscitation (DCR)  
   approach, 248  
 hemorrhage control, 249  
 history of resuscitation of massively  
   bleeding patients, 245–6  
 management of the massively  
   bleeding patient, 250  
 massive transfusion, 247–8  
 measuring coagulation, 248–9  
 prehospital transfusion, 249–50  
 triage and initial assessment, 246–7  
 trauma-induced coagulopathy (TIC),  
   247  
 traumatic brain injury, 204  
   use of hypertonic fluids, 28–9  
 tritium, 42  
 thromboxanes, 239  
  
 unbalanced solutions, 170  
 uncontrolled hemorrhage  
   anesthetist approach to, 231  
   controlled vs. uncontrolled  
   hemorrhage, 231–2  
   in the clinic, 233–4  
  
 lessons from animal studies, 233  
 management of trauma victims,  
   233–4  
 particular strategy for fluid therapy,  
   231  
 potential for fluid therapy to  
   exacerbate, 231–2  
 studies in pigs, 232  
 studies in small animals, 232–3  
 typical injuries associated with,  
   231  
 urinary losses, 156  
 urinary retention  
   postoperative, 152  
  
 vascular permeability  
   influence of the glycocalyx layer,  
   75–6  
 vasopressors, 220  
 ventilator-induced lung injury (VILI)  
   and pulmonary edema, 95–7  
 ventilatory support  
   and abdominal edema, 97  
 Vigilance™ system, 102  
  
 Vigileo/FloTrac System™, 104, 105  
 viscoelastic hemostatic assays (VHAs),  
   248  
 vitamin C oxygen free radical  
   scavenger, 240  
 volume equivalents  
   crystalloid and colloid fluids, 17–18  
 volume kinetics, 46–7  
 effects of anesthesia and surgery, 48  
   glucose solutions, 49  
   hypertonic saline, 49  
   non-functional fluid spaces, 48–9  
   volunteer studies, 47–8  
 VolumeView™ system, 103–4  
 vomiting  
   preoperative fluid therapy, 2  
 von Willebrand factor  
   effects of hydroxyethyl starch (HES),  
   60–1  
  
 water equilibrium equation, 53  
  
 zero-balance fluid therapy  
   abdominal surgery, 157