dysfunction may also be present, and management is an important aspect of critical care for these patients.

General Approach to Volume Management

Volume resuscitation can influence outcomes in septic shock and ARDS. There is conflicting evidence about whether a goal-directed approach for fluid administration is superior to standard volume loading.[202–205] There is also evidence suggesting that excessive volume resuscitation is harmful and that relative volume restriction is safe after the initial resuscitation phase.[206–208] After initial volume resuscitation, additional fluid administration should be guided by markers of end-organ perfusion, including central venous oxygen saturation, pulmonary arterial catheter, or point-of-care ultrasound.

It is currently unclear whether volume balance should be managed differently in patients after CA compared with other ICU populations because of the lack of evidence specific to the post-CA phase. Prehospital cold saline during induction of hypothermic temperature control was associated with no benefit and with increased adverse events.[209] These findings cannot be extrapolated to the inpatient setting because a majority of the patients did not have a secured airway, and shivering resulting from cold fluid was inconsistently treated. Because of the overwhelming heterogeneity in patients with CA, a single approach to volume resuscitation cannot be applied to all patients.

Balanced Crystalloid Solutions Compared With Normal Saline

There are no trials evaluating balanced solutions compared with normal saline specifically in the post-CA population. However, several trials in other critically ill cohorts are informative.[210–212] The largest RCT, the SMART trial (Isotonic Solutions and Major Adverse Renal Events Trial), demonstrated a lower rate of the composite outcome of death, renal replacement therapy (RRT), or persistent renal dysfunction in patients treated with balanced solutions compared with normal saline.[213] Numerous systematic reviews evaluated the potential benefit of balanced crystalloid solutions.[214–219] These analyses had mixed results, which may be due to the end points chosen (eg, a composite end point in the SMART trial), the trial designs permitted (ie, prospective versus observational), and the patient populations included.

A single approach to fluid selection may not apply to patients with post-CA syndrome because of the associated neurological injury. Although data exist describing the potentially harmful effects of hypotonic solutions on cerebral edema, data comparing individual balanced solutions are limited. Clinicians must consider the fact that balanced solutions are slightly more hypotonic than normal saline and could aggravate cerebral edema. Additional prospective studies are needed to evaluate the effect of hyperchloremia on kidney failure and mortality.

Sodium Bicarbonate

Few data describe sodium bicarbonate use specifically in the post-CA period. Most studies investigate the role of sodium bicarbonate for metabolic acidosis in heterogeneous critically ill populations, and the available data do not support routine administration of sodium bicarbonate for metabolic acidosis.[220] Two recent studies, however, suggest benefit with bicarbonate in patients with extreme acidosis and acute kidney injury (AKI).[221,222] The lack of clear effect in the overall population could be due to the multitude of causes for metabolic acidosis and the possible benefit for some causes (ie, AKI) but not others (ie, lactic acidosis). Further prospective research is needed that is specific to patients with post-CA syndrome or focuses on subgroups most likely to have physiological benefit.

Renal Replacement Therapy

RRT is used to support critically ill patients who are in renal failure. Receipt of RRT is generally a marker of higher illness severity and therefore is associated with worse outcomes. A notable concern for patients after CA is the potential for dialysis disequilibrium syndrome, especially in intermittent hemodialysis, in which RRT can cause fluid shifts and rapid changes in solute concentration, resulting in increased cerebral edema and seizures.

AKI after CA is common (37% of patients) and sometimes leads to RRT (33% of patients with AKI). When patients with AKI are supported aggressively, renal recovery is possible, and most patients do not require long-term RRT.[223–225] AKI after CA is associated with shock, older age, comorbidities, and illness severity but, it is important to not, not with iodinated contrast exposure during the first 24 hours after resuscitation.[224,226]

Corticosteroids

Lower cortisol levels after CA were associated with the degree of shock and with mortality during the first 48 hours after CA, with up to 75% of nonsurvivors having low cortisol.[227,228] Supplemental steroids have inconsistent associations with outcome after CA, but much of these data precede the era of temperature control. Two nonrandomized studies compared patients treated with steroids and those not treated with steroids after CA and found no significant difference in the incidence of survival or regaining consciousness.[229,230] Other nonrandomized studies have correlated steroid use in patients after CA with higher rates of survival to discharge.[231,232]

Clinical trials of steroid administration during and after CA have found no overall improvement in outcome but suggest subgroups of interest. Hydrocortisone