Three studies addressed the use of continuous infusion 3% NaCl adjusted to achieve a targeted sodium concentration of 145–155 mEq/L [9, 37, 49]. Hauer et al. reported on a mixed neurocritical care patient population that included 120 patients with ICH [9]. These patients received 3% NaCl infusions with a goal serum sodium of 145–155 mEq/L compared to a historical cohort, and the results are reported specific to patients with ICH. A prospective study of 26 ICH patients treated with 3% NaCl continuous infusion demonstrated a reduction in cerebral edema and number of ICP crises [49]. Conversely, a retrospective cohort study with a subset of eight ICH patients who received 3% sodium acetate/chloride continuous infusion (with additional boluses as needed) found no differences in ICP or mass effect at 12 h [37]. Data from the aforementioned Koenig study was included to address this PICO question as patients with ICH were included even though they could not be separated out from the other patient populations [10]. The data from these studies are conflicting, and clinicians should weigh the risks and benefits of targeting a sodium concentration in the short-term management of ICP and cerebral edema in ICH patients.

The panel acknowledges that there are some commonly referenced articles reporting on the use of mannitol in patients with ICH that were not included in this guideline, as they did not address these specific PICO questions [50–52]. Two recent publications, both of which demonstrated potential risk of hematoma expansion, were ultimately excluded from our assessment as the study outcomes did not directly address the PICO questions as written (though hematoma expansion is important clinically, the panel did not feel this variable was directly related to cerebral edema or ICP) [53, 54]. However, the panel felt that their results may give providers some pause regarding the safety of mannitol in patients with ICH. Given these concerns, along with the lack of published articles assessing the impact of mannitol on short-term outcomes, the panel was unable to recommend use of mannitol in this population at this time.

While the overall quality of evidence in this area is very low, the panel felt there was enough consistency across published studies to suggest that HTS is effective in reducing ICP elevations and cerebral edema. In contrast, the available published studies on mannitol were not directly related to the PICO question and they implied harm; thus, the panel favored HTS over mannitol.

Recommendations for Corticosteroids in Patients with Intracerebral Hemorrhage

1. We recommend against the use of corticosteroids to improve neurological outcome in patients with intracerebral hemorrhage due to the potential for increased mortality and infectious complications (strong recommendation, moderate-quality evidence).

The panel evaluated whether use of corticosteroids in patients with ICH impacts neurological outcome, including mortality or functional status at any designated time point. The panel included a Cochrane meta-analysis, two moderate- to high-quality studies, and several other lower-quality studies in their assessment (Table 1, Question 8) [55–62]. The overall quality of evidence was moderate (Table 6).

A 2005 Cochrane Review assessed the impact of corticosteroids on neurological outcome in patients with ICH compared to placebo or standard of care controls. The review found no evidence to support the routine use of corticosteroids in patients with primary ICH and highlighted a potential for harm in these patients [61]. One prospective, randomized, placebo-controlled trial (n = 93) of dexamethasone to placebo in patients with ICH was halted due to increased rates of infectious and diabetic complications, while another (n = 40) showed no difference in mortality or neurological outcomes [55, 62]. Sharafadinzadeh et al. published a placebo-controlled trial of 225 patients which found higher mortality in the dexamethasone group [56]. Four other lower-quality studies all found no improvement in outcomes related to dexamethasone use, with two studies demonstrating increased mortality in the treatment group [57–60].

Treatment of Cerebral Edema in Patients with Bacterial Meningitis

In patients with bacterial meningitis, does the use of hypertonic sodium solutions for cerebral edema improve CE compared to mannitol?

In patients with bacterial meningitis, does the use of corticosteroid therapy improve neurological outcomes compared to placebo/control?

Recommendations

1. We recommend dexamethasone 10 mg intravenous every 6 h for 4 days to reduce neurological sequelae (primarily hearing loss) in patients with community-acquired bacterial meningitis (strong recommendation, moderate-quality evidence).
2. We suggest dexamethasone 0.15 mg/kg intravenous every 6 h for 4 days as an alternative dose for patients with low body weight or high risk of corticosteroid adverse effects (good practice statement).
3. We recommend administering dexamethasone before or with the first dose of antibiotic in patients with bacterial meningitis (strong recommendation, moderate-quality evidence).