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[Intervention Review]

Buffered solutions versus 0.9% saline for resuscitation in critically ill adults and children

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ABSTRACT

Background

Fluid therapy is one of the main interventions provided for critically ill patients, although there is no general consensus regarding the type of solution. Among crystalloid solutions, 0.9% saline is the most commonly administered. Buffered solutions may offer some theoretical advantages (less metabolic acidosis, less electrolyte disturbance), but the clinical relevance of these remains unknown.

Objectives

To assess the effects of buffered solutions versus 0.9% saline for resuscitation in critically ill adults and children.

Search methods

We searched the following databases to July 2018: CENTRAL, MEDLINE, Embase, CINAHL, and four trials registers. We checked references, conducted backward and forward citation searching of relevant articles, and contacted study authors to identify additional studies. We imposed no language restrictions.

Selection criteria

We included randomized controlled trials (RCTs) with parallel or cross-over design examining buffered solutions versus intravenous 0.9% saline in a critical care setting (resuscitation or maintenance). We included studies on participants with critical illness (including trauma and burns) or undergoing emergency surgery during critical illness who required intravenous fluid therapy. We included studies of adults and children. We included studies with more than two arms if they fulfilled all of our inclusion criteria. We excluded studies performed in persons undergoing elective surgery and studies with multiple interventions in the same arm.

Data collection and analysis

We used Cochrane's standard methodological procedures. We assessed our intervention effects using random-effects models, but when one or two trials contributed to 75% of randomized participants, we used fixed-effect models. We reported outcomes with 95% confidence intervals (CIs).

Main results

We included 21 RCTs (20,213 participants) and identified three ongoing studies. Three RCTs contributed 19,054 participants (94.2%). Four RCTs (402 participants) were conducted among children with severe dehydration and dengue shock syndrome. Fourteen trials reported results on mortality, and nine reported on acute renal injury. Sixteen included trials were conducted in adults, four in the paediatric population, and one trial limited neither minimum or maximum age as an inclusion criterion. Eight studies involving 19,218 participants were rated as high methodological quality (trials with overall low risk of bias according to the domains: allocation concealment, blinding of participants/assessors, incomplete outcome data, and selective reporting), and in the remaining trials, some form of bias was introduced or could not be ruled out.

We found no evidence of an effect of buffered solutions on in-hospital mortality (odds ratio (OR) 0.91, 95% CI 0.83 to 1.01; 19,664 participants; 14 studies; high-certainty evidence). Based on a mortality rate of 119 per 1000, buffered solutions could reduce mortality by 21 per 1000 or could increase mortality by 1 per 1000. Similarly, we found no evidence of an effect of buffered solutions on acute renal injury (OR 0.92, 95% CI 0.84 to 1.00; 18,701 participants; 9 studies; low-certainty evidence). Based on a rate of 121 per 1000, buffered solutions could reduce the rate of acute renal injury by 19 per 1000, or result in no difference in the rate of acute renal injury. Buffered solutions did not show an effect on organ system dysfunction (OR 0.80, 95% CI 0.40 to 1.61; 266 participants; 5 studies; very low-certainty evidence). Evidence on the effects of buffered solutions on electrolyte disturbances varied: potassium (mean difference (MD) 0.09, 95% CI -0.10 to 0.27; 158 participants; 4 studies; very low-certainty evidence); chloride (MD -3.02, 95% CI -5.24 to -0.80; 351 participants; 7 studies; very low-certainty evidence); pH (MD 0.04, 95% CI 0.02 to 0.06; 200 participants; 3 studies; very low-certainty evidence); and bicarbonate (MD 2.26, 95% CI 1.25 to 3.27; 344 participants; 6 studies; very low-certainty evidence).

Authors' conclusions

We found no effect of buffered solutions on preventing in-hospital mortality compared to 0.9% saline solutions in critically ill patients. The certainty of evidence for this finding was high, indicating that further research would detect little or no difference in mortality. The effects of buffered solutions and 0.9% saline solutions on preventing acute kidney injury were similar in this setting. The certainty of evidence for this finding was low, and further research could change this conclusion. Patients treated with buffered solutions showed lower chloride levels, higher levels of bicarbonate, and higher pH. The certainty of evidence for these findings was very low. Future research should further examine patient-centred outcomes such as quality of life. The three ongoing studies once published and assessed may alter the conclusions of the review.

PLAIN LANGUAGE SUMMARY

Buffered solutions versus 0.9% saline for resuscitation in critically ill adults and children

Background

Intravenous fluid therapy serves as the cornerstone of treatment for a wide spectrum of severe illnesses. Knowing its impact in terms of clinical outcomes is an important issue. There are some doubts as to whether the use of 0.9% saline may cause higher mortality among inpatients or a relevant worsening of their kidney function.

The aim of this Cochrane Review was to find out if fluid therapy with buffered solutions (water-based salt (saline) solution with a buffer to maintain a constant pH) resulted in fewer hospital deaths and less damage to the kidneys for critically ill adults and children, when compared to 0.9% saline.

Study characteristics

We found 21 studies conducted in both children and adults, with a total of 20,213 participants. These studies compared buffered solutions with 0.9% saline solutions for critically ill adults and children (including those with sepsis, trauma, burns, or shock) who had

not had planned surgery. We excluded trials where participants underwent planned (elective) surgery. These studies took place in 13 countries.

Study funding sources

Twelve of the included studies were funded by governments or non-profit organizations, two received mixed funding, one was funded by a company whose role was not clarified, and six provided no details about trial funding.

Key results

Buffered solutions did not seem to reduce hospital deaths or worsening of renal (kidney) function in critically ill adults and children when compared to 0.9% saline.

The review shows that when critically ill patients received buffered solutions compared to 0.9% saline solutions:

1. buffered solutions made little or no difference to overall mortality (19,664 participants; 14 studies; high-certainty evidence);

2. buffered solutions probably may make little or no difference in reducing the number of patients with worsening kidney function (18,701 participants; 9 studies; low-certainty evidence); and

3. we are uncertain whether buffered solutions reduce impairment of other organs (e.g., lung, liver, or brain function), electrolyte disturbances (increasing or decreasing chloride or sodium or other salts), and the need to receive blood transfusions because evidence certainty has been assessed as very low.

None of the studies looked at blood loss, clotting disturbances (concerning risk of bleeding or clots), and quality of life.

Results varied in terms of the time points at which they were reported, the unit of measurement used, and the measures reported. The total amount of fluid given as fluid therapy was not recorded. Only four studies involved children. These children were less sick than participants included in the adult trials, and kidney damage was not reported. The three ongoing studies once published and assessed may alter the conclusions of this review.

How up-to-date is this review?

We searched for studies that had been published up to July 2018.