

Σε συνέχεια των προτάσεων της εταιρίας Baxter, για τα διαλύματα αιμοκάθαρσης, σας επισυνάπτω τα τελευταία KDIGO με αναφορά στα διαλύματα αιμοδιαθήρησης – αιμοδιαδιήθησης σε ασθενείς με ΟΝΑ από την International Society of Nephrology.

Όπως θα δείτε προτείνεται η χρήση των διττανθρακικών έναντι των γαλακτικών ως ρυθμιστικός παράγοντας των διαλυμάτων στην ΟΝΑ και ειδικά στις περιπτώσεις ηπατικής ανεπάρκειας και/ ή γαλακτικής οξέωσης. Τέλος παραθέτει διάφορες μελέτες που αιτιολογούν αυτές τις κατευθυντήριες οδηγίες.

5.7.1: We suggest using bicarbonate, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI.

5.7.2: We recommend using bicarbonate, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and circulatory shock.

5.7.3: We suggest using bicarbonate, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and liver failure and/or lactic acidemia.

Επισυνάπτεται το σχετικό κεφάλαιο.

Chapter 5.7: Buffer solutions for renal replacement therapy in patients with AKI

One goal of CRRT is to maintain normal or near-normal acid-base balance, thus preventing detrimental effects of acidosis on cardiovascular performance and hormonal response. Options for correction of metabolic acidosis include the use of acetate-, lactate-, and bicarbonate-containing replacement solutions or dialysate. Some centers use citrate anticoagulation, and the citrate load provides an adequate supply of anionic base to control metabolic acidosis. Dialysate solutions for IHD are produced on-line by the dialysis machine, by mixing specially treated municipal water with electrolytes. Dialysate or replacement solutions for CRRT are produced commercially or locally in hospital pharmacies.

- 5.7.1: We suggest using bicarbonate, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI. (2C)
- 5.7.2: We recommend using bicarbonate, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and circulatory shock. (1B)
- 5.7.3: We suggest using bicarbonate, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and liver failure and/or lactic acidemia. (2B)

RATIONALE

Options for correction of metabolic acidosis in patients with AKI include acetate, lactate, bicarbonate, and citrate. The use of acetate has been largely abandoned in view of the associated hemodynamic instability and weight loss, probably related to excessive nitric oxide production and cytokine synthesis.⁷⁴⁸ Citrate, used for regional anticoagulation of the extracorporeal circuit, is alkalinizing, and most patients receiving citrate anticoagulation do not need an additional buffer in the dialysate or replacement fluid.

Original HF solutions contained lactate as a buffer. Under normal circumstances, this lactate is metabolized, resulting in adequate correction of acidosis in most patients. A survey in 34 Australian ICUs concluded that 55% of the ICU patients with AKI were treated with lactate-based solutions⁷⁴⁹ that, in most countries, are less expensive than bicarbonate solutions. In addition, bicarbonate solutions have a higher risk of bacterial contamination and the solution is unstable in the presence of calcium and magnesium. However, in recent years, bicarbonate has gained popularity because of concerns

that lactate may not be rapidly metabolized in the setting of multiple-organ failure.⁷⁴⁹ Since lactate is a strong anion, insufficient lactate conversion will result in worsening acidosis, especially since bicarbonate losses are ongoing in the extracorporeal circuit. Hyperlactatemia has also been linked to impaired cellular function and catabolism due to lowering of the cellular redox state and phosphorylation potential.⁷⁵⁰ In addition, iatrogenic increases in lactate levels may lead to misinterpretation of the clinical situation. The risk of "lactate intolerance" is highest in patients with liver failure (impaired lactate clearance) or circulatory shock (increased endogenous lactate production).

Few adequately designed trials have compared different buffers during RRT in AKI patients, and most of them have been performed during CRRT. Barenbrock *et al.*⁷⁵¹ randomized 117 AKI patients to CVVH with lactate or bicarbonate replacement fluid. The use of bicarbonate resulted in better correction of acidosis and lower lactate levels. Also, the incidence of hypotension and other cardiovascular events was lower with bicarbonate. In the subgroup of patients with cardiac failure, mortality tended to be lower with bicarbonate, whereas in the subgroup of septic patients no difference in outcome was found (Suppl Table 36). A nonrandomized crossover study in 54 patients with multiple-organ dysfunction undergoing CVVHDF confirmed the superior control of acidosis and better hemodynamic tolerance with bicarbonate.⁷⁵² However, another RCT in 40 patients treated with CVVH could not find a difference in hemodynamic tolerance, despite the higher lactate levels in the lactate-buffered group.⁷⁵³ Differences in the case-mix may explain these different results.

Two small prospective randomized crossover comparisons of bicarbonate- and lactate-buffered solutions in AKI patients treated with CVVH or CVVHDF found elevated serum lactate levels with lactate, an effect that was more pronounced in patients with hepatic insufficiency.^{754,755} An observational trial in 27 patients found a compromised lactate tolerance in patients with coincidental liver disease, those on inotropic support, and in patients with initial blood lactate measurements of >40.1 mg/dl (>10 mmol/l) and large base deficits.⁷⁵⁶

In conclusion, the use of bicarbonate as a buffer in the dialysate or replacement fluid of AKI patients results in better correction of acidosis, lower lactate levels, and improved hemodynamic tolerance. This effect is most pronounced in patients with circulatory problems and in those with liver dysfunction.

Table 23 | Microbiological quality standards of different regulatory agencies

	ANSI/AAMI/ISO ⁷⁶¹⁻⁷⁶³	ERA-EDTA guideline ⁷⁶⁴
Water for dialysis		
Bacteria (CFU/ml)	<100 (action level at 50)	<100
Endotoxin (EU/ml)	<0.5	<0.25
Dialysate		
Bacteria (CFU/ml)	<100 (action level at 50)	<100
Endotoxin (EU/ml)	<0.5	<0.25
Dilution of dialysate		
Bacteria (CFU/ml)	<0.1	<0.1
Endotoxin (EU/ml)	<0.03	<0.03
Substitution of dialysate		
Bacteria (CFU/ml)	Sterile	<10 ⁶
Endotoxin (EU/ml)	Undetectable	<0.03

AAMI, Association for the Advancement of Medical Instrumentation; ANSI, American National Standards Institute; CFU, colony-forming units; ERA-EDTA, European Renal Association—European Dialysis and Transplant Association; EU, endotoxin units; ISO, International Organization for Standardization.

5.7.4: We recommend that dialysis fluids and replacement fluids in patients with AKI, at a minimum, comply with American Association of Medical Instrumentation (AAMI) standards regarding contamination with bacteria and endotoxins. (1B)

RATIONALE

Replacement fluids for HF or HDF are infused directly into the patient's circulation and should be sterile. A potential major step forward in acute RRT, reducing the costs and the need for storage of fluids, is the on-line production of replacement fluids, which is achieved by passing water and/or dialysate through two or three ultrafilters before being infused.^{757,758} On-line production of replacement fluids has not yet been approved by the FDA or by some regulatory authorities in Europe.

Conventional IHD uses nonsterile dialysate, as there is no direct contact between blood and dialysate. However, with the use of high-permeability membranes, the lower blood side pressures at the end of the dialyzer filter may allow back-filtration of dialysate to the blood,⁷⁵⁹ raising the possibility of endotoxin or other contaminant exposure. Two studies confirmed microbial contamination of (locally prepared and

commercial) fluids and circuitry during CRRT.^{760,761} Dialysate for CRRT should preferably be ultrapure, and should at least comply with quality standards for dialysis water and dialysis fluids that may differ worldwide (Table 23).⁷⁶²

Finally, an international quality standard for dialysis fluid is in preparation by the International Society for Standardization. Until international standards are in place, we recommend that dialysis fluids and replacement fluids in patients with AKI, at a minimum, comply with AAMI standards for bacteria and endotoxins. When local standards exceed AAMI standards, local standards should be followed (Table 23).

RESEARCH RECOMMENDATION

- Further studies are required to explore the impact of on-line preparation of replacement fluid for HDF on clinical outcomes (incidence of sepsis, renal recovery, mortality) in AKI patients requiring RRT.

SUPPLEMENTARY MATERIAL

Supplementary Table 36: Summary table of RCTs examining the effect of bicarbonate vs. lactate as buffer for CVVH replacement fluid on acidosis in AKI.

Supplementary material is linked to the online version of the paper at http://www.kdigo.org/clinical_practice_guidelines/AKI.php