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Electrolyzed Hydrogen Water and the *Kidney*

Chemistry, mechanisms and clinical evidence — what the research supports, what it does not, and the questions worth taking to your nephrologist.

01 What it is

Electrolyzed reduced water is drinking water that has passed through an electrolysis cell. Research since 2007 has shifted attention from its pH to its dissolved hydrogen.

The stream collected at the cathode (negative electrode) is called reduced, alkaline-ionized or electrolyzed hydrogen water. It has three measurable features: a mildly alkaline pH (about 8.5–9.8), a strongly negative oxidation–reduction potential (ORP), and dissolved molecular hydrogen (H_2). Household devices have been sold in Japan since the 1960s, where they are regulated as home medical devices for gastrointestinal symptoms [12, 15].

A 2022 review concluded that H_2 alone accounts for both the negative ORP and the biological effects of ERW [10].

02 How it is made

A water ionizer contains two electrode chambers separated by a porous membrane. Direct current drives two half-reactions.

At the cathode (reduction) — produces the drinking water

$$2\,H_2O + 2e^- \rightarrow H_2(g) + 2\,OH^- \qquad E^\circ = -0.83\ V$$

Water molecules accept electrons and split into hydrogen gas and hydroxide ions. The hydroxide raises the pH; part of the H_2 stays dissolved.

At the anode (oxidation) — produces the acidic waste stream

$$2\,H_2O \rightarrow O_2(g) + 4\,H^+ + 4e^- \qquad E^\circ = +1.23\ V$$

Where tap water contains chloride, a side reaction also forms hypochlorous acid, which is why the acidic stream is used for cleaning, not drinking:

$$2\,Cl^- \rightarrow Cl_2 + 2e^- \qquad Cl_2 + H_2O \rightleftharpoons HOCl + H^+ + Cl^-$$

Overall reaction

$$2\,H_2O \xrightarrow{\text{electric current}} 2\,H_2 + O_2$$

During electrolysis, cations already in the water (Ca^{2+}, Mg^{2+}, Na^+, K^+) migrate toward the cathode, while anions (Cl^-, SO_4^{2-}, HCO_3^-) move toward the anode. The cathode water therefore ends up alkaline and slightly richer in minerals. **This mineral shift matters for people who must limit potassium.**

03 Why the ORP is negative

The negative ORP is not a mysterious property of the water. It follows from the Nernst equation for the hydrogen electrode at 25 °C:

$$E\,(\mathrm{V}) = -0.0592\,\mathrm{pH} - 0.0296\,\log_{10} p_{\mathrm{H_2}}$$

Higher pH and more dissolved H_2 both push the potential more negative [10]. Because ORP depends on pH as well as H_2, **an ORP meter cannot tell you how much H_2 the water holds.** A dedicated H_2 meter or titration reagent is needed [11].

H_2 dissolves poorly: about 1.6 mg/L (0.8 mM) at saturation at room temperature and normal pressure. ERW typically holds well below that, and H_2 escapes within hours from an open glass. Concentrations in the studies below ranged from 30–80 µg/L in dialysis fluid to 0.35 mg/L in drinking water [6, 8].

04 Why the kidney is a target

Chronic kidney disease raises oxidative stress throughout the body, and each hemodialysis session adds to it [2, 12]. Three reactions are central.

1. Superoxide forms and is converted to hydrogen peroxide

$$\mathrm{O_2} + e^- \rightarrow \mathrm{O_2^{\bullet -}} \qquad 2\,\mathrm{O_2^{\bullet -}} + 2\,\mathrm{H^+} \xrightarrow{\mathrm{SOD}} \mathrm{H_2O_2} + \mathrm{O_2}$$

2. The Fenton reaction turns H_2O_2 into the hydroxyl radical

The most reactive and damaging species. Free iron from intravenous iron therapy and hemolysis can feed this reaction:

$$\mathrm{Fe^{2+}} + \mathrm{H_2O_2} \rightarrow \mathrm{Fe^{3+}} + \mathrm{OH^-} + {}^{\bullet}\mathrm{OH}$$

3. Activated white cells release myeloperoxidase

Which makes hypochlorous acid. Contact between blood and the dialysis membrane triggers this:

$$\mathrm{H_2O_2} + \mathrm{Cl^-} + \mathrm{H^+} \xrightarrow{\mathrm{MPO}} \mathrm{HOCl} + \mathrm{H_2O}$$

Nitric oxide and superoxide also combine into peroxynitrite ($NO\bullet + O_2\bullet^- \rightarrow ONOO^-$), which damages proteins and lipids. These oxidants injure tubular cells, blood vessels and red cells, and they are linked to the high cardiovascular risk of dialysis patients.

05 How hydrogen may help

Direct, selective scavenging

Ohsawa and colleagues showed in 2007 that H_2 reduces the hydroxyl radical and peroxynitrite but does not react with superoxide, H_2O_2 or nitric oxide, which the body uses for signaling [3]. The key reaction is a hydrogen-atom abstraction:

$$^{\bullet}OH + H_2 \rightarrow H_2O + H^{\bullet} \qquad k \approx 4.2 \times 10^{7}\ M^{-1}\,s^{-1}$$

The hydrogen atom formed is then consumed, for example by a second radical or by oxygen:

$$H^{\bullet} + {}^{\bullet}OH \rightarrow H_2O \qquad H^{\bullet} + O_2 \rightarrow HO_2^{\bullet}$$

The net effect is that a highly destructive radical becomes water. H_2 is small, uncharged and diffuses rapidly through membranes into mitochondria and the nucleus, which partly offsets its modest reaction rate.

Signaling effects

The amounts of H_2 reached by drinking are probably too low to explain all reported effects by scavenging alone [14]. Reviews describe additional actions: activation of the Nrf2–Keap1 pathway, which switches on the body's own antioxidant enzymes; damping of NF-κB, the master switch for inflammatory cytokines; and effects on MAPK, HIF and Wnt/β-catenin signaling [13, 16]. In kidney models these translate into less apoptosis, inflammation and fibrosis [9].

The "active hydrogen" hypothesis — now superseded

The original 1997 study proposed that atomic "active hydrogen" in ERW, not dissolved H_2, scavenged superoxide and H_2O_2 and protected DNA [1]. Later work suggested platinum nanoparticles shed from electrodes could catalyze such reactions. A 2022 review concluded that these ideas, along with "microclusters" and alkaline "neutralization of acid waste", were **not supported**, and that H_2 alone explains ERW's effects [10].

06 Research in kidney disease

STUDY	MODEL	DESIGN	MAIN FINDING
Huang et al., 2003 [2]	Hemodialysis patients	Clinical study, ERW used in dialysis	Lowered dialysis-induced oxidative stress; raised H_2O_2- and HOCl-dependent antioxidant defense
Huang et al., 2006 [5]	Hemodialysis patients (n = 15 per group)	Controlled comparison with vitamin C and vitamin E-coated dialyzer	Reduced lipid peroxidation, hemolysis and inflammatory cytokines; effect ranked vitamin C > ERW > vitamin E dialyzer
Nakashima-Kamimura et al., 2009 [4]	Mice given cisplatin	Animal study, H_2 gas or H_2 water (0.8 mM)	Less kidney damage (creatinine, BUN, apoptosis) without reducing cisplatin's anti-tumor effect
Nakayama et al., 2010 [7]	Hemodialysis patients	Open-label clinical trial, 6 months, dialysate with ~48 µg/L H_2	Fewer patients with post-dialysis hypertension (21% → 62% reaching SBP < 140 mmHg); lower MCP-1 and MPO; no adverse effects
Zhu et al., 2011 [6]	Salt-sensitive CKD rats	Animal study, drinking electrolyzed water (0.35 mg/L H_2) for 6 weeks	Less kidney and heart injury after ischemia; lower BUN, MCP-1 and methylglyoxal
Nakayama et al., 2018 [8]	Hemodialysis patients, multi-center	Prospective, non-randomized, ~3.3 years	Death plus major cardio-cerebrovascular events: hazard ratio 0.59 (95% CI 0.38–0.92); fewer blood-pressure drugs needed
Reviews, 2022–2025 [9, 12, 13, 16]	Animal and human	Narrative and scoping reviews	Consistent renoprotection in animals; call for large randomized human trials

HOW TO READ THIS EVIDENCE

First, the human studies mainly used hydrogen-enriched **dialysis fluid**, so they do not prove that **drinking** ERW protects the kidneys. Second, no large randomized controlled trial has yet confirmed the outcome benefit, and some studies were co-funded by a device manufacturer [7].

07 Recommended use

7.5–8.5 pH

For people with reduced kidney function, we recommend drinking ERW at a **mild setting**, not the strongest alkaline setting, and only with your nephrologist's agreement. This range is a practitioner recommendation chosen for safety; it has not itself been tested in a clinical trial.

- **Why a mild pH.** Safety concerns rise with pH, and hyperkalemia has been linked to ERW above pH 9.8 [11]. A 7.5–8.5 range keeps a wide margin below that level.
- **Check the hydrogen, not just the pH.** The studied benefit comes from dissolved H_2, not alkalinity [10]. Lower pH settings use gentler electrolysis and may produce less H_2, so measure H_2 with a dedicated meter or reagent. Study concentrations ranged from 30–80 µg/L in dialysis fluid to 0.35 mg/L in drinking water [6, 8].
- **Drink it fresh.** H_2 escapes from an open glass within hours.
- **Count it in your fluid allowance.** ERW replaces, not adds to, the water you are allowed each day.
- **Monitor and review.** Ask for eGFR, creatinine, potassium and bicarbonate at your regular visits. Your nephrologist decides whether to continue, adjust or stop as your kidney function changes.

08 Safety: who should be careful

- **Advanced CKD and dialysis.** High-pH ERW has been linked to hyperkalemia, especially above pH 9.8; regulations cap drinking ERW at that level [11]. Japan's industry association tells people with kidney problems to consult a doctor first, and those with impaired potassium excretion to avoid it [15].
- **Fluid restriction.** ERW is still water. It counts toward any daily fluid limit set by your care team.
- **Medications.** The safety of taking medicines with alkaline ionized water is not established [15].
- **Device quality.** Electrode wear can release metals into the water. Use certified devices, follow cleaning schedules and measure H_2 directly rather than relying on ORP [11].
- **Not a substitute.** ERW does not replace dialysis, blood-pressure control, diabetes management or any prescribed medicine.

09 Questions to ask your nephrologist

1. Is my potassium level, or my kidney function, a reason to avoid alkaline water?
2. How should ERW fit within my daily fluid allowance?
3. Does my dialysis unit use, or have access to, hydrogen-enriched dialysis?
4. Should my potassium, bicarbonate or calcium be checked more often if I start drinking it?
5. Are there clinical trials of hydrogen therapy I could join?

This brochure is for information only and is not medical advice.

10 References

Numbered as cited in the website and brochure text. Items 1–8 are original research; 9–16 are contemporary reviews and guidance.

Original research

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Contemporary reviews and guidance

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10. LeBaron TW, Sharpe R, Ohno K. Electrolyzed–reduced water: Review I. Molecular hydrogen is the exclusive agent responsible for the therapeutic effects. *Int J Mol Sci.* 2022;23(23):14750. doi:10.3390/ijms232314750
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15. Association of Alkaline Ionized Water Apparatus (Japan). Notes on the use of alkaline ionized water. Accessed 29 Oct 2026.
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Educational information only. Not medical advice, diagnosis or treatment. Speak with your nephrologist before changing anything about your fluid intake or your care.