Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 58 Issue: 09:2025
DOI: 10.5281/zenodo.17129823

EFFECTIVENESS OF NURSE-DRIVEN HYDRATION PROTOCOLS IN PREVENTING POST-CONTRAST ACUTE KIDNEY INJURY IN ADULTS UNDERGOING CONTRAST-ENHANCED CT: A SYSTEMATIC REVIEW

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Abstract

Nurse-driven hydration protocols are widely used to prevent post-contrast acute kidney injury (PC-AKI) in adults receiving iodinated contrast for contrast-enhanced CT (CECT). We systematically synthesized randomized trials and implementation studies pertinent to nurse-coordinated or protocolized hydration around CECT. In high-quality randomized trials, withholding pre-CT hydration was non-inferior to sodium bicarbonate or saline hydration for stage-3 chronic kidney disease (CKD) patients (PC-AKI =2–3%) and avoided line-related adverse events and costs. Observational and service redesign studies showed that standardized, nurse-led outpatient regimens were operationally safe and reduced appointment postponements, without fluid-overload signal, and that electronic alerts plus outpatient pathways improved quality of care for PC-AKI risk after CT. One before–after CT cohort using IV plus guided oral hydration found no significant creatinine rise. Guideline and consensus statements now emphasize that IV contrast-induced kidney injury risk is lower than previously thought; prophylactic IV isotonic saline is reserved for AKI or eGFR < 30 mL/min/1.73 m², with case-by-case consideration for eGFR 30–44. Nurse-driven protocols add safety checks, patient education, and workflow benefits; however, for most stage-3 CKD outpatients undergoing CECT, routine prehydration is not required.

Keywords: Contrast-Enhanced CT; Post-Contrast Acute Kidney Injury; Nurse-Driven Protocol; Hydration; Sodium Bicarbonate; Saline; CKD.

INTRODUCTION

Concern about kidney injury after iodinated contrast has historically driven routine peri-procedural hydration in at-risk patients. Recent randomized trials in CECT have reshaped

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this view. In AMACING (high-risk elective imaging), no hydration was non-inferior to guideline-recommended IV saline for PC-AKI prevention and avoided line-related complications and costs (Nijssen et al., 2017). In the KOMPAS multicenter RCT limited to CECT in stage-3 CKD, omitting prehydration was non-inferior to 250 mL sodium bicarbonate over 1 hour (PC-AKI 2.7% vs 1.5%) (Timal et al., 2020). Kooiman et al. showed a brief 1-hour bicarbonate regimen was non-inferior to more burdensome peri-procedural saline (Kooiman et al., 2014a), and in acute CTPA a no-hydration strategy did not increase AKI versus bicarbonate (Kooiman et al., 2014b). Subgroup analyses in oncology CECT similarly found no signal that routine prehydration reduces PC-AKI (Nijssen et al., 2022). These data collectively question the blanket use of IV prehydration for typical CECT in stable stage-3 CKD.

Parallel implementation work highlights the role of nursing. A rapid, nurse-coordinated outpatient hydration pathway (oral, IV, or both) was safe—no fluid-overload events—and reduced postponements by =95% in patients with eGFR 30–60 (Wee et al., 2021). A before–after CT cohort using 500 mL IV saline pre-CT plus structured oral hydration post-CT found no significant change in creatinine or urea (Mansour et al., 2021). A national-journal report described an outpatient electronic-alert protocol improving care quality around PC-AKI risk after CT (KRCP, 2023).

Contemporary guidance has evolved accordingly. The ACR–NKF consensus states that the true risk of CI-AKI with IV contrast is often overstated; prophylactic IV isotonic saline is indicated for patients with AKI or eGFR < 30, and may be considered selectively for eGFR 30–44 (Davenport et al., 2020; ACR Manual). Narrative reviews reach similar conclusions and emphasize standardized pathways and patient factors (Cleveland Clinic J Med, 2020). Where hydration is chosen, departments commonly operationalize nurse-driven order sets (isotonic saline 1–3 mL/kg/h around the scan) (UW Radiology protocol).

Given this shifting evidence and the central operational role of nurses, we performed a focused systematic review of nurse-driven or protocolized hydration strategies in adults undergoing CECT.

METHODS

Design and objective. We conducted a systematic review of studies relevant to nurse-driven or protocolized hydration around CECT. Because you supplied a predefined corpus, we applied PRISMA concepts to screening, eligibility, and data extraction within that corpus, without external database expansion.

Eligibility criteria. Population: adults undergoing CECT with IV iodinated contrast. Interventions: protocolized hydration delivered or coordinated via nursing workflows (standardized IV isotonic saline, brief sodium bicarbonate infusion, structured oral hydration, electronic alerts/order sets facilitating nurse-released pre/post hydration). Comparators: no prehydration; alternative hydration regimens. Outcomes: PC-AKI (per study definition), creatinine/urea change, fluid-overload events, logistical outcomes (postponements). Designs: randomized trials, prospective/retrospective cohorts, before–

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after implementation studies. We excluded non-CECT (pure intra-arterial) unless mixed but reporting CECT-relevant outcomes. Information sources & study selection. Nine primary studies and eight secondary/guideline sources were provided. We verified each article and extracted data from abstracts or full text where accessible online (PubMed, journal sites, PMCID, PDF). Two reviewers were not available; to mitigate bias, we followed a pre-specified extraction template and limited interpretation strictly to reported results. (Sources: AMACING RCT; KOMPAS RCT; 1-h bicarbonate vs saline RCT; no-hydration vs bicarbonate in CTPA RCT; oncology subanalysis; rapid outpatient hydration cohort; Gaza IV+oral before–after; KRCP e-alert outpatient protocol; plus ACR–NKF consensus, ACR Manual, CCJM review, institutional protocols, and related appraisals).

Data extraction. We collected: setting; sample size; kidney function thresholds; hydration protocol (route, volume, timing); comparator; PC-AKI definition; primary renal outcomes; adverse events; and operational outcomes (cancellations/postponements).

Risk of bias. For RCTs, we noted open-label designs and outcome definitions (relative creatinine increase, KDIGO/PC-AKI). For cohorts/before–after studies, we considered selection bias, lack of control groups, and confounding (exclusion of eGFR < 30 in some cohorts). Because some full texts were behind paywalls, results were taken from peer-reviewed abstracts/pages to avoid inference beyond reported data.

Synthesis. Given heterogeneity and limited numeric reporting across implementation studies, we performed narrative synthesis and tabulated key characteristics and outcomes. Where exact numerators/denominators were not reported on accessible pages, we present reported between-group differences without imputed values.

RESULTS

Study Overview

Nine studies met inclusion. Four randomized trials evaluated hydration vs no hydration or regimen type in adults undergoing CECT: AMACING (elective imaging including CECT in eGFR 30–59), KOMPAS (CECT, stage-3 CKD), a trial of 1-hour sodium bicarbonate vs peri-procedural saline, and a CTPA trial of no hydration vs bicarbonate (Nijssen et al., 2017; Timal et al., 2020; Kooiman et al., 2014a; Kooiman et al., 2014b). An oncologic subanalysis of the trial program examined CECT patients with cancer (Nijssen et al., 2022). Three implementation-oriented studies described nurse-coordinated outpatient pathways: a rapid hydration protocol (Wee et al., 2021), a before–after CT cohort combining modest IV saline plus structured oral hydration (Mansour et al., 2021), and an outpatient electronic-alert pathway to improve PC-AKI risk care after CT (Kidney Res Clin Pract, 2023).

Renal Outcomes in Randomized Trials

In 660 high-risk elective imaging patients (eGFR 30–59), PC-AKI occurred in 2.6% without prophylaxis vs 2.7% with IV saline; non-inferiority criteria were met.

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Hydration-related complications occurred in =5.5%, and no dialysis or mortality attributable to contrast occurred within 35 days (Nijssen et al., 2017). Among stage-3 CKD patients undergoing CECT, no prehydration was non-inferior to 250 mL 1.4% sodium bicarbonate infused over 1 hour. PC-AKI within 2–5 days: 2.7% (no prehydration) vs 1.5% (bicarbonate), with no clinically meaningful differences in secondary outcomes; cost and workflow favored the no-prehydration arm (Timal et al., 2020).

In CKD patients scheduled for CECT, a brief pre-CT bicarbonate infusion (250 mL) was non-inferior to standard saline before and after CT for relative creatinine rise and CI-AKI incidence, and reduced hydration-related costs (Kooiman et al., 2014a). In suspected pulmonary embolism requiring urgent CTPA, a small RCT found no significant difference in AKI between no hydration and pre-scan bicarbonate infusion (Kooiman et al., 2014b). (Abstract-level data only available on the index page.). In cancer patients undergoing CECT within the same randomized program, prehydration did not reduce PC-AKI versus no prehydration (Nijssen et al., 2022).

For typical outpatients with stage-3 CKD (eGFR 30–59) receiving modern low-/iso-osmolar agents for CECT, routine prehydration offers little to no renal benefit compared with no prehydration, while adding logistics (IV access, chair time), cost, and small risks of volume overload or line complications (Nijssen et al., 2017; Timal et al., 2020; Kooiman et al., 2014a, b).

Implementation and Nurse-Driven Pathways

A nurse-coordinated pathway mandating rapid hydration (oral, IV, or both) for eGFR 30–60 outpatients cut appointment postponements by about 95% and reported no significant fluid-overload admissions; longer-term eGFR change was not meaningfully worse (Wee et al., 2021). This demonstrates that when hydration is chosen (local policy, clinician preference), nurse-led execution is feasible and safe operationally. In hospitalized adults undergoing CECT, a simple bundle—500 mL IV saline pre-CT plus structured oral hydration up to 3 L over 12 hours—showed no significant pre/post change in creatinine or urea on paired testing, supporting the safety of modest, protocolized regimens (Mansour et al., 2021). A Kidney Research and Clinical Practice report described an outpatient e-alert protocol that improved quality of care for patients at risk of PC-AKI following CT (KRCP, 2023), aligning with the broader movement toward standardized, nurse-released pre/post ordersets.

Alignment with Guidance

The ACR–NKF consensus and the ACR Manual on Contrast Media emphasize that for IV contrast the risk of true CI-AKI is lower than historically believed, and recommend prophylactic IV isotonic saline primarily for patients with AKI or eGFR < 30; selective consideration for eGFR 30–44 is reasonable in special situations (multiple risk factors) (Davenport et al., 2020; ACR Manual). Institutional protocols (UW Radiology) operationalize such decisions with nurse-driven order sets, typically using 0.9% saline 1–3 mL/kg/h around the scan (UW protocol). A narrative review (Cleveland Clinic J Med) echoes these thresholds and cautions to balance benefits vs risks of hypervolemia.

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Table 1: Characteristics of included studies (CECT-focused)

Study	Design & setting	Population	Hydration protocol	Comparator	Primary renal outcome definition
Nijssen 2017 (AMACING)	RCT, elective imaging (incl. CECT)	eGFR 30–59	Guideline IV saline (peri-procedural)	No hydration	PC-AKI: >25% or ≥0.5 mg/dL creatinine rise 2–6 days
Timal 2020 (KOMPAS)	Multicenter RCT, CECT	Stage-3 CKD	250 mL 1.4% $NaHCO_3$ over 1 h pre-CT	No prehydration	Relative creatinine change; PC-AKI 2–5 days
Kooiman 2014a (NDT)	RCT, CECT	CKD	250 mL 1.4% $NaHCO_3$ ×1 h	Saline before & after CT	Relative creatinine change; CI-AKI
Kooiman 2014b (JTH)	RCT, CTPA (urgent)	Suspected PE	1-h $NaHCO_3$	No hydration	AKI by creatinine criteria
Nijssen 2022 (Support Care Cancer)	Subanalysis of RCT, CECT oncology	Cancer pts	Prehydration strategy per trial	No prehydration	PC-AKI
Wee 2021 (Singapore Med J)	Prospective cohort, outpatient CECT	eGFR 30–60	Rapid oral/IV/both per protocol	— (implementation)	Safety (fluid overload), eGFR change
Mansour 2021 (EJGM)	Before–after, inpatient CECT	Mostly normal baseline renal function	500 mL IV saline pre-CT + structured oral hydration (up to 3 L/12 h)	Pre/post within-subject	Paired creatinine/urea change
KRCP 2023	Service redesign	Outpatient CECT	e-alert + protocolized care	Pre-implementation	Quality-of-care indicators

Table 2: Key outcomes relevant to nurse-driven hydration

Study	PC-AKI / renal signal	Adverse events	Operational outcomes
AMACING (2017)	2.6% (no hydration) vs 2.7% (saline); non-inferior	5.5% hydration-related complications; no dialysis	Cost-saving with no-hydration
KOMPAS (2020)	2.7% (no prehydration) vs 1.5% (bicarb); non-inferior	No clinically meaningful differences	Lower resource use without prehydration
Kooiman 2014a	Non-inferior renal outcomes	— (not detailed in abstract)	Lower hydration-related costs with brief regimen
Kooiman 2014b	No significant AKI difference	—	Demonstrates feasibility without routine prehydration in urgent CTPA

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Oncology subanalysis (2022)	No benefit from routine prehydration	—	Supports selective, not routine, prehydration
Wee 2021	No fluid-overload admissions	None reported	=95% reduction in postponed scans; practical nurse-led execution
Mansour 2021	No significant pre/post creatinine or urea change	—	Simple bundle feasible on wards with nursing oversight
KRCP 2023	— (quality metric-focused)	—	Electronic alerts + pathway improved care quality

Narrative Interpretation

Across trials and settings, routine prehydration around CECT in stable stage-3 CKD does not meaningfully lower PC-AKI versus no prehydration, while it increases logistical burden and small but real risks tied to IV lines and fluids (Nijssen et al., 2017; Timal et al., 2020; Kooiman et al., 2014a, b). Implementation studies show that when hydration is pursued (e.g., for eGFR < 30, recent AKI, multiple risk factors, or local policy), nurse-coordinated pathways deliver the intervention safely, efficiently, and with strong scheduling benefits (Wee et al., 2021; KRCP, 2023). A simple inpatient bundle that pairs modest pre-CT IV saline with structured oral hydration appears metabolically neutral (Mansour et al., 2021). Together with modern consensus guidance, these data support selective, criteria-based hydration rather than blanket policies, with nurses central to screening (eGFR checks), education (oral hydration), and timed release of pre/post orders.

DISCUSSION

Guidelines and contemporary reviews have moved away from earlier assumptions. The ACR–NKF consensus underscores that IV contrast-associated AKI is often coincidental rather than causal; indiscriminate prophylaxis can delay needed imaging and add harm. They recommend IV isotonic saline for AKI or eGFR < 30, with selective consideration for eGFR 30–44 based on cumulative risk (Davenport et al., 2020; ACR Manual). Institutional playbooks mirror this with nurse-driven order sets (e.g., 0.9% saline at =1–3 mL/kg/h around the scan) and explicit contraindications in fluid-intolerant states (UW Radiology). A clinician-facing summary from Cleveland Clinic likewise stresses judicious use of prophylaxis and shared decision-making (CCJM review).

Appraisals of guidelines note heterogeneity in recommended volumes, timing, and patient selection, but broad agreement on prioritizing high-risk groups and favoring iso/low-osmolar media (Zhong et al., 2024). Endovascular literature (outside pure CECT) similarly trends toward minimizing iodine load or using alternatives where feasible; while not directly CECT-focused, the theme of dose minimization over blanket hydration is consistent (CVIR Endovascular).

From a nursing and operations perspective, protocolization yields tangible benefits. A well-specified outpatient pathway (screening eGFR, rapid hydration options, education on oral fluids) reduced postponements and avoided fluid-overload events (Wee et al.,

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2021). Electronic alerts coupled to standardized outpatient protocols improved care quality in KRCP's report, again highlighting nurses' role in releasing timed pre/post orders and ensuring follow-up labs when indicated. Departmental protocols such as UW's "Hydration Protocol" offer pragmatic guardrails and empower nurses to implement or withhold hydration appropriately when the patient is fluid-intolerant or when eGFR does not warrant prophylaxis.

Practically, for stage-3 CKD outpatients undergoing CECT, RCTs support no routine prehydration. For eGFR < 30 or AKI, an isotonic saline strategy remains reasonable when time and hemodynamics allow—preferably via standing nurse-driven orders that limit volume, define start/stop times, and include fluid-overload checks. For urgent imaging, evidence suggests proceeding without delaying for prehydration, using the lowest effective contrast dose and documenting risk discussion (Kooiman et al., 2014b; consensus statements). Where oral hydration is employed, nurse education and monitoring improve adherence without measurable metabolic harm (Mansour et al., 2021).

Limitations: Some implementation studies are single-center with limited numerical detail, and not all full texts were accessible; we therefore avoided extrapolation beyond reported outcomes. Variation in PC-AKI definitions persist (KDIGO vs older CIN thresholds), complicating pooling. Nonetheless, convergence across trials, reviews, and consensus documents supports the main conclusions.

CONCLUSION

In adults undergoing CECT, high-quality trials show that routine prehydration of stage-3 CKD outpatients offers no meaningful renal benefit versus no hydration, while adding logistics and small risks. Nurse-driven protocols remain crucial—not for universal prehydration, but to screen risk, implement selective hydration for eGFR < 30 or AKI, optimize oral hydration education, and run safe, efficient workflows (e.g., e-alerts, order sets). Departments should align nurse-led protocols with ACR–NKF thresholds, emphasize contrast-dose minimization, and reserve IV fluids for those most likely to benefit.

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