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A Meta-Analysis on Inflammatory Marker Variations among Patients with End-Stage Renal Disease: Peritoneal Dialysis vs. Conventional

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ADMINISTRATIVE INFORMATION

Support - This study was supported by the Chongqing Natural Science Foundation (CSTB2024NSCQ-MSX0050) and the First Affiliated Hospital of Army Medical University Clinical Research Incubation Project (2024IITZDB08).

Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202630084

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 23 March 2026 and was last updated on 22 July 2026.

INTRODUCTION

Review question / Objective This study aims to systematically examine the effects of peritoneal dialysis (PD) versus conventional hemodialysis (HD) on inflammatory markers in end-stage renal disease (ESRD) patients, providing evidence-based guidance for optimal dialysis selection.

Condition being studied Objective: This study aims to systematically examine the effects of peritoneal dialysis (PD) versus conventional hemodialysis (HD) on inflammatory markers in end-stage renal disease (ESRD) patients, providing evidence-based guidance for optimal dialysis selection.

Methods: Comprehensive database searches were conducted in CNKI, VIP, Wanfang, Web of Science, PubMed, Embase, and Cochrane Library, covering studies from inception to December 2025. The analysis focused on randomized controlled trials comparing PD and HD effects on inflammatory markers in ESRD patients. Two researchers independently screened studies, extracted data, and assessed bias risk. Meta-analysis was performed using RevMan 5.4 and Stata 17.0. Primary outcomes included tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and C-reactive protein (CRP) levels.

Results: This analysis included 22 trials with 3,176 patients. TNF-α levels were significantly lower in the PD group compared to HD (MD = -3.26, 95% CI: -3.65 to -2.87). CRP (SMD = -1.35, 95% CI: -1.46 to -1.23) and IL-6 levels (SMD = -1.04, 95% CI: -1.16 to -0.92) also showed significant reductions (all $p < 0.0001$). Subgroup analysis indicated that ESRD patients with diabetic nephropathy had the greatest IL-6 reduction (SMD = -2.40). Egger's test showed no significant publication bias.

Conclusion: PD is more effective than HD in reducing inflammatory markers in ESRD patients, especially those with diabetic nephropathy,

offering valuable insights for dialysis modality selection.

METHODS

Participant or population Study participants: Patients with chronic renal failure who were clearly diagnosed as requiring PD or HD.

Intervention No applicable.

Comparator The control group underwent conventional hemodialysis (HD) as the primary renal replacement therapy.

Study designs to be included Only randomized controlled trials (RCTs) comparing peritoneal dialysis (PD) and conventional hemodialysis (HD) effects on serum inflammatory markers in ESRD patients were included, regardless of blinding status. Two investigators independently screened studies, extracted data, and assessed risk of bias. Discrepancies were resolved through discussion or consultation with a third investigator.

Eligibility criteria
Inclusion Criteria:
(1) Study design: Randomized controlled trials (RCTs), regardless of blinding status;
(2) Population: Adult patients (≥ 18 years) with end-stage renal disease (ESRD) or chronic renal failure requiring maintenance dialysis;
(3) Intervention and comparator: The experimental group received peritoneal dialysis (PD), while the control group underwent conventional hemodialysis (HD);
(4) Outcomes: At least one of the following serum inflammatory markers was reported: TNF-α, CRP, or IL-6, with sufficient quantitative data (mean and standard deviation or data convertible thereto) to enable meta-analysis.
Exclusion Criteria:
(1) Non-RCT design, including observational studies, case reports, narrative reviews, editorials, or conference abstracts without full-text availability;
(2) Interventions that did not involve a direct comparison between PD and conventional HD;
(3) Studies that did not report any of the predefined inflammatory markers or provided insufficient data for quantitative synthesis;
(4) Duplicate publications or overlapping patient cohorts.

Information sources The experimental group received peritoneal dialysis (PD), including continuous ambulatory peritoneal dialysis (CAPD) or automated peritoneal dialysis (APD), as the primary renal replacement therapy.

Main outcome(s) This analysis included 22 trials with 3,176 patients. TNF-α levels were significantly lower in the PD group compared to HD (MD = -3.26, 95% CI: -3.65 to -2.87). CRP (SMD = -1.35, 95% CI: -1.46 to -1.23) and IL-6 levels (SMD = -1.04, 95% CI: -1.16 to -0.92) also showed significant reductions (all $p < 0.0001$). Subgroup analysis indicated that ESRD patients with diabetic nephropathy had the greatest IL-6 reduction (SMD = -2.40). Egger's test showed no significant publication bias.

Quality assessment / Risk of bias analysis
Assessment of Bias and Study
Quality Critical domains including randomization, blinding, and control of confounding factors were assessed by utilizing Cochrane RoB 2.0 tool. This assessment was independently completed by two researchers. Discrepancies were resolved through discussion or with the assistance of a third-party. The studies were classified into high, moderate, or low according to their risk of bias levels. The assessment results were presented as traffic light plots and barcharts.

Strategy of data synthesis Meta-analysis was performed using R version 4.3. The meta package (version 8.2.1) was utilized for estimating pooled effect sizes, conducting subgroup analysis and sensitivity analysis. The metafor package (version 4.8.0) was employed for meta-regression, and the robvis package (version 0.3.0) for visualizing risk of bias across studies.
For TNF-α, the mean difference (MD) was used as the effect measure, as measurement units were consistent across studies. For CRP and IL-6, the standardized mean difference (SMD) was used owing to heterogeneity in measurement methods and units. All effect sizes were reported with 95% confidence intervals (CIs).
Between-study heterogeneity was assessed using Cochran's Q test and the I^2 statistic, with a significance threshold of $\alpha = 0.10$. When I^2 was below 50% and Q test p-value exceeded 0.10, a fixed-effects model was applied; otherwise, a random-effects model was used. In the presence of substantial heterogeneity, meta-regression was further conducted to identify potential moderating variables.
Publication bias was evaluated using Egger's linear regression test, with $p < 0.05$ indicating significant asymmetry. Sensitivity analysis was performed via a leave-one-out method, whereby each study was sequentially removed from the pooled analysis to assess its influence on the overall effect estimate.

All statistical tests were two-tailed, with $p < 0.05$ considered statistically significant.

Subgroup analysis Given the high heterogeneity in the overall meta-analysis ($I^2 = 92.9\%$), we conducted a subgroup analysis to investigate possible sources of variability and assess whether treatment effects differed across patient populations and dialysis protocols.

Sensitivity analysis sensitivity analysis was performed by sequentially removing each individual study from the analysis to evaluate the potential effect on the pooled SMD results, allowing to determine whether any single study had a disproportionate influence on the overall outcome.

Country(ies) involved China.

Amendment Note Amendment Note: This protocol was originally registered on March 23, 2026, at the data analysis stage. The present amendment corrects several discrepancies between the originally registered protocol and the methods as actually implemented, which arose from insufficient coordination between the investigators responsible for protocol registration and those conducting the analysis. The key changes are: (1) the eligibility criteria were corrected from "retrospective studies, prospective studies, or RCTs" to RCTs only. This was a registration error rather than a post hoc change in methodology. (2) the statistical software was changed from RevMan 5.4 and Stata 17.0 to R version 4.3 (meta, metafor, and robvis packages); (3) The Intervention and Comparator fields were previously marked as "No applicable," while the relevant PD versus HD comparison information had been placed under "Study designs to be included" and "Eligibility criteria." These descriptions have now been relocated to their appropriate fields.

Keywords Search keywords used both Chinese characters for "PD," "HD," "end-stage renal disease," "inflammation," "TNF-α," "CRP," and IL-6 and English terms.

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