



IMPROVEMENT IN AVERAGE UREA REDUCTION RATIO (URR) IN PATIENTS UNDERGOING HAEMODIALYSIS: A QUALITY IMPROVEMENT PROJECT AT A TERTIARY CARE HOSPITAL IN NORTHEAST INDIA

Dr. Anannya Mahanta¹, Dr. Lipika Barman^{2*}, Dr. Seema Konwar³, Dr. Karan Saraf⁴, Dr. K. Brijesh Singh⁵,
Dr. Angela Phukan⁶, Dr. Kukil Mahanta⁷, Ms. V. Pamthing⁸, Ms. Anjali Sarma⁹

¹Quality Manager, Apollo Excelcare Hospital, Guwahati, Assam.

²Microbiologist and Infection Control Specialist, Apollo Excelcare Hospital, Guwahati, Assam.

³Medical Superintendent, Apollo Excelcare Hospital, Guwahati, Assam.

⁴Consultant and HOD Nephrology, Apollo Excelcare Hospital, Guwahati, Assam.

⁵Associate Consultant – Nephrology, Apollo Excelcare Hospital, Guwahati, Assam.

⁶Consultant Pathologist and Laboratory HOD, Apollo Excelcare Hospital, Guwahati, Assam.

⁷Clinical Associate - Nephrology, Apollo Excelcare Hospital, Guwahati, Assam.

⁸Lead Nursing Administrator, Apollo Excelcare Hospital, Guwahati, Assam.

⁹Lead Nurse – Nephrology, Apollo Excelcare Hospital, Guwahati, Assam.

Corresponding Author*: Dr. Lipika Barman, Microbiologist and Infection Control Specialist, Apollo Excelcare Hospital, Guwahati, Assam.

Email ID: lipikabarman18@gmail.com

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ABSTRACT

Background: Urea Reduction Ratio (URR) is a widely accepted indicator of haemodialysis adequacy, reflecting the efficiency of uremic toxin removal. Maintaining a URR $\geq 65\%$ is associated with improved patient outcomes, while suboptimal URR is linked to increased morbidity and reduced quality of life. Preliminary unit data indicated fluctuating and often suboptimal URR levels, necessitating a structured clinical audit to identify gaps and implement targeted improvements.

Aim: To assess and improve the average URR in patients undergoing haemodialysis at a tertiary care hospital.

Methods: A Descriptive Analytical clinical audit was conducted in two phases: Retrospective (April–November 2024) and Prospective (December 2024–March 2025). Adult maintenance haemodialysis patients with valid paired pre- and post-dialysis BUN measurements were included. Data was collected using a standardized audit checklist from laboratory information systems, dialysis machine records, and clinical charts. Key measures included monthly mean URR and the proportion of sessions achieving $\geq 65\%$. Interventions included optimization of dialysis duration, standardization of dialyzer selection, reinforcement of correct sampling protocols, Logistics, Staff Duty Roster reallocation and staff training. Data was analyzed using descriptive statistics and trend analysis.

Results: Baseline analysis showed a mean URR of 63.63% during April–November 2024, indicating suboptimal dialysis adequacy. Following targeted interventions, mean URR improved to 66.57% during December 2024–March 2025. The overall annual mean URR was 64.61%, demonstrating progressive improvement toward the benchmark of $\geq 65\%$. Improvements were associated with better adherence to prescribed dialysis duration, enhanced dialyzer selection, trained

staff duty reallocation cum logistics and stricter monitoring practices thus leading to a effective Quaity Improvement.

Conclusion: The QIP effectively identified modifiable factors affecting dialysis adequacy and demonstrated that structured interventions can significantly improve URR within a short period. Strengthening process reliability, staff training, and continuous monitoring are critical to sustaining outcomes. The audit highlights the value of multidisciplinary collaboration and data-driven quality improvement in enhancing haemodialysis care and patient outcomes.

KEYWORDS: Urea Reduction Ratio, Haemodialysis Adequacy, Clinical Audit, Quality Improvement, Dialysis Outcomes.

Introduction

Haemodialysis adequacy is a critical determinant of outcomes in patients with end-stage renal disease (ESRD). Inadequate removal of uremic toxins is associated with increased morbidity, mortality, hospitalization, and poor quality of life. Among the various indicators used to assess dialysis adequacy, the Urea Reduction Ratio (URR) remains one of the most practical, cost-effective, and widely used surrogate markers in routine clinical practice. It reflects the percentage reduction in blood urea nitrogen (BUN) during a dialysis session and provides a simple measure of solute clearance[9].

International guidelines, including those from the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI)[1], recommend maintaining a URR of $\geq 65\%$ to ensure adequate dialysis. Failure to achieve this benchmark is often indicative of suboptimal dialysis delivery, which may arise from multiple modifiable factors such as reduced treatment duration, inadequate dialyzer performance, suboptimal blood and dialysate flow rates, vascular access dysfunction[4], and poor patient adherence to prescribed dialysis schedules.

Despite advances in dialysis technology and protocols, maintaining consistent adequacy remains challenging in real-world settings. Variability in URR values across sessions and patients highlights gaps in process reliability and quality of care. In addition, inadequate monitoring, improper sampling techniques for pre- and post-dialysis BUN, and lack of structured quality assurance mechanisms can further compromise the accuracy and effectiveness of dialysis adequacy assessment.

A Quality Improvement Project is a systematic approach to evaluate current practices, compare them against established standards, and implement targeted interventions to improve quality of care. It plays a pivotal role in identifying practice gaps, enabling data-driven decision-making, and ensuring compliance with accreditation and clinical governance standards such as NABH. In the context of haemodialysis, clinical audits focused on URR can help identify key determinants of inadequate dialysis and guide corrective strategies.

At Apollo Excelcare Hospital, periodic monitoring of dialysis adequacy revealed fluctuating and frequently suboptimal URR levels, suggesting inconsistencies in dialysis delivery and monitoring processes. This necessitated a structured

clinical audit to systematically assess current performance, identify modifiable factors, and implement targeted quality improvement interventions.

The present study was therefore undertaken to evaluate the average Urea Reduction Ratio among patients undergoing maintenance haemodialysis and to improve dialysis adequacy through a multidisciplinary, audit-driven approach. This initiative aimed to standardize URR parameter as it is a significant Apollo Clinical Evaluation (ACE) Quality Key Performance Indicator, align clinical practice with established guidelines, enhance process reliability, and ultimately improve patient outcomes through sustained quality improvement.

Aims and Objectives

To evaluate the efficacy of current dialysis protocols and improve the mean Urea Reduction Ratio among patients undergoing maintenance haemodialysis at our tertiary care facility.

To assess the average Urea Reduction Ratio (URR) among patients undergoing maintenance haemodialysis at a tertiary care hospital in Northeast India, and to implement structured, audit-driven quality improvement interventions aimed at enhancing dialysis adequacy in line with National Kidney Foundation K/DOQI benchmarks (URR $\geq 65\%$).

Objectives

- To determine the baseline monthly mean Urea Reduction Ratio (URR) among adult maintenance haemodialysis patients during the retrospective phase (April–November 2024).
- To design and implement targeted quality improvement interventions — including optimization of dialysis session duration, standardization of dialyzer selection, correction of pre- and post-dialysis BUN sampling protocols, and staff training — to improve dialysis adequacy.
- To reassess the monthly mean URR and the proportion of patients achieving the recommended benchmark of $\geq 65\%$ during the prospective phase (December 2024–March 2025) following intervention.

Methods

Study Design and Setting This clinical audit was conducted as a descriptive analytical study in the haemodialysis unit of Apollo Excelcare Hospital. The audit followed a structured quality improvement framework based

on the clinical audit cycle, including baseline assessment, intervention, and re-evaluation.

The audit was implemented in two phases:

- Retrospective phase: April 2024 to November 2024 (baseline assessment)
- Prospective phase: December 2024 to March 2025 (post-intervention assessment)

Study Population

The study included adult patients (age>18yrs) undergoing maintenance haemodialysis during the audit period.

Inclusion Criteria

- Patients aged ≥ 18 years on maintenance haemodialysis.
- Patients with at least one valid monthly URR measurement based on paired pre- and post-dialysis blood urea nitrogen (BUN) samples.
- Patients receiving dialysis within the hospital dialysis unit.

Exclusion Criteria

- Patients with acute kidney injury on temporary dialysis.
- Paediatric patients (<18 years).
- Patients on peritoneal dialysis.
- Sessions terminated prematurely for non-clinical reasons affecting URR validity

Audit Criteria and Standards

The audit focused on evaluating dialysis adequacy using Urea Reduction Ratio (URR) as the primary outcome measure.

Primary Outcome

- Monthly mean URR of the dialysis cohort
- Proportion of patients achieving $URR \geq 65\%$

Standards

1. Minimum acceptable URR benchmark: $\geq 65\%$, based on National Kidney Foundation Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines
2. Target: $\geq 80\%$ of patients achieving $URR \geq 65\%$
3. Process compliance targets included:
 - 100% monthly URR measurement
 - 100% adherence to correct timing of pre- and post-dialysis BUN sampling
 - $\geq 95\%$

Sample Size and Sampling Technique

A purposive sampling strategy was employed. More than 50% of the dialysis population was included monthly, with approximately 100–105 cases sampled each month during the audit period.

Data Collection

Data were collected monthly using a standardized audit

checklist and structured data collection tool.

Data Variables

The following parameters were recorded:

- Pre- and post-dialysis BUN levels (with timestamps)
- Dialysis session duration (prescribed vs delivered)
- Dialyzer type and model
- Blood flow rate and dialysate flow rate
- Ultrafiltration volume
- Pre- and post-dialysis weight
- Vascular access type and related issues
- Missed or shortened sessions
- Intradialytic complications
- Patient adherence and education status

Data Sources

- Laboratory Information System (LIS)
- Dialysis machine logs
- Nursing and medical records

Data quality was ensured through dual data entry, random verification by a second reviewer, and monthly validation by senior clinical and quality teams. All data were de-identified prior to analysis.

URR Calculation

- URR was calculated using the standard formula [3]
- $URR (\%) = ((\text{Pre-dialysis BUN} - \text{Post-dialysis BUN}) / \text{Pre-dialysis BUN}) \times 100$
- Measurements were performed monthly for each patient using appropriately timed blood sampling.

Interventions

Following baseline analysis, targeted interventions were implemented during the prospective phase, including:

- Optimization of dialysis duration and adherence to prescribed treatment time.
- Standardization of dialyzer selection based on patient needs
- Reinforcement of correct pre- and post-dialysis BUN sampling protocols
- Staff training and re-education on dialysis adequacy and monitoring
- Enhanced patient education on treatment adherence and fluid management [7]
- Introduction of monitoring mechanisms, including regular audit reviews and feedback

Data Analysis

Data was analyzed using descriptive statistical methods.

- Monthly mean URR values were calculated.
- Trends were assessed using run charts over the audit period.
- Comparative analysis was performed between baseline and post-intervention phases.
- Subgroup observations were made based on treatment-

related variables (e.g., duration, access type, dialyzer)

The audit was conducted by a multidisciplinary team comprising Nephrologists, Lead Nursing staff, dialysis technicians, Quality personnel, Infection Prevention & Control team and Medical Administration. Data validation and oversight were ensured through periodic review by Quality Department.

Regular review meetings were conducted to monitor compliance, identify deviations, and implement corrective actions. A Plan–Do–Study–Act (PDSA) approach was used to guide iterative quality improvement.

Ethical Considerations

As a clinical audit aimed at quality improvement, the study used patient data and did not involve any direct patient intervention. Confidentiality of patient information was maintained throughout the audit process.

Audit Criteria

- Monthly mean URR $\geq 65\%$
- $\geq 80\%$ patients achieving URR $\geq 65\%$
- Proper sampling and documentation
- $\geq 95\%$ adherence to prescribed treatment duration

Results Descriptive Analysis

More than 50 per cent of eligible haemodialysis patients were included monthly during the audit period (April 2024–March 2025). The baseline phase (April–November 2024) showed a mean URR of 63.63 per cent, which was below the recommended adequacy benchmark of ≥ 65 per cent. Monthly URR values ranged from 61.56 per cent to 64.86 per cent, indicating variability and suboptimal performance.

Following implementation of targeted interventions, the post-intervention phase (December 2024–March 2025) demonstrated improvement, with mean URR increasing to 66.57 per cent. All months during this phase achieved URR values above 65 per cent, with peak performance observed in January 2025 (67.83%).

The overall mean URR across the study period was 64.61 per cent, reflecting a progressive upward trend in dialysis adequacy.

Comparative Analysis

A clinically meaningful improvement in URR was observed between the baseline and post-intervention phases. The increase of approximately 3 percentage points suggests improved dialysis adequacy following process optimization and targeted interventions.

Monthly URR Trend

- April–November 2024: URR ranged from 61.56% to 65.15%
- December 2024–March 2025: URR improved to 65.38%–67.83%

Overall Findings

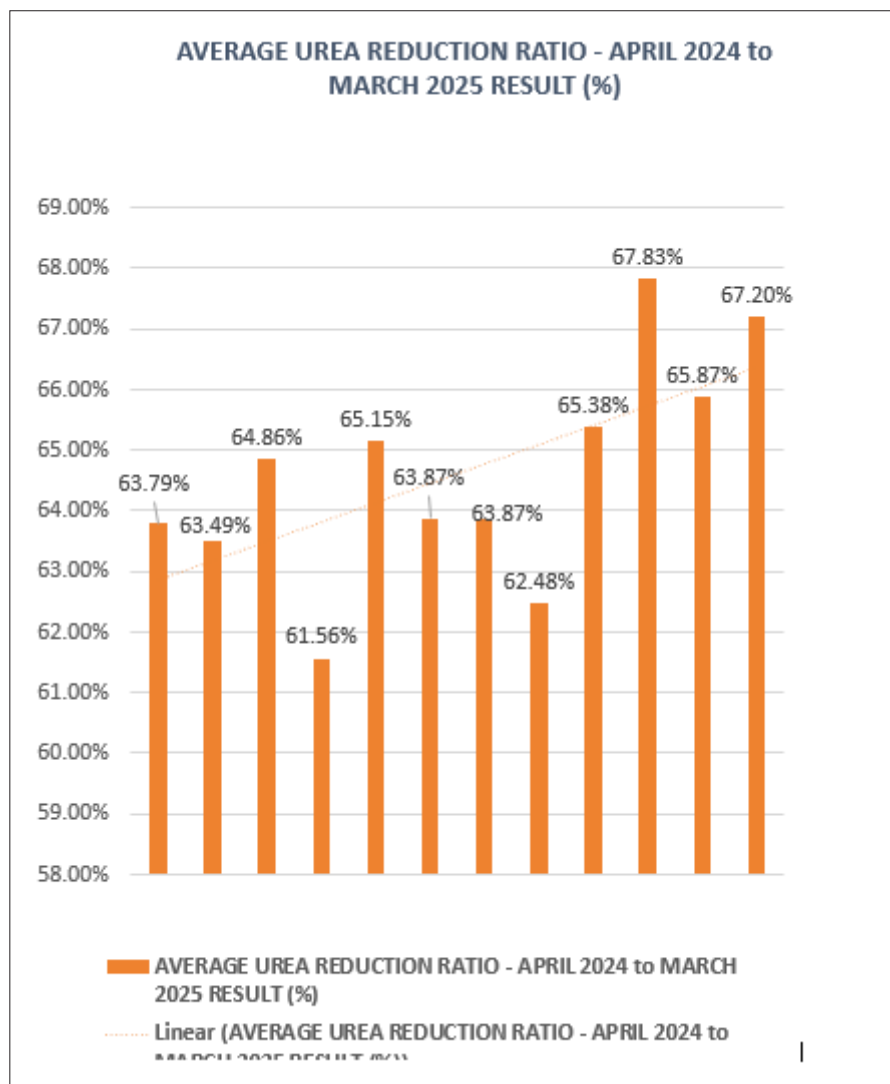
- Baseline mean URR: 63.63% (suboptimal)
- Post-intervention mean URR: 66.57%
- Overall mean URR: 64.61%

Interpretation

- Majority of initial values were below benchmark
- Significant improvement observed following interventions

Table 1: Monthly average urea reduction ratio (URR) during baseline and post-intervention phases

Month	URR%
Apr 2024	63.79
May 2024	63.49
Jun 2024	64.86
Jul 2024	61.56
Aug 2024	65.15
Sep 2024	63.87
Oct 2024	63.87
Nov 2024	62.48
Baseline mean (Apr–Nov 2024)	63.63
Dec 2024	65.38
Jan 2025	67.83
Feb 2025	65.87
Mar 2025	67.20
Post-intervention mean (Dec 2024–Mar 2025)	66.57



Statistical Analysis

Data was entered into a standardized spreadsheet and analyzed using statistical software (e.g., IBM SPSS Statistics version 26.0). Continuous variables were summarized as mean $\pm$ standard deviation (SD), while categorical variables were expressed as frequencies and percentages.

The primary outcome, monthly mean Urea Reduction Ratio (URR), was calculated for each month across the audit period. A run chart analysis was performed to visualize temporal trends and identify shifts in process performance before and after implementation of corrective interventions.

For comparison between phases:

- Baseline phase (April–November 2024)
- Post-intervention phase (December 2024–March 2025)

an independent samples t-test (or Mann–Whitney U test for non-normally distributed data) was used to assess differences in mean URR between the two periods.

To evaluate the within-unit improvement over time, a paired t-test was performed where applicable, comparing pre- and post-intervention monthly averages.

The proportion of patients achieving the target URR ($\geq 65\%$) before and after intervention was compared using the Chi-square test (or Fisher's exact test when appropriate).

Trend analysis across the audit period was further assessed using linear regression analysis, with URR as the dependent variable and time (months) as the independent variable, to determine the statistical significance of improvement over time. A p-value < 0.05 was considered statistically significant. Missing or incomplete data were excluded from inferential statistical analysis but included in descriptive reporting where appropriate. Sensitivity checks were performed to ensure that exclusion of incomplete cases did not significantly bias the results.

Discussion

This clinical audit evaluated haemodialysis adequacy using Urea Reduction Ratio (URR) as a key performance indicator[9] and demonstrated a measurable improvement following targeted quality interventions. The baseline mean URR of 63.63% observed in our unit was below the recommended threshold of $\geq 65\%$, indicating suboptimal dialysis adequacy. Post-intervention improvement

to 66.57% reflects successful implementation of corrective measures and aligns the unit with accepted international standards.

URR has long been recognized as a practical surrogate marker for dialysis adequacy, particularly in resource-constrained settings where more complex measures such as Kt/V may not be consistently feasible. The National Kidney Foundation K/DOQI guidelines recommend a minimum URR of 65%[1], which is supported by evidence linking adequate urea clearance with improved survival and reduced hospitalization rates[3]. Similar to our findings, several global studies have reported baseline inadequacies in dialysis delivery, often attributed to modifiable process-related factors rather than patient characteristics alone.

In studies from the United States Dialysis Outcomes and Practice Patterns Study (DOPPS) [5],[4], variability in URR and Kt/V across centres has been attributed to differences in treatment duration, dialyzer efficiency, vascular access, and adherence to prescribed dialysis schedules[4,5]. Our audit findings are consistent with these observations, as suboptimal URR in the baseline phase was associated with issues such as shortened dialysis sessions, variability in dialyzer selection, and inconsistencies in sampling practices. Importantly, these factors were amenable to targeted intervention, underscoring the value of process standardization.

Similar quality improvement initiatives in haemodialysis units globally have demonstrated that relatively simple interventions—such as ensuring adequate dialysis duration, optimizing dialyzer use, and reinforcing staff training—can significantly improve URR outcomes. For example, audits conducted in European dialysis centres have shown that adherence to prescribed session duration alone can improve URR by 2–5%[6,8] which is comparable to the magnitude of improvement observed in our study. Additionally, improvements in vascular access function and monitoring have been shown to enhance solute clearance and contribute to achieving adequacy targets[4].

An important observation in our audit was the sustained improvement beyond the benchmark in all months of the post-intervention phase. This suggests that the observed change was not incidental but reflected a systematic improvement in practice. The incorporation of regular monitoring, structured audit feedback, and multidisciplinary engagement likely contributed to this sustained effect. Similar findings have been reported in quality improvement studies where continuous monitoring using run charts and dashboards facilitated early identification of deviations and timely corrective actions (Berwick, 2008).

The effect size observed in this study further emphasizes the clinical relevance of the improvement. In quality improvement research, effect size provides additional insight into the practical significance of interventions beyond statistical significance, particularly when working with

aggregate or operational data. The observed improvement of approximately 3 percentage points in mean URR is clinically meaningful, as even modest increases in dialysis adequacy have been associated with better patient outcomes in prior studies[3,8].

Our findings also highlight the importance of addressing pre-analytical and process-related variables in dialysis adequacy assessment. Proper timing of pre- and post-dialysis BUN sampling, accurate documentation and adherence to protocol are essential to ensure reliability of URR measurement. Similar concerns have been raised in international literature, where variability in sampling techniques has been identified as a source of error affecting URR interpretation[2].

The audit reinforces the role of clinical governance frameworks, such as the Plan–Do–Study–Act (PDSA) cycle (Berwick, 2008) in driving improvement. The structured approach adopted—comprising baseline measurement, root cause analysis, targeted intervention, and re-evaluation—mirrors best practices in quality improvement and is consistent with recommendations from accreditation bodies such as NABH. The success of this audit was further supported by multidisciplinary collaboration involving nephrologists, nursing staff, technicians, quality teams and Infection Control team, which is recognized globally as a key determinant of effective quality improvement.

Despite these strengths, there were certain limitations in the study. The study relied primarily on aggregate monthly data rather than individual patient-level analysis, limiting the ability to perform robust inferential statistics and adjust for potential confounders. Additionally, as a single-centre audit, the findings may not be directly generalizable to all dialysis settings, particularly those with differing patient demographics or resource constraints. However, the consistency of findings with global literature supports the external validity of the observed trends.

Future directions include incorporating additional measures of dialysis adequacy, such as Kt/V (Daugirdas, 1993) and exploring patient-level predictors of inadequate URR. Strengthening vascular access surveillance, enhancing patient education, and integrating real-time monitoring dashboards may further sustain and improve outcomes. Continuous re-audit and adherence to evidence-based practices will be essential to maintain gains and prevent regression.

In conclusion, this clinical audit demonstrates that systematic evaluation and targeted interventions can significantly improve dialysis adequacy in routine clinical practice. The findings are consistent with global evidence and reinforce the importance of process optimization, staff training, and continuous monitoring in achieving and sustaining quality haemodialysis care.

Quality Improvement Interventions

- Standardization of dialysis session duration

- Proper timing of BUN sampling
- Optimization of dialyzer selection
- Staff training and monitoring
- Implementation of URR dashboard and audit reviews

Limitations

- Single-center study
- Possible data completeness issues
- Lack of advanced statistical modeling
- Kt/V correlation not assessed.

Conclusion

This clinical audit demonstrated that structured quality improvement interventions can significantly enhance haemodialysis adequacy as measured by URR. The improvement from suboptimal baseline performance to sustained achievement of recommended targets highlights the effectiveness of process optimization, multidisciplinary collaboration, and continuous monitoring.

The findings emphasize that modifiable factors such as dialysis duration, dialyzer selection, and adherence to protocols play a critical role in achieving adequacy targets. Sustained improvements require ongoing audit cycles, staff training, and patient engagement.

Recommendations

- Maintain URR $\geq 65\%$ consistently
- Monthly monitoring and feedback
- Integration with Kt/V for comprehensive assessment
- Continuous staff training
- Implementation of PDSA cycles for sustained improvement

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Conflict of Interest

The authors do not have any conflicts of interest.

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