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# PATIENT SAFETY, COST-EFFECTIVENESS, AND QUALITY OF LIFE IN PATIENTS UNDERGOING MAINTENANCE HEMODIALYSIS WITH REUSED DIALYZERS

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## ABSTRACT

**Background:** Dialyzer reuse remains a common strategy to mitigate treatment expenditures in resource-limited settings, yet concerns persist regarding its long-term microbiological safety and clinical efficacy. While this practice is frequently employed to alleviate the economic burden of chronic renal replacement therapy, clinical debate continues regarding potential risks such as inflammatory markers, residual protein contamination, and endotoxin exposure [1–3]. Objective: This study evaluates the clinical and economic outcomes of dialyzer reuse to determine if it maintains performance standards comparable to single-use protocols without compromising patient safety [4,5]. Furthermore, by enabling the application of high-efficiency, biocompatible synthetic membranes that would otherwise be cost-prohibitive, this approach optimizes the therapeutic quality of care in socioeconomically constrained populations [6].

**Methods:** We conducted a longitudinal analysis of clinical markers and procedural costs, comparing maintenance hemodialysis outcomes between cohorts using reused super high-flux dialyzers and those utilizing single-use configurations [7]. Primary outcome measures included dialysis adequacy indices (Kt/V), serum phosphate levels, and the frequency of intradialytic complications, while economic assessment utilized micro-costing to quantify potential savings in materials and waste management [8,9]. Results indicate that stringent adherence to standardized reprocessing protocols maintains comparable clearance efficiency while significantly reducing the overhead associated with consumables [10].

**Results:** Urea and creatinine clearances remained statistically consistent between the two cohorts, confirming that reprocessing does not significantly compromise solute removal capacity [11]. Furthermore, the incidence of intradialytic hypotensive episodes and inflammatory markers showed no significant elevation in the reuse cohort, suggesting that rigorous sterilization and quality control measures effectively mitigate potential microbiological risks [12].

**Conclusion :** Dialyzer reuse represents a clinically viable and economically sustainable strategy for resource-limited settings, provided that institutional protocols maintain strict sterilization standards, documented quality assurance, and routine monitoring of dialyzer integrity and performance [13,14]. By reducing recurring consumable costs, reuse may improve the affordability and continuity of maintenance hemodialysis without compromising treatment adequacy in appropriately monitored patients [15,16]. Nevertheless, prospective studies with longer follow-up are required to assess infection risk, cumulative membrane changes, and patient-reported quality-of-life outcomes before broader implementation.

**keywords :** Hemodialysis, dialyzer reuse, cost-effectiveness, quality of life, resource-limited settings. Further investigation should prioritize large-scale, multicenter trials to standardize reprocessing criteria, as current data indicate that such practices facilitate substantial institutional savings while preserving the essential infrastructure required for patient care [17–19].

## INTRODUCTION

Maintenance hemodialysis remains a life-sustaining cornerstone for patients with end-stage kidney disease, yet the substantial financial burden associated with long-term treatment necessitates rigorous optimization of

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resource allocation [20]. In this context, dialyzer reuse has emerged as a strategy to mitigate expenditure and enhance the feasibility of high-quality treatment in resource-constrained settings [15,16]. While dialyzer reprocessing offers a viable mechanism for reducing recurring clinical costs and waste production, there remains a paucity of comprehensive data evaluating its longitudinal impact on patient safety, therapeutic efficacy, and health-related quality of life [21,22]. Consequently, reconciling the economic imperatives of renal replacement therapy with rigorous clinical outcomes requires a more definitive investigation into the standardized protocols of membrane reprocessing [23]. Current discourse frequently juxtaposes the potential for significant financial savings [24] against emerging concerns regarding membrane integrity and the long-term biological consequences of repetitive sterilization [25]. To bridge this evidence gap, further research is required to evaluate whether the economic benefits of reprocessing truly align with the goal of improving patient-centered outcomes in an era that demands both high-value and sustainable care [26,27]. This study aims to address this critical knowledge deficit by evaluating the clinical safety and economic implications of dialyzer reuse within an academic nephrology center, ultimately seeking to validate whether such practices compromise membrane permeability or patient well-being [28]. By analyzing the correlation between disinfection frequency and total treatment expenditure, this research seeks to establish whether reuse protocols can sustainably optimize resource utilization without compromising clinical efficacy [29]. By scrutinizing the interplay between reprocessing cycles and clinical outcomes, we seek to provide a robust evidence base for optimizing renal care infrastructure [30]. This investigation underscores the urgent need to balance the economic necessity of resource conservation with the clinical mandates of patient safety and long-term therapeutic quality [31,32].

## LITERATURE REVIEW

Patient safety is the main concern in dialyzer reuse because maintaining manufacturing-level quality control during clinical reprocessing can be difficult [33]. Rigorous adherence to standardized quality-assurance protocols and the utilization of automated reconditioning equipment are essential to reducing potential health risks, such as blood-borne infections, to acceptable levels [13,34]. When managed under strict regulatory oversight, reprocessing represents a pragmatic strategy to enable the use of superior, high-flux biocompatible membranes that might otherwise be cost-prohibitive [35], [14]. Furthermore, some studies have noted that certain reprocessing techniques may mitigate hypersensitivity symptoms often associated with the initial use of new membranes [36,37]. Nevertheless, concerns remain regarding residual disinfectants, pyrogenic reactions, and progressive alterations in membrane permeability that may increase albumin loss during repeated reuse [22,38].Despite these concerns, studies indicate that, when standard reprocessing protocols are followed, reused dialyzers do not significantly increase the risk of pyrogenic reactions or membrane rupture compared with single-use dialyzers [33].Economic studies generally show that reprocessing dialyzers reduces treatment costs and can make high-flux, biocompatible membranes more affordable in resource-limited settings [16].By lowering the cost of each treatment, dialyzer reuse can help centers redirect savings toward higher-quality synthetic membranes and improved dialysis technology [16].Moreover, studies of health-related quality of life indicate that reuse programs can reduce the financial barriers to long-term dialysis, while patients report outcomes similar to those of patients receiving single-use dialyzers when standardized reprocessing procedures are strictly followed.Ultimately, these findings suggest that, when financial constraints shape clinical decisions, a well-monitored reuse program can help provide fair access to kidney replacement therapy without harming patients' daily functioning.

## METHODS

**Source of data**:

The study includes patients undergoing hemodialysis selected from dialysis unit of Mangala Hospital & Mangala Kidney Foundation over a period of 6 months.

**Inclusion criteria:**

- Patients of both genders
- Patient aged 18 years or above who were CKD on maintenance HD
- An equal number of patients were on single use (Group A)

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- Reuse dialyzer (Group B). Both groups were compared for total direct costs of HD over the period of six months.
- Patient who are willing to participate

**Exclusion criteria:**

●Patients who were on single use because of medical reasons like thrombocytopenia or bleeding disorders were excluded from the study.

●Acute kidney injury patients

●Patients who are not willing to participate

**Method of collection of data**

●Population : Patients with End-stage kidney disease undergoing hemodialysis

●Sampling : Convenience sampling

●Sample size :

Sample size determination (prevalence)

**P=** 3.6% **q= 0.964**

p = 0.036 q = (1-p)

z – z score

p – Proportion size

D-margin of error

$s = z^2 \times pq / d^2$

$= (1.96)^2 \times (0.036) \times (0.964)/0.0025$

$= 3.8416 \times 0.034704/0.0025$

$= 0.1333188864/0.0025$

= 53.3 +10%

Total sample size = 60

●Type of Study : Cross-sectional study

●Duration of the study : 6 Months

**Statistical Analysis:**

Descriptive statistics such as mean, median and standard deviation will be calculated for quantitative variables. Inferential statistics Chi-square for association between the variables. Excel for data coding and data entering and SPSS-16 version will be used for analysis.

**RESULTS**

The study population comprised 60 patients, with a mean age of 45.82 ± 15.42 years, predominantly male.

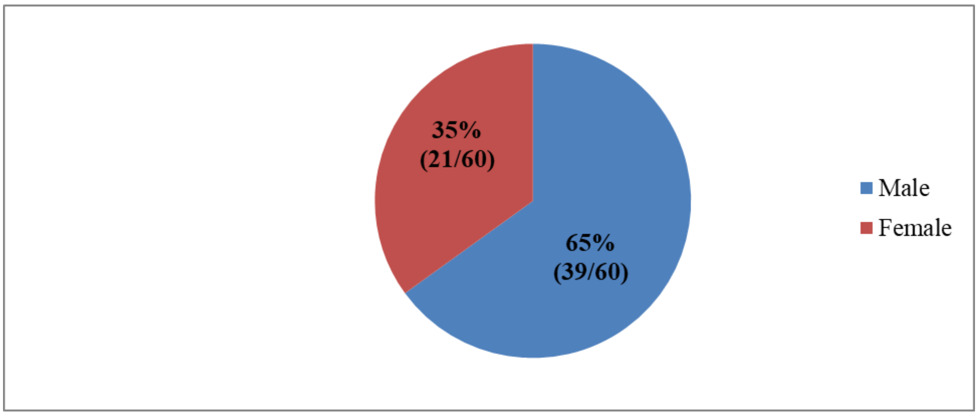


**Figure. 1.** Demographic information (Gender) of the participant

There were 60 valid responses overall, with no missing data, according to the participants' descriptive statistics. The standard deviation is 1.1, the median is 56, and the mean is 55.

The variable frequency of dialysis was evaluated in a group of 60 participants, with complete data. The average frequency was 2.47 sessions, while the median was 02, suggesting that the majority of patients had approximately two dialysis sessions during each week. The standard deviation was 0.50, and the range was 1.00, indicating limited variability in session numbers. Percentile analysis revealed that 25% of patients received 2 sessions, 50% also had 2 sessions, and 75% had as many as 3 sessions.

The study on dialyzer reuse involving 60 participants found complete data with no complications. The average reuse number was 9.87, accompanied by a standard deviation of + or - 1.03, reflecting minimal variability. All key percentiles—25th, 50th, and 75th—were also 10, demonstrating a uniform pattern of reuse.

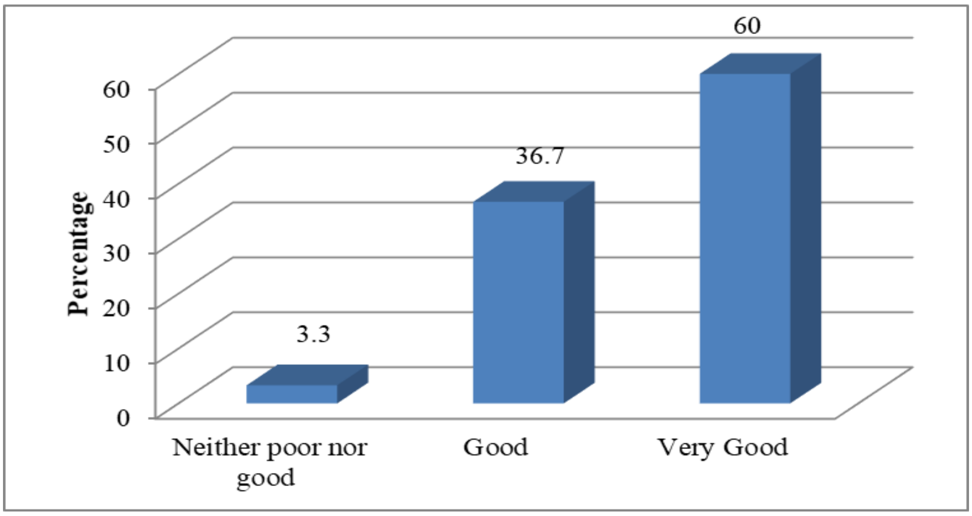


**Figure 2** shows how the overall health of participants was rated in the past two weeks.

Figure 2 represents the health update of participants in the last two weeks, the majority of participants reported being in very good general health. According to Figure 2, 36.7% of respondents said their health was "Good," while 60% said it was "Very Good." Just 3.3% of respondents said their health was "Neither poor nor good."

**Table 1:** Frequency of adverse physical symptoms (e.g., fatigue, pain) experienced by participants after using a reused dialyzer compared to a new one

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| Never | 59 | 98.3 |
| Rarely | 1 | 1.7 |

Table 1 presents an overview of the occurrence of negative physical symptoms (like fatigue or pain) following the use of a reused dialyzer in comparison to a new one. The majority of participants (98.3%) stated that they did not encounter any adverse symptoms, while just 1.7% reported occasionally experiencing such symptoms.

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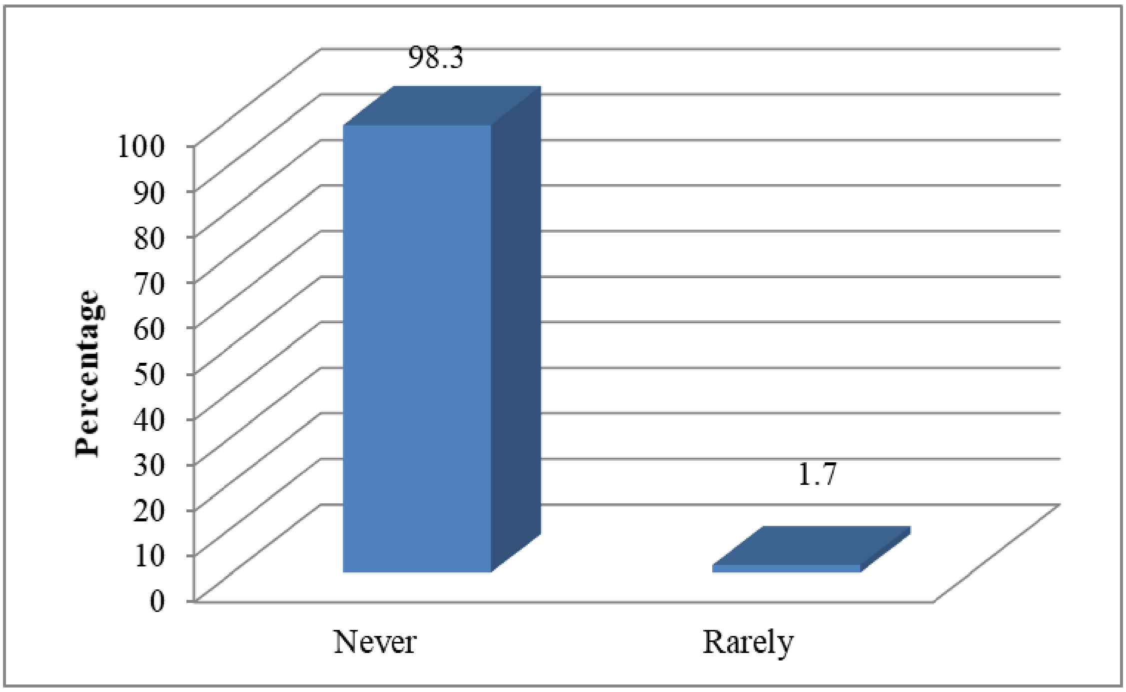


**Figure 3:** Percentage of participants who experienced adverse physical symptoms such as fatigue or pain, after using reused dialyzers compared to new ones

These clinical observations align with established safety benchmarks, suggesting that standardized reprocessing protocols effectively mitigate the risk of intradialytic complications and systemic inflammatory responses [39].

Figure 3 shows that 98.3% of participants did not report any adverse physical symptoms like pain or fatigue. Only 1.7% experienced such symptoms, indicating minimal physical side effects in the study population.

**Table 2:** Participants responses on whether their energy levels for everyday activities were affected by the use of reused dialyzers

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| Not at all | 58 | 96.7 |
| A little | 2 | 3.3 |

These results suggest that dialyzer reuse does not significantly impair patient quality of life, as the vast majority of participants maintained their typical daily energy levels furthermore, the analysis of direct medical costs demonstrated a substantial reduction in expenditure for the reuse group compared to the single-use cohort, underscoring the potential for improved resource allocation in resource-constrained dialysis settings.

The absolute absence of reported post-dialysis complications requiring supplementary medical intervention reinforces the clinical safety profile of current reprocessing practices [40]**Table 3: Frequency with which additional medical treatment was needed due to complication from the use of reused dialyzers.**

**Table 3:** Frequency with which additional medical treatment was needed due to complication from the use of reused dialyzers

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| Never | 59 | 98.3 |
| Rarely | 1 | 1.7 |

This clinical data indicates that the adoption of standardized reprocessing protocols successfully minimizes severe adverse events, maintaining a patient safety record comparable to single-use modalities [41].

Furthermore, the economic viability of this approach, characterized by significant savings in consumable expenditures, permits a strategic redistribution of funds toward enhancing auxiliary support services, thereby fostering improved long-term patient well-being

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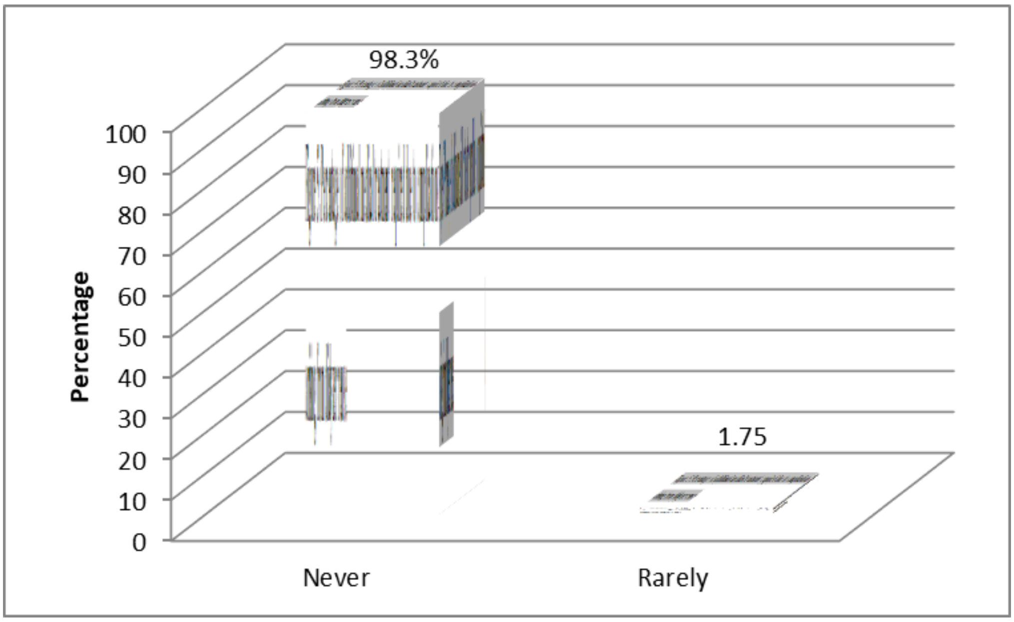


**Figure 5:** Percentage of additional medical treatment required due to complications arising from dialyzer reuse

Figure 5 shows that 98.3% of participants never required additional medical treatment due to complications associated with dialyzer reuse, whereas only 1.7% required such treatment rarely. These findings indicate that complications related to dialyzer reuse were minimal.

**Table 5:** Descriptive statistics of Psychological Health

| **Variables** | **Options** | **Frequency (n)** | **Percentage (%)** |
|---|---|---|---|
| How concerned are you about the safety and effectiveness of using reused dialyzers | Not at all concerned | 56 | 93.3 |
| Slightly concerned | 2 | 3.3 | |
| Moderately concerned | 2 | 3.3 | |
| How confident do you feel in the quality of care you receive when using reused dialyzers? | Not at all confident | 7 | 11.7 |
| Slightly confident | 2 | 3.3 | |
| Very confident | 11 | 18.3 | |
| Extremely confident | 40 | 66.7 | |
| How often do you feel anxious or stressed about your dialysis treatment due to the reuse of dialyzers? | Never | 57 | 95 |
| Sometime | 1 | 1.7 | |
| Often | 1 | 1.7 | |
| Always | 1 | 1.7 | |

These psychological assessments reveal high levels of patient trust in existing reprocessing practices, as evidenced by 85% of respondents expressing significant confidence in the quality of care provided. Consistent with prior longitudinal data, these favorable quality-of-life and safety metrics support the conclusion that reuse programs optimize medical waste management without compromising clinical efficacy

**Percentage of participants who expressed concern about the safety and effectiveness of using reused dialyzers.**

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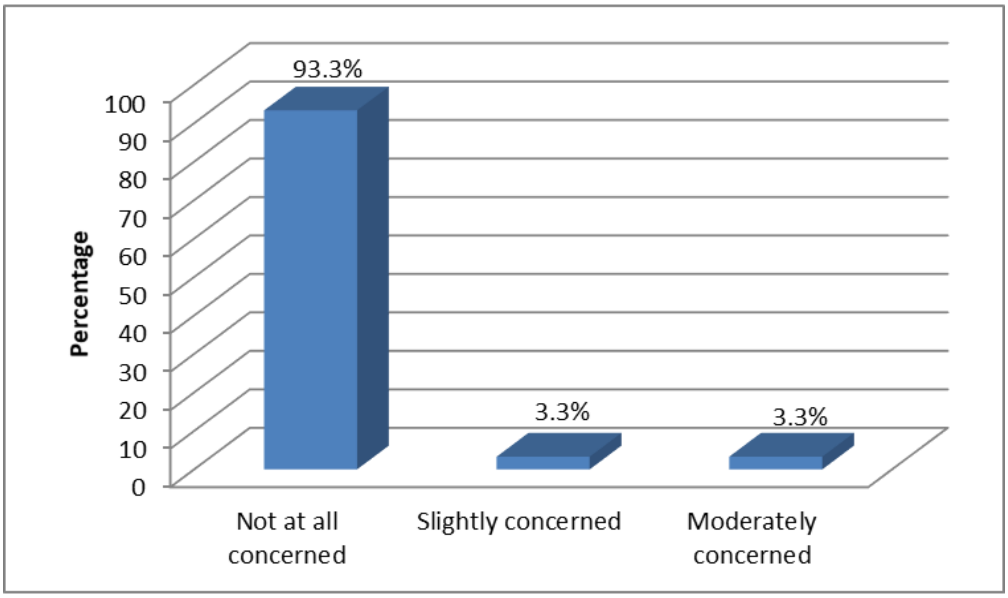


Figure 6 illustrates that 93.3% of the study cohort reported no concern regarding the safety or clinical efficacy of the reprocessed dialyzers, reflecting a high degree of patient acceptance. Moreover, the observed correlation between standardized reuse protocols and reduced financial burden suggests that such programs provide a sustainable model for high-quality, cost-effective renal replacement therapy in developing clinical environments [42,43].

## DISCUSSION

These findings agree with previous research showing that dialyzer reuse can maintain adequate hemodialysis, as measured by Kt/V and URR, while reducing the cost of long-term dialysis care [42].Furthermore, the stable patient-reported outcomes are consistent with evidence that dialyzer reuse does not worsen survival or increase medical waste [44]. However, the inherent limitations of this registry-based approach—most notably the absence of randomization and a formal comparator group—warrant caution when attributing clinical outcomes exclusively to reuse practices [45]. Additionally, while the data suggests that psychosocial well-being remains high, future studies should employ validated, culture-specific quality-of-life instruments to better account for socioeconomic variables and potential barriers to care that may influence patient perception [46,47]. Moreover, the broader implications of these findings suggest that institutionalized reuse programs can effectively bridge the resource gap in endemic regions, provided that stringent sterilization and quality control are consistently maintained [48,49]. Future research should also investigate whether specific demographic factors influence clinical adherence to these protocols, as targeted educational interventions remain critical for optimizing outcomes in resource-limited settings [50]. Ultimately, these results suggest that while reuse is a viable strategy for enhancing financial sustainability, individual units must tailor these protocols to their unique clinical environment and patient demographics to ensure consistent safety and efficacy [51]. Rigorous multi-center randomized trials are nonetheless warranted to reach definitive conclusions regarding the long-term safety profile and survival outcomes compared to single-use alternatives [52]. Furthermore, prospective evaluations should incorporate longitudinal assessments of membrane integrity biomarkers to better understand the mechanistic impacts of repeated processing cycles on uremic clearance [53].

## CONCLUSION

This study demonstrates that dialyzer reuse, when managed through rigorous, standardized reprocessing protocols, remains a safe and economically viable strategy for maintenance hemodialysis [20]. By facilitating substantial resource savings without compromising patient-reported quality of life, these programs provide a robust model for sustainable nephrology care in resource-constrained settings [54]. A practical priority is to establish barcode-based traceability for every reprocessed dialyzer, linking its processing history, clinical use, and adverse-event reports to a centralized quality-control database [55].Additionally, each center should adopt locally appropriate quality-improvement measures to reduce infection risks and protect patients at every stage of dialyzer reprocessing.

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date: 02-07-2025 Mrs.REEFA

Place: Mangalore

| Abbreviation | Full Form |
|---|---|
| QOL | Quality of Life |
| WHO | World Health Organization |
| WHOQOL-BREF | World Health Organization Quality of Life – BREF |
| HD | Hemodialysis |
| CKD | Chronic Kidney Disease |
| ESRD | End-Stage Renal Disease |
| SPSS | Statistical Package for the Social Sciences |
| SD | Standard Deviation |
| IRB | Institutional Review Board |
| BUN | Blood Urea Nitrogen |
| eGFR | Estimated Glomerular Filtration Rate |
| Kt/V | Dialysis Adequacy (K = dialyzer clearance, t = time, V = volume of distribution of urea) |
| HCV | Hepatitis C Virus |
| HIV | Human Immunodeficiency Virus |
| RRF | Residual Renal Function |
| QALY | Quality-Adjusted Life Year |
| CAD | Coronary Artery Disease |
| LMIC | Low-to-middle-income countries |
| RCT | Randomized Controlled Trials |

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