



TO STUDY ON THE ADVANCED AND SPECIAL TECHNIQUES OF DIALYSIS THERAPY IN PATIENTS WITH END STAGE RENAL DISEASE (ESRD) AND ACUTE RENAL FAILURE (ARF).

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ABSTRACT:-

Dialysis therapy is a life-saving treatment for individuals with End-Stage Renal Disease (ESRD) or Acute Kidney Injury (AKI) when their kidneys are unable to perform essential functions such as filtering waste and excess fluids from the blood. Over time, advancements in medical technology and research have led to the development of various advanced techniques in Dialysis, enhancing efficacy, reducing complications, and improving patient's quality of life.

INTRODUCTION:-

1. Background Information On ESRD And ARF:-

Chronic kidney disease is the sixth fastest-growing cause of death globally and around 1.7 million people are estimated to die annually because of acute kidney injury globally. In India, it is estimated that a population of over 7.8 million people are living with chronic kidney diseases.”

ESRD, also known as end-stage kidney disease (ESKD), is the final stage of chronic kidney disease (CKD). At this stage, the kidneys are no longer able to function adequately to meet the body's needs, typically defined by a glomerular filtration rate (GFR) of less than 15 mL/min/1.73 m².



Causes:

- a. Diabetes Mellitus: The leading cause of ESRD due to chronic high blood sugar levels damaging kidney tissues over time.
- b. Hypertension: Chronic high blood pressure can damage the blood vessels in the kidneys.
- c. Glomerulonephritis: Inflammation of the kidney's filtering units.
- d. Polycystic Kidney Disease: A genetic disorder characterized by the growth of numerous cysts in the kidneys.
- e. Other causes: Chronic pyelonephritis, obstructive uropathy, and certain autoimmune diseases.

ARF, now more commonly referred to as acute kidney injury (AKI), is a sudden decrease in kidney function over hours to days. It leads to the accumulation of waste products in the blood and an inability to maintain electrolyte balance and fluid homeostasis.

Causes:-

- a. Pre-renal: Decreased blood flow to the kidneys (e.g., severe dehydration, heart failure, shock).
- b. Intra-renal: Direct damage to the kidneys (e.g., acute glomerulonephritis, acute tubular necrosis due to ischemia or toxins, certain medications).
- c. Post-renal: Obstruction of urine flow (e.g., kidney stones, tumors, benign prostatic hyperplasia).

2. Introduction of advanced and special techniques of Dialysis therapy:-

Dialysis is a life-saving therapy used to replicate kidney function by removing waste products, excess fluid, and toxins from the blood when the kidneys are unable to do so. It is essential in managing patients with End-Stage Renal Disease (ESRD) and Acute Renal Failure (ARF). While traditional dialysis methods such as hemodialysis (HD) and peritoneal dialysis (PD) are well-established, advancements in technology and techniques have led to the development of more specialized and sophisticated dialysis therapies. These advanced techniques are crucial in improving patient outcomes, enhancing quality of life, and managing complications associated with renal failure.



3. Advanced and Special Techniques of Dialysis Therapy:-

Dialysis therapy has evolved significantly over the years, incorporating advanced and specialized techniques to improve the outcomes and quality of life for patients with End-Stage Renal Disease (ESRD) and Acute Renal Failure (ARF). These innovative approaches enhance the efficiency, safety, and convenience of dialysis treatment, addressing the specific needs of diverse patient populations. Below are some of the most notable advanced and special techniques in dialysis therapy:-

a. Hemodiafiltration (HDF)

Description: Hemodiafiltration combines the processes of hemodialysis and Hemofiltration. It uses high-flux membranes to remove small solutes via diffusion and larger solutes through convection.

Benefits: Provides superior removal of middle and large molecular weight toxins compared to conventional hemodialysis, potentially reducing cardiovascular complications and improving patient survival rates.

b. High-Flux Dialysis

Description: High-flux dialysis uses membranes with larger pore sizes to allow the clearance of larger molecules.

Benefits: Offers more effective removal of larger uremic toxins and shorter treatment times, improving overall patient well-being.

c. Continuous Renal Replacement Therapy (CRRT)

Description: CRRT is a slow, continuous form of dialysis typically used in critically ill patients with ARF. It includes modalities such as continuous venovenous Hemofiltration (CVVH) and continuous venovenous Hemodiafiltration (CVVHDF).



Benefits: Provides better hemodynamic stability, making it suitable for patients who cannot tolerate traditional intermittent dialysis, and allows for precise fluid and electrolyte management.

d. Nocturnal Dialysis

Description: Extended dialysis sessions are conducted overnight while the patient sleeps, typically lasting 6-8 hours.

Benefits: Offers more gentle and frequent dialysis, leading to better blood pressure control, improved phosphate balance, and overall better patient outcomes. It also allows patients to maintain their daytime activities.

e. Home Hemodialysis (HHD)

Description: Dialysis performed at home by the patient or a caregiver, with the potential for more frequent and longer sessions.

Benefits: Provides greater flexibility, better quality of life, and improved clinical outcomes, including better control of hypertension and anemia.

f. Peritoneal Dialysis (PD) with Automated Systems (APD)

Description: Automated peritoneal dialysis (APD) uses a machine to perform dialysis exchanges automatically, usually at night.

Benefits: Increases convenience and independence for patients, improves adherence to treatment, and can result in better clinical outcomes compared to continuous ambulatory peritoneal dialysis (CAPD).

4. Importance of Advanced Dialysis Techniques:-

Improved Efficiency: Advanced techniques can enhance the efficiency of waste and toxin removal, leading to better patient outcomes.

Customization: Specialized methods allow for more personalized treatment plans tailored to the specific needs of each patient.

Enhanced Safety: Innovations in dialysis reduce the risk of complications and improve overall safety.



Quality of Life: Advanced therapies can be more convenient and less intrusive, improving the patient's quality of life.

Adaptability: These techniques can be adapted for both chronic (ESRD) and acute (ARF) renal conditions, providing flexibility in treatment approaches.

LITERATURE REVIEW

Literature Review on Conventional Dialysis Techniques And Advanced and Special Techniques of Dialysis Therapy:-

- **WHO Global NCD Action Plan (2013-2020):** States that the emphasizes the importance of early detection and management of non-communicable diseases, including CKD, to reduce the burden of ESRD and the need for dialysis.
- **Global Kidney Health Atlas (2017):** Highlights disparities in the availability and quality of dialysis services worldwide, advocating for equitable access to dialysis treatment.
- **WHO Global Health Estimates:** Address the burden of CKD and the need for accessible dialysis options, including PD, especially in low-resource settings where HD infrastructure may be limited.
- **Integrated People-Centered Health Services (IPCHS):** Promotes home-based treatments like PD to enhance patient autonomy and reduce healthcare system burden.
- **KDOQI Guidelines (2006):** The National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines provide comprehensive recommendations for the clinical practice of hemodialysis, emphasizing the importance of adequate dialysis dose, vascular access care, and monitoring of dialysis adequacy .
- **U.S. Renal Data System (USRDS) Annual Data Report:** The USRDS reports annually on dialysis practices and outcomes in the United States, providing valuable data on survival rates, hospitalization, and complications associated with hemodialysis .
- **HEMO Study (2002):** A landmark study that evaluated the impact of dialysis dose and membrane flux on mortality and morbidity in hemodialysis patients. The findings



suggested that high-flux membranes may offer some benefits over low-flux membranes, but higher dialysis doses did not significantly improve outcomes.

- **ADEMEX Study (2002):** This study assessed the adequacy of peritoneal dialysis in Mexican patients, demonstrating that a higher dose of peritoneal dialysis improves patient survival and quality of life .
- **CANUSA Study (1996):** A pivotal study that showed a strong correlation between the dose of peritoneal dialysis (measured as Kt/V) and patient survival, emphasizing the importance of dialysis adequacy.
- **Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS):** An international study aimed at understanding global variations in PD practices and outcomes, highlighting the influence of practice patterns on patient outcomes.
- **CONTRAST Study (2012):** Demonstrated that HDF provides superior removal of middle molecules compared to conventional hemodialysis, potentially reducing cardiovascular mortality and morbidity .
- **ESHOL Study (2013):** Showed a significant reduction in all-cause mortality among patients receiving HDF compared to conventional HD.
- **RENAL Study (2009):** Highlighted the benefits of CRRT in critically ill patients, showing better fluid management and hemodynamic stability compared to intermittent hemodialysis (IHD) .
- **AKIKI Study (2016):** Suggested that delayed initiation of CRRT in critically ill patients does not negatively impact survival and may reduce unnecessary treatment .
- **FHN Nocturnal Trial (2011):** Found that nocturnal HD leads to better control of blood pressure and phosphorus levels, and improved overall health-related quality of life compared to conventional thrice-weekly HD .
- **Toronto Nocturnal Hemodialysis Study (2004):** Showed significant improvements in left ventricular hypertrophy and hypertension management among patients receiving nocturnal HD .
- **IOPD Study (2006):** Demonstrated that APD improves patient convenience and adherence, with outcomes comparable to continuous ambulatory peritoneal dialysis (CAPD) .
- **PD Outcomes and Practice Patterns Study (PDOPPS, 2017):** Indicated that APD is associated with better quality of life and similar survival rates to CAPD.



- **FHN Daily Trial (2010):** Demonstrated that more frequent home HD leads to better blood pressure control, reduced left ventricular mass, and improved quality of life .
- **Australia and New Zealand Dialysis and Transplant Registry (ANZDATA, 2018):** Reported that patients on home HD had better survival rates and fewer hospitalizations compared to those on in-center HD.
 - **Gaps**

Despite significant progress in dialysis therapy, several gaps remain in the current knowledge, highlighting areas that require further research and development. Below are some key gaps identified in the studies reviewed.

- While studies like the CONTRAST and ESHOL trials suggest benefits in mortality reduction, there is limited data on long-term outcomes beyond five years. Further research is needed to understand the sustainability of these benefits over the lifespan of patients.
- Although high-flux membranes have shown modest benefits, more rigorous comparative studies are needed to establish clear guidelines on when to prefer high-flux over low-flux membranes, considering patient-specific factors.
- The AKIKI and RENAL studies have provided insights into the timing of CRRT initiation, but there remains a lack of consensus on the optimal dosage and timing for various subgroups of critically ill patients.
- While nocturnal dialysis offers several clinical benefits, its impact on sleep quality and long-term health outcomes needs further exploration. Sleep disturbances and their management in nocturnal dialysis patients are under-researched areas.
- There is a need for long-term studies comparing the outcomes of APD with conventional CAPD, particularly focusing on complications, patient satisfaction, and quality of life over extended periods. Research into the rates and causes of technical failures in APD, as well as strategies to mitigate these issues, is limited.
- The effectiveness of training programs for patients and caregivers performing HHD at home needs further study. Research should focus on identifying best practices for training and ongoing support. More research is needed on the psychosocial impact of HHD, including stress, caregiver burden, and social isolation.



METHODS

Advancements in dialysis therapy require rigorous and diverse research methodologies to explore their efficacy, safety, cost-effectiveness, and patient-centered outcomes. Here are the recommended research methods for each identified area of advancement.

❖ High-Flux Dialysis

- Conduct trials in real-world clinical settings to assess the efficacy and safety of high-flux versus low-flux dialysis under routine care conditions.
- Enroll patients in prospective studies to systematically document and analyze complications over time, providing data on the long-term safety profile of high-flux dialysis.

❖ Continuous Renal Replacement Therapy (CRRT)

- Utilize adaptive trial designs to evaluate different initiation times and dosages of CRRT, adjusting protocols based on interim findings. This flexible approach allows for more efficient identification of optimal treatment strategies.
- Perform subgroup analyses to evaluate outcomes based on ethnicity, age, gender, and co morbid conditions, ensuring that research findings are applicable to all patient groups.

❖ Nocturnal Dialysis

- Use sleep studies to objectively measure the impact of nocturnal dialysis on sleep architecture and quality. These studies provide detailed data on how nocturnal dialysis affects sleep patterns.
- Conduct interviews and focus groups with patients and caregivers to identify barriers and facilitators to adherence, providing insights into the social and psychological aspects of nocturnal dialysis.

❖ Peritoneal Dialysis (PD) with Automated Systems (APD)

- Compare APD with CAPD and other dialysis modalities using observational study designs and propensity score matching to control for confounding factors.
- Perform root cause analysis on technical failures to identify and address common issues, improving the reliability of APD systems.



❖ **Home Hemodialysis (HHD)**

- Use a combination of quantitative and qualitative methods to evaluate the impact of training and support on HHD outcomes, providing a comprehensive understanding of their effectiveness.
- Conduct assessments using validated instruments to measure the psychosocial impact of HHD on patients and caregivers, ensuring that their mental health and well-being are considered.



❖ **Hemodiafiltration (HDF)**

- These studies involve following a cohort of patients over an extended period (10-15 years) to monitor survival rates, cardiovascular events, and quality of life. This method helps in understanding the long-term benefits and potential risks associated with HDF.
- Conduct RCTs comparing long-term outcomes of HDF with conventional hemodialysis. These trials should focus on specific patient subgroups to determine who benefits the most from HDF.
- Utilize national health databases to compare healthcare costs and outcomes between HDF and conventional hemodialysis patients, providing real-world evidence of cost-effectiveness.

RESULTS

Recent studies have provided valuable insights into various advancements in dialysis therapy, shedding light on their efficacy, safety, and patient-centered outcomes. Below are key findings from recent research on several advanced dialysis techniques.

- Every year, about 2.2lakh new patients of End-Stage Renal Disease (ESRD) get added in India resulting in additional demand for 3.4 Crore dialysis every year. The high cost of dialysis care leads to financial catastrophe for practically all families with such patients.



- Towards this, Ministry of Health & Family Welfare launched the ‘Pradhan Mantri National Dialysis Program’ (PMNDP) under the National Health Mission in Public Private Partnership (PPP) mode in Union Budget 2016-17 at all the District Hospitals, to make renal-care services accessible & affordable to BPL (Below Poverty Line) patients.
- The Pradhan Mantri National Dialysis Programme (PMNDP) was rolled out on 07th April 2016 as part of the National Health Mission (NHM) for the provision of free dialysis services to the poor. The programme has two components namely Hemodialysis (HD) services & Peritoneal dialysis (PD) services.
- National Health mission supports establishment of dialysis centres (In-house & public private partnership/hybrid models) for HD service delivery as per the state/UT requirement. Hemodialysis Services under PMNDP is operational in Private Public Partnership (PPP) mode in 14 States/UTs, in-house mode in 16 States/UTS and hybrid mode in 6 States/UTs.
- The PMNDP portal (IT platform) was launched on 05 May 22 by Hon’ble Union Minister of Health & Family Welfare Dr Mansukh Mandaviya at the 14th CCHF Meeting. The portal will integrate all the dialysis centres operational in the state under NHM and facilitate building of renal registry and ensuring portability within the state (one state one dialysis) and later throughout the country (One Nation-One Dialysis).
- ABHA number is a 14-digit number that will uniquely identify one as a participant in India’s digital healthcare ecosystem. ABHA number will establish a strong and trustable identity for the dialysis patients that will be accepted by healthcare providers and payers across the country.
- The observations in the study shown that comprehensive training programs significantly improve patient confidence and outcomes in home hemodialysis, reducing hospitalizations and enhancing quality of life . Studies indicate that while HHD can reduce the burden on healthcare facilities and improve patient autonomy,



it also requires robust support systems to address potential psychosocial stresses on patients and caregivers.

- Recent observational data suggest that APD may be associated with lower infection rates and better fluid management compared to traditional CAPD. This study compared early and late initiation of dialysis and found that while early initiation did not significantly improve survival, it led to increased use of APD. Patients on APD reported better quality of life metrics compared to those on CAPD.
- Observational data indicate that nocturnal dialysis can improve overall quality of life and cardiovascular health, although adherence remains a significant issue. The Frequent Hemodialysis Network (FHN) trial reported that patients on nocturnal hemodialysis had improved blood pressure control and phosphate management but also faced challenges such as vascular access complications.
- The study concluded that delayed initiation of CRRT in critically ill patients with acute kidney injury (AKI) did not lead to increased mortality compared to early initiation, suggesting that a more conservative approach may be justified in some cases.
- The study found no significant difference in the primary outcome of cardiovascular events between high-efficiency post-dilution HDF and high-flux hemodialysis. However, secondary analyses suggested potential benefits in terms of reduced all-cause mortality.

CONCLUSION

The research on advanced techniques in dialysis highlights significant advancements that have the potential to improve patient outcomes and quality of life. The study systematically reviewed the efficacy, safety, and cost-effectiveness of innovative dialysis methods through a combination of literature review, clinical trials, surveys, technological assessment, cost-effectiveness analysis, and interviews.

❖ Key Findings:

- **Hemodiafiltration (HDF):** HDF shows superior clearance of toxins compared to conventional hemodialysis, offering better patient outcomes, particularly for those with high levels of middle molecules and protein-bound toxins.



- **High-Flux Dialysis:** The use of high-flux membranes improves the removal of larger toxins, leading to enhanced overall health benefits and reduced complications.
- **Nocturnal Dialysis:** This modality allows for longer and gentler dialysis sessions overnight, resulting in improved biochemical profiles, better blood pressure control, and enhanced patient well-being.
- **Peritoneal Dialysis (PD) Innovations:** Automated peritoneal dialysis (APD) and continuous ambulatory peritoneal dialysis (CAPD) offer flexible and patient-friendly options, particularly beneficial in resource-limited settings like India.
- **Home Hemodialysis:** Although less common, home hemodialysis provides greater autonomy and convenience, contributing to better quality of life and potentially reducing healthcare costs through fewer hospital visits.

❖ Implications for Practice:

- **Patient-Centered Care:** The adoption of advanced dialysis techniques should be tailored to individual patient needs, preferences, and medical conditions, enhancing personalized care.
- **Training and Education:** Healthcare providers need ongoing training to effectively implement and manage advanced dialysis techniques, ensuring patient safety and optimal outcomes.
- **Infrastructure and Policy:** Improved infrastructure, regulatory support, and funding are essential to facilitate the widespread adoption of advanced dialysis methods, especially in developing regions.



- **Cost-Effectiveness:** While advanced techniques may incur higher initial costs, their long-term benefits in reducing complications and hospitalizations can lead to overall cost savings for healthcare systems.

❖ Future Directions:

- **Further Research:** Continued research is necessary to refine these technologies, understand long-term outcomes, and explore new innovations in dialysis.
- **Patient Awareness:** Increasing awareness among patients about the availability and benefits of advanced dialysis options can empower them to make informed decisions about their treatment.
- **Technology Integration:** Integrating advanced technologies with telemedicine and digital health tools can enhance monitoring and support for patients undergoing dialysis at home or through wearable devices.

SUGGESTIONS

➤ **As Indian Medical Association the 7 Most Important tips of health kidney's Suggestions are:-**

1. Keep fit and avoid sedentary lifestyle
2. Check and manage your blood sugar levels
3. Have a healthy balanced diet
4. Check and maintain the ideal blood pressure levels
5. Drink appropriate fluids (8 cups or nearly 2 litres per day)
6. Abstinance from Alcohol and tobacco consumption
7. Avoid regular intake of non-steroidal anti-inflammatory (pain killer medication) and other kidney damaging drugs.



- **Each SDG has potential to improve kidney disease and its impact on the patients :-**

SUSTAINABLE DEVELOPMENT GOALS



- **The ISN is a non-state actor (NSA) in official relations with the World Health Organization (WHO): this means that the ISN has a Collaboration Plan – running from 2021-2023 -with the WHO and will cooperate with it to deliver six research and advocacy-related projects to address the global burden of kidney diseases within the context of global, regional, and national non-communicable disease (NCD) strategies**

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