Short Communication
Volume 15:01, 2025

Journal of Nephrology & Therapeutics

ISSN: 2161-0959

Open Access

Recent Advances in Peritoneal Dialysis: A Narrative Review of Developments in Dialysis Fluid

Eric Roset*

Department of Nursing, Universitat de Girona, Girona, Catalonia, Spain

Introduction

Peritoneal dialysis has undergone significant advancements in recent years, particularly in the development of dialysis fluid, which plays a crucial role in the efficacy and biocompatibility of the therapy. Peritoneal dialysis fluid has evolved from conventional glucose-based solutions to more sophisticated formulations aimed at reducing peritoneal membrane damage, enhancing ultrafiltration efficiency, and improving patient outcomes. Understanding the latest progress in peritoneal dialysis fluid development is essential for optimizing treatment strategies and addressing complications associated with long-term therapy.

Traditional peritoneal dialysis fluids have primarily relied on glucose as the osmotic agent to facilitate fluid removal. While effective, chronic exposure to glucose and its degradation products has been associated with peritoneal membrane fibrosis, inflammation, and structural deterioration. This has prompted the exploration of alternative osmotic agents such as icodextrin and amino acid-based solutions. Icodextrin, a starch-derived polymer, offers prolonged ultrafiltration by maintaining oncotic pressure without the deleterious effects of glucose. Clinical studies have demonstrated that icodextrin-based solutions reduce glucose load, lower systemic glucose absorption, and help preserve peritoneal membrane integrity over time. Additionally, amino acid-based peritoneal dialysis solutions provide a dual benefit of ultrafiltration and nutritional support, particularly for malnourished patients undergoing long-term dialysis [1].

Description

The impact of peritoneal dialysis fluid composition on peritoneal membrane biocompatibility has been a central focus of recent research. Conventional solutions contain high concentrations of Glucose Degradation Products (GDPs), which contribute to local inflammation, mesothelial cell damage, and neoangiogenesis. To mitigate these adverse effects, new-generation peritoneal dialysis fluids with neutral pH and low GDP content have been developed. These biocompatible solutions help maintain mesothelial cell viability, reduce oxidative stress, and limit peritoneal fibrosis, thereby prolonging the effectiveness of peritoneal dialysis. Clinical trials have shown that patients using low-GDP, neutral-pH solutions experience fewer peritoneal complications, improved residual kidney function preservation, and better long-term ultrafiltration capacity. Osmotic agent innovations in peritoneal dialysis fluid have also led to the exploration of alternative solutes beyond glucose and icodextrin. Hyperbranched polyglycerol (HPG) and sodium chloride-based osmotic agents are currently under investigation for their potential to enhance ultrafiltration while minimizing metabolic and peritoneal membrane complications. HPG, in particular, has shown promise due to its biocompatibility, low inflammatory response, and ability to sustain peritoneal ultrafiltration without glucose-mediated toxicity. Research into these novel osmotic agents aims to develop peritoneal dialysis fluids that offer superior efficacy and reduced long-term adverse effects [2].

Beyond solute composition, the role of peritoneal dialysis fluid in modulating inflammatory responses and immune function has been increasingly recognized. Chronic peritoneal exposure to bioincompatible solutions can lead to peritonitis, fibrosis, and functional decline of the peritoneal membrane. Advances in fluid formulation now focus on incorporating anti-inflammatory and cytoprotective additives, such as bicarbonate-based buffering agents and antioxidants. Bicarbonate-buffered solutions, as opposed to lactate-based buffers, offer improved acid-base homeostasis while reducing peritoneal irritation and inflammation [3]. Additionally, antioxidants such as vitamin E and N-acetylcysteine are being investigated for their potential to mitigate oxidative stress and mesothelial injury in peritoneal dialysis patients. Personalized approaches to peritoneal dialysis fluid prescription are gaining traction as the understanding of patient-specific membrane characteristics and metabolic needs expands. Tailoring dialysis fluid selection based on peritoneal membrane transport status, residual kidney function, and metabolic profile allows for more individualized and effective treatment. For instance, patients with high peritoneal transport rates may benefit from icodextrin-containing regimens to optimize fluid balance, while those with malnutrition may require amino acid-enriched solutions. The integration of precision medicine in peritoneal dialysis fluid formulation is expected to improve patient adherence, reduce complications, and enhance overall treatment success.

Technological advancements in peritoneal dialysis delivery systems have further contributed to optimizing fluid management. Automated peritoneal dialysis (APD) has facilitated improved ultrafiltration control and patient convenience, with newer machines offering adaptive algorithms that adjust fill volumes and dwell times based on real-time patient data. The advent of remote monitoring systems has enabled healthcare providers to assess peritoneal dialysis fluid status and treatment efficacy remotely, allowing for early intervention in cases of inadequate dialysis or fluid imbalance [4]. These innovations, combined with advances in peritoneal dialysis fluid composition, are shaping the future of home-based dialysis care. The potential for bioengineered and regenerative medicine approaches in peritoneal dialysis fluid development is also being explored. Studies investigating the use of mesenchymal stem cell-derived factors and growth-promoting peptides in peritoneal dialysis fluid formulations aim to enhance peritoneal membrane repair and regeneration. These emerging strategies seek to counteract the progressive deterioration of the peritoneal membrane associated with long-term dialysis, ultimately extending the viability of peritoneal dialysis as a renal replacement therapy.

Despite the significant progress in peritoneal dialysis fluid development, challenges remain in balancing fluid efficacy, biocompatibility, and patient safety. Further research is needed to establish long-term clinical outcomes associated with novel dialysis fluid formulations, particularly regarding metabolic effects, cardiovascular risk, and peritoneal membrane longevity. Collaborative efforts between researchers, clinicians, and industry stakeholders will be essential in translating these advancements into widespread clinical practice [5].

Conclusion

In conclusion, recent advances in peritoneal dialysis fluid composition and delivery have led to improved biocompatibility, enhanced ultrafiltration, and better patient outcomes. The transition from conventional glucose-based solutions to innovative formulations incorporating icodextrin, amino acids, low-

***Address for Correspondence:** Eric Roset, Department of Nursing, Universitat de Girona, Girona, Catalonia, Spain; E-mail: roseteri@gmail.com*

Received: 01 January, 2025, Manuscript No. jnt-25-161748; **Editor assigned:** 03 Jnuary, 2025, Pre QC No. P-161748; **Reviewed:** 17 January, 2025, QC No. Q-161748; **Revised:** 23 January, 2025, Manuscript No. R-161748; **Published:** 31 January, 2025, DOI: 10.37421/2161-0959.2025.15.546

GDP compositions, and novel osmotic agents marks a significant step forward in peritoneal dialysis care. Personalized fluid prescription, technological integration, and emerging regenerative medicine approaches hold promise for further optimizing peritoneal dialysis therapy. As ongoing research continues to refine peritoneal dialysis fluid development, the future of peritoneal dialysis is expected to be characterized by greater efficacy, reduced complications, and improved quality of life for patients undergoing this life-sustaining treatment.

Acknowledgment

None.

Conflict of Interest

None.

References

1. Nakayama, Masaaki, Masanobu Miyazaki, Kazuho Honda and Kenji Kasai, et al. "Encapsulating peritoneal sclerosis in the era of a multi-disciplinary approach based on biocompatible solutions: the NEXT-PD study." *Perit Dial Int* 34 (2014): 766-774.
2. Honda, Kazuho, Kosaku Nitta, Shigeru Horita and Wako Yumura, et al. "Accumulation of advanced glycation end products in the peritoneal vasculature of continuous ambulatory peritoneal dialysis patients with low ultra-filtration." *Nephrol Dial Transplant* 14 (1999): 1541-1549.
3. Witowski, Janusz, Justyna Wisniewska, Katarzyna Korybalska and Thorsten O. Bender, et al. "Prolonged exposure to glucose degradation products impairs viability and function of human peritoneal mesothelial cells." *J Am Soc Nephrol* 12 (2001): 2434-2441.
4. Ito, Yasuhiko, Ting Sun, Mitsuhiro Tawada and Hiroshi Kinashi, et al. "Pathophysiological mechanisms of peritoneal fibrosis and peritoneal membrane dysfunction in peritoneal dialysis." *Int J Mol Sci* 25 (2024): 8607.
5. Hansson, Joni H. and Suzanne Watnick. "Update on peritoneal dialysis: core curriculum 2016." *Am J Kidney Dis* 67 (2016): 151-164.

How to cite this article: Roset, Eric. "Recent Advances in Peritoneal Dialysis: A Narrative Review of Developments in Dialysis Fluid." *J Nephrol Ther* 15 (2025): 546.