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Artificial intelligence for home dialysis: An innovative response to the challenges of chronic kidney disease in the French West Indies and French Guiana

(L'intelligence artificielle au service de la dialyse à domicile : une réponse innovante aux défis de la maladie rénale chronique aux Antilles Guyane)

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Summary

Chronic kidney disease is a major global public health issue. It affects nearly 850 million people and is one of the fastest-growing causes of premature death. In France's overseas territories, particularly in the French West Indies and French Guiana region, end-stage renal failure imposes a disproportionate burden, amplified by low medical density, geographical dispersion, and cultural diversity. Home dialysis, including peritoneal dialysis and hemodialysis, is an indispensable tool that improves quality of life, autonomy, and continuity of care. However, its adoption remains limited by human, organizational, and medical obstacles. In this context, artificial intelligence is emerging as a strategic lever for overcoming these limitations, enabling the prediction of complications, the optimization of personalized treatment, and proactive remote monitoring. However, it is imperative that, in view of its deployment, particular attention be paid to ethical aspects, data protection, training of professionals, and adaptation to local cultural specificities. International experience shows that these innovative approaches improve safety, adherence, and technical survival. In overseas territories, contextualized and adapted artificial intelligence can make home dialysis a scalable, equitable, and sustainable solution that addresses both health challenges and organizational constraints, while placing the patient and their sociocultural context at the heart of care.

Résumé

La maladie rénale chronique représente un enjeu majeur de santé publique mondiale. Elle affecte près de 850 millions de personnes et figure parmi les causes de mortalité prématurée dont la croissance est la plus rapide. Dans les territoires ultramarins français et particulièrement aux Antilles-Guyane, l'insuffisance rénale terminale impose un fardeau disproportionné, amplifié par la faible densité médicale, la dispersion géographique et la diversité culturelle. La dialyse à domicile, incluant la dialyse péritonéale et l'hémodialyse, constitue un outil indispensable, améliorant la qualité de vie, l'autonomie et la continuité des soins. Cependant, son adoption reste limitée par des obstacles humains, organisationnels et médicaux. Dans ce contexte, l'intelligence artificielle émerge comme un levier stratégique permettant de surplomber ces limites, en permettant la prédiction des complications, l'optimisation personnalisée des traitements et la télésurveillance proactive. Toutefois, il s'avère impératif en vue de son déploiement qu'une attention particulière soit portée aux aspects éthiques, à la protection des données, à la formation des professionnels et à l'adaptation aux spécificités culturelles locales. Les expériences internationales démontrent que ces approches innovantes améliorent la sécurité, l'adhésion et la survie technique. Dans les territoires ultramarins, l'intelligence artificielle contextualisée et adaptée peut ériger la dialyse à domicile en une solution scalable, équitable et durable, répondant à la fois aux défis sanitaires et aux contraintes organisationnelles, tout en plaçant le patient et son contexte socioculturel au cœur de la prise en charge.

Keywords: French West Indies and Guiana, home dialysis, artificial intelligence, chronic kidney disease

Mots-clés : Antilles-Guyane, dialyse à domicile, intelligence artificielle, maladie rénale chronique

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Introduction

Chronic kidney disease, a neglected global health issue

Chronic kidney disease (CKD) is now a major global public health problem, affecting nearly 850 million people [1]. It is one of the fastest-growing causes of premature mortality among chronic noncommunicable diseases (NCDs) [1]. Some projections place it as the fifth leading cause of death worldwide by 2040 [1, 3].

Despite its considerable burden, CKD remains insufficiently recognized as a health priority. Francis et al. [1] emphasize the urgent need to include CKD on the list of NCDs officially recognized by the WHO, thereby enabling the structuring of national policies, the development of renal registries, the allocation of adequate resources, and the stimulation of innovation, particularly in renal replacement therapies [1, 3]. This lack of recognition contributes to widening inequalities, as disadvantaged populations, low-income countries, and small island states bear the heaviest burden [2, 3].

These issues are particularly acute in overseas territories, where geographical dispersion, low medical density, and cultural diversity make care complex and require innovative, tailored solutions. The same is true in the French West Indies and French Guiana, where the incidence and prevalence of chronic kidney disease are much higher than in mainland France [4].

French West Indies and Guiana: Epidemiological disparities influenced by socioeconomic factors

In France, more than 100,000 patients received renal replacement therapy in 2023, mainly through hemodialysis in centers [4]. In the French West Indies and French Guiana, prevalence is higher, dialysis is started earlier, and a higher proportion of patients have diabetes and hypertension [4].

According to the REIN 2023 report, the standardized incidence rate of renal failure is 162 per million inhabitants in mainland France, compared to 297 per million in the overseas departments, with extreme values in French Guiana (425 per million) and Réunion (353 per million) [4]. The incidence is higher in men, particularly after the age of 45.

Table I. Comparison of the incidence of renal failure

Territory	**Incidence (per million people)**	**Comment**
France	162	National reference value
Overseas departments and territories	297	Average for overseas territories
French Guiana	425	High local burden, frequent late presentation, high proportion of comorbidities
Guadeloupe	24	High standardized incidence
Martinique	256	Structural disparity
Mayotte	242	Variability according to medical density and access to care
Réunion	353	Very high standardized incidence

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These data highlight extremely high incidence rates in the French overseas departments, particularly in French Guiana and Réunion, often two to three times higher than those in mainland France. They underscore the health emergency and the need for innovative solutions adapted to geographical constraints, limited medical density, and local cultural diversity.

Treatment modalities for chronic kidney disease and the role of home dialysis

Kidney transplantation remains the treatment of choice for renal failure, but access to it remains limited due to a shortage of transplants [5]. In-center hemodialysis is the most common treatment option, but it is costly, restrictive, and ill-suited to the sociocultural and geographical realities of island territories [6].

Home dialysis modalities, including peritoneal dialysis (PD) and home hemodialysis (HHD), offer significant advantages, including improved quality of life, reduced hospitalizations, promotion and maintenance of increased autonomy, and cost optimization [7]. However, they are used by less than 10% of patients in France [8], compared to other countries where home treatment is more common (16.7% in New Zealand [9], more than 20% in Canada 25%, and the Nordic countries) [10]. This contrast highlights France's lag in home dialysis, even though these methods are recognized for their benefits.

Several types of obstacles can explain this lower use of home dialysis [8]:

• Human: Low acculturation (doctors/patients), cultural acceptability, burden on the caregiver, patient anxiety.
• Organizational: Logistical requirements, insufficient training, isolation.
• Medical: Risk of infection in PD, hemodynamic stability in HHD [10].
• Additionally, the linguistic and cultural complexity of local populations requires appropriate training and support tools to ensure patient adherence and safety.

The role and innovations of artificial intelligence in home dialysis techniques

The idea of digitally monitoring home dialysis patients is not new. As early as the late 1990s, the DIATELIC project had already demonstrated the feasibility of a remote monitoring system for home dialysis patients in France, foreshadowing current approaches to e-health and connected monitoring [11].

Artificial intelligence (AI) is now a major lever for optimizing home dialysis in contexts where human, organizational, and medical constraints limit its widespread use [12]. The most promising applications involve predicting complications, personalizing treatments, and proactive remote monitoring.

1. Applications in peritoneal dialysis (PD) and home hemodialysis (HHD)

AI technologies applied to PD and HHD aim to enhance patient safety and autonomy through continuous analysis of physiological and technical data.

They intervene at several levels:

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• Prediction of complications and loss of technique: Machine learning models identify patients at risk of peritonitis (algorithms analyzing dialysate and symptoms to detect early abnormalities, PD failure, or hemodynamic instability), enabling preventive interventions (Hammami et al., 2024) [13, 14].
• Optimization of prescriptions and ultrafiltration patterns: Algorithms automatically adjust the volumes, durations, and frequency of dialysis exchanges according to the patient's hydration, metabolic, and cardiovascular profiles [13, 14]. These approaches are based on multicenter observational studies, particularly in Japan and Taiwan [12, 15].
• Surveillance and smart alerts: Connected platforms analyze data from dialysis devices (pressure, volume, flow rate, biological parameters) in real time and generate automatic alerts in the event of an anomaly [16]. North American pilot studies have shown a decrease in hospitalizations and major adverse events [17].
• Adaptive learning and remote support: Through continuous learning, systems adjust their recommendations based on historical data and patient behavior [13, 14]. Nephrologists can simultaneously monitor multiple patients via secure interfaces, optimizing the medical workload in areas with low professional density [15].

2. Hybrid systems and smart remote monitoring

The integration of these tools into hybrid remote monitoring systems enables a comprehensive and proactive approach:

• Automatic alerts and predictive planning: Triggering interventions before complications arise [18].
• Multimodal analysis: Combining biological, hemodynamic, and behavioral parameters to refine anomaly detection and improve treatment adherence [18].
• Integration with national registries: Improving data quality, clinical research, and practice evaluation [4, 9].

International examples of integrating artificial intelligence into home dialysis

Experiments conducted in other countries provide proof of concept demonstrating AI's potential in home dialysis. However, they are not directly transferable to the health systems in the French West Indies and French Guiana and must be adapted to the geographical, sociocultural, and economic context, as well as the legislation in force in France and Europe.

In Japan, the government has rolled out a national program of AI-assisted PD and telemonitoring [12]. The main innovations include predicting technique loss, preventing peritonitis, personalized monitoring, and continuing education. The Japanese model combines predictive machine learning, telemonitoring, and continuing education, providing a benchmark for island territories with low medical coverage. It also illustrates the importance of locally managing the training of healthcare teams and patients speaking different languages [12].

In Taiwan, the integration of AI into PD is based on predictive analysis of complications and optimization of personalized prescriptions. This approach demonstrates that AI can improve safety, efficiency, and personalization even in decentralized, densely populated urban systems, and illustrates the importance of remotely accessible platforms in island contexts [15].

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In the United States, several connected digital platforms are already being deployed for PD and HHD, which predict technique loss, optimize personalized prescriptions, and integrate remote monitoring. Pilot programs and large-scale deployments have shown a notable improvement in safety, treatment adherence, and patient quality of life [13].

Table II. Summary comparison of international AI models in home dialysis

Country	Targeted modality	Type of AI/function	Observed impact	Special features
Japan	PD	Machine learning, prediction of loss of technique, remote monitoring	Reduction in hospitalizations, improved adherence	National program, centralized monitoring, continuing education [12]
Taiwan	PD	Predictive analysis of complications, optimization of prescriptions	Reduction in complications, improved technical survival	Centralized platform accessible to nephrologists [15]
United States	PD and HHD	Prediction of technical loss, prescription adjustment, remote monitoring	Improved safety, adherence, and quality of life	Connected digital platforms, multi-center integration [13]

These experiments demonstrate the feasibility and clinical value of AI for home dialysis, but their direct application in French overseas territories remains limited. Recent literature highlights that most of these devices are still at an experimental stage of development, and that medical and economic evaluations remain rare and inconsistent [19].

Given the unique characteristics of the French West Indies and Guiana, which are marked by low medical density, significant geographical dispersion, limited digital acculturation, and a strict legislative framework for health data, the introduction of these technologies must be gradual and contextualized. It must be based on locally adapted pilot projects, including:

• Specific training for healthcare professionals and patients;
• Technical and cultural support;
• Rigorous assessment of safety, feasibility, and economic impact; and
• Strict compliance with GDPR requirements and French regulations on digital health.

The experiences of Japan, Taiwan, and the United States offer useful benchmarks to guide the discussion, but their success is based on very different structural and legislative conditions.

Expected benefits for the French West Indies and Guiana

Due to the unique social and health characteristics of the French West Indies and Guiana, AI can:

• Improve access to primary care and home healthcare through telemedicine, compensating for the shortage of local skills.
• Enhance patient safety through proactive remote monitoring.
• Personalize care by adjusting dialysis prescriptions to physiological needs.
• Optimize human and economic resources by minimizing hospitalizations, medical evacuations, transfers, and emergency interventions.

The integration of AI must also consider ethical and regulatory aspects: data protection, informed

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consent in a multilingual context, cultural acceptability, and equity of access. These elements are essential for the credibility and sustainability of the program.

Proposed roadmap for deployment in the French West Indies and French Guiana

This roadmap is based on Maastricht University's recommendations concerning the digitization of nephrology [20].
1. Develop secure digital infrastructure (connectivity, platforms, GDPR-compliant data collection).
2. Train professionals and patients in the use of AI tools, with modules adapted to local cultural and linguistic specificities.
3. Launch AI-assisted PD and HHD pilot projects in strategically located decentralized prevention and care centers (CDPS).
4. Conduct a scientific evaluation of the clinical, organizational, and economic benefits (comparative studies, quality and safety indicators).
5. Support public-private partnerships, inspired by Japanese and Taiwanese experiences, to promote the sustainability and maintenance of the tools.
6. Draft ethics and data management protocols, including informed consent and equitable access.
7. Ensure monitoring and continuous improvement: Use adaptive learning for ongoing adjustments to protocols in response to local realities.

Limitations and potential risks of artificial intelligence in home dialysis

The integration of AI into home dialysis techniques has several limitations and risks that should be anticipated:

• The costs of implementation, maintenance, and staff training can be high, particularly in areas with low medical coverage.
• Dependence on digital infrastructure and internet connectivity may expose patients to potential disruptions or interruptions in care.
• Overconfidence in algorithms could delay human intervention in the event of unforeseen complications.
• Limited understanding of how algorithms work raises issues of clinical responsibility.
• The acculturation of digital health tools, data confidentiality, and compliance with ethical standards must be constantly monitored to ensure safe and equitable use.

Ethical considerations and data protection

Ethical principles and personal data protection must be strictly adhered to:

• Comply with the General Data Protection Regulation (GDPR) and local legislation in force on health data.
• Ensure the traceability of interventions and decisions made by AI systems.
• Obtain informed consent tailored to the specific characteristics of local populations.
• Build trust and social acceptance among patients for innovative health technologies.

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Advocate for support from the public and health authorities

The successful deployment of AI in home dialysis techniques requires a strong commitment from the public and health authorities:

• Develop legislative and regulatory frameworks adapted to technological innovations.
• Fund the development, deployment, and maintenance of AI tools.
• Ensure the equity and accessibility of home dialysis in overseas territories.

Role of learned societies and professional networks

International and regional learned societies and professional networks have a key role to play in guiding and promoting the use of AI in home dialysis, particularly through the involvement of the International Society for Peritoneal Dialysis (ISPD), the International Home Dialysis Consortium (IHDC), the European Renal Association (ERA), the International Society of Nephrology (ISN), and the Société Francophone de Néphrologie, Dialyse et Transplantation (SFNDT).

This involvement should take the form of:

• The standardization of recommendations for the use of AI in home dialysis practices.
• The organization and continuing education of healthcare professionals and the dissemination of rules for good clinical and technical practices.
• The facilitation of the exchange of experiences, the promotion of pilot projects, and the adaptation of innovations to local and international contexts.

Conclusion

Artificial intelligence has the potential to transform home dialysis into a strategic lever in the therapeutic arsenal for end-stage renal disease, the burden of which remains particularly heavy in the French West Indies and French Guiana. It can improve safety, help to individualize treatment protocols, and ensure remote monitoring and adaptation of care to local sociocultural specificities. Its gradual and appropriate integration, respecting ethical and data protection principles, supporting the training of professionals, and benefiting from the support of health authorities and learned societies, constitutes an accessible, safe, equitable, and sustainable solution for overseas territories. AI will not replace the care relationship, but it can catalyze it by bringing medical expertise closer to remote areas.

Data Availabilité Statement

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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