

# From Dialysis to Destinations: Safe Travel Strategies for Patients With CKD



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Chronic kidney disease (CKD) and end-stage kidney disease (ESKD) represent growing global health burdens, driven by aging populations and increasing prevalence of diabetes and hypertension. Patients with ESKD face significant lifestyle limitations, particularly regarding mobility and travel, because of treatment schedules, medical complexity, and heightened vulnerability to complications. Air and long-distance travel pose distinct risks—cardiovascular stress, infection, and logistical challenges—that demand tailored assessment and preparation. This review outlines key travel-related complications in CKD and patients on dialysis, including cardiovascular and thromboembolic events, infection, jet lag, and vascular access risks. It further examines aeromedical considerations, such as hypobaric hypoxemia and venous thromboembolism (VTE), and evaluates airline-specific medical clearance protocols in major global carriers. Detailed recommendations are provided for hemodialysis and peritoneal dialysis (PD) patients, including pre-travel assessment, medication and supply management, international dialysis coordination, and inflight precautions.

*Kidney Int Rep* (2025) **10**, 4162–4173; <https://doi.org/10.1016/j.ekir.2025.09.035>

**KEYWORDS:** aerospace medicine; air travel; chronic renal insufficiency; hemodialysis; peritoneal dialysis; travel medicine

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**C**KD (a persistent kidney dysfunction such as estimated glomerular filtration rate < 60 ml/min per 1.73 m<sup>2</sup> for ≥ 3 months or evidence of kidney damage)

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Received 3 July 2025; revised 15 September 2025; accepted 23 September 2025; published online 4 October 2025

and ESKD (advanced CKD requiring hemodialysis or PD or transplantation) are growing health concerns, with prevalence rates steadily increasing globally. According to recent epidemiological data, the global prevalence of CKD is estimated to be 13.4%, affecting approximately 700 million individuals.<sup>1</sup> The incidence of ESKD requiring kidney replacement therapy is increasing at an annual rate of 5% to 8% in many countries, outpacing population growth.<sup>2</sup> This alarming trend is largely attributed to the increasing prevalence of diabetes and hypertension and to the aging population.<sup>3</sup> The socio-economic implications of this epidemic are profound, with healthcare expenditures for patients with ESKD consuming disproportionate resources. In the United

States alone, ESKD management accounts for nearly 7% of Medicare expenditure, although the patients represent <1% of the covered population.<sup>4</sup>

Patients with CKD, particularly those requiring dialysis, face unique challenges that significantly restrict their mobility and independence. Patients on hemodialysis typically require treatment 3 times a week for 3 to 4 hours per session, creating a rigid schedule that limits their travel opportunities. PD, though offering more flexibility, still necessitates daily treatments and substantial medical supplies. These supplies include dialysate solution bags, tubing sets, and other equipment that must be transported and stored properly during any travel, creating logistical challenges that can discourage patients from venturing far from home or for extended periods. Beyond treatment schedules, these patients deal with medication regimens, dietary restrictions, vascular access care, and increased vulnerability to infection and cardiovascular complications.<sup>5</sup> These limitations significantly impact the quality of life, contributing to the disproportionately high rates of depression observed in the dialysis population—approximately 20% to 30% of patients on dialysis experience clinical depression, compared with 2% to 9% in the general population.<sup>6</sup> Travel restrictions have been specifically identified as significant contributors to

feelings of loss of freedom and decreased life satisfaction among patients with kidney disease.<sup>7</sup> These limitations are experienced globally; however their impact is particularly pronounced in regions with both high dialysis burden and increasing international mobility. In many Asian countries, where both dialysis prevalence and outbound travels are increasing, the mobility gap for patients with CKD has particularly become pronounced. This intersection underscores the growing importance of addressing mobility challenges (Figure 1).

Travel, especially air and long-distance travels, presents peculiar challenges and potential risks for patients with CKD and on dialysis and should be considered carefully. Physiological stressors during air travels, including cabin pressure changes, prolonged immobility, dehydration, and disrupted medication schedules, may exacerbate existing health vulnerabilities in this population.<sup>8</sup> This review aimed to comprehensively examine the specific risks associated with travel for patients with kidney disease, outline essential considerations for pre-travel planning, and detail necessary preparations to ensure the safety of their journeys. In addition, we explored the potential for innovative solutions and systematic improvements that could enhance travel accessibility for this growing patient population in the future.

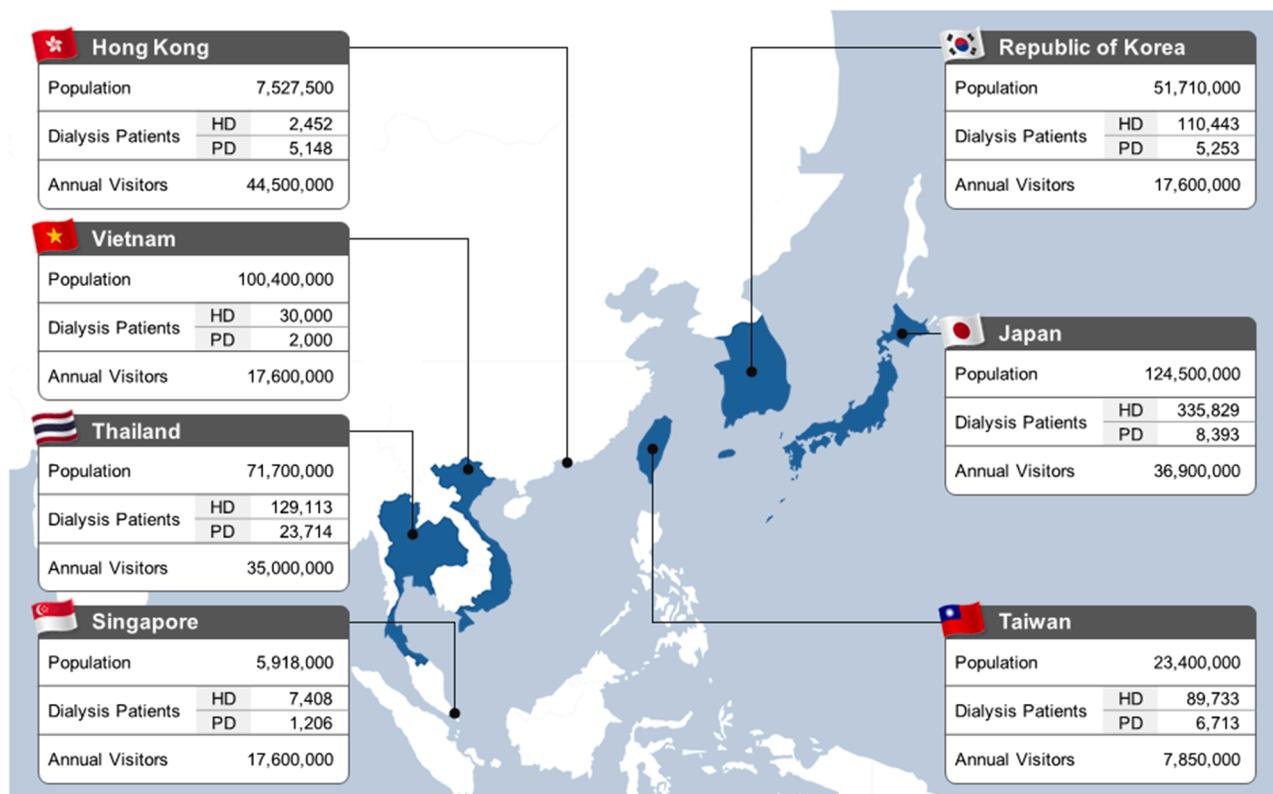


Figure 1. Dialysis burden and inbound travel volume in Asian countries. HD, Hemodialysis; PD, Peritoneal dialysis.

## Complications During Travel in Patients

### With CKD

#### CKD

Patients with CKD have a significantly elevated risk of cardiovascular events, with approximately 50% of mortality in the ESKD population attributed to cardiovascular disease.<sup>9,10</sup> The physiological stressors of travels—particularly air travels, with its pressure changes, hypoxemia, and prolonged immobility—can further increase this risk.<sup>11,12</sup> Circadian rhythm disruptions caused by time zone changes may further increase the risk of cardiovascular events, which is particularly concerning because of the already elevated cardiovascular risk in patients with CKD.<sup>13,14</sup> Disruptions in regular dialysis schedules, combined with dietary changes and altered medication timing during travel, can trigger excessive fluid overload or electrolyte abnormalities. A study has documented that missed or shortened dialysis sessions are associated with a 1.4-fold increase in hospitalization risk and a significant increase in emergency department visits for volume overload and hyperkalemia.<sup>15</sup>

#### Infections

Patients with CKD have impaired immunity and are at an increased risk of infections, making international travel particularly challenging. Their immunocompromised state increases susceptibility to infections, necessitating additional precautions when traveling to high-risk regions, such as Southeast Asia, South America, and Africa. International travel may expose patients to unfamiliar pathogens, and the need to connect with dialysis facilities in different locations increases the risk of bloodstream and access-site infections. Infection rates in traveling patients on dialysis are estimated as 1.5 to 2.0 times higher than those in non-traveling counterparts.<sup>16</sup> According to the 2026 Center for Disease Control Yellow Book, travelers' diarrhea, defined as the passage of  $\geq 3$  loose stools within 8 hours or  $\geq 4$  within 24 hours and typically accompanied by abdominal pain and vomiting, remains a substantial global health burden, particularly in developing countries, and represents a particular concern for patients with CKD during international travel.<sup>17</sup> Risk factors for developing infection include age  $< 30$  years, destination region, rainy season travel, extended stay duration, reduced gastric acid, immunocompromised status, and diabetes—many of which apply to the CKD population.<sup>18</sup> Essential preventive measures include meticulous attention to hydration status within fluid restrictions for patients on dialysis, strict hand hygiene with soap and water, and consumption of only thoroughly cooked foods.<sup>17,19</sup>

#### Jet Lag

Patients with CKD experience progressive decline in melatonin levels as kidney function deteriorates, with patients on hemodialysis demonstrating particularly reduced nocturnal melatonin production.<sup>18</sup> In addition, the elevated levels of tumor necrosis factor receptors observed in CKD may further suppress melatonin, potentially exacerbating jet lag symptoms.<sup>20</sup> Although melatonin supplementation represents a potential intervention to mitigate these effects, specific research in the CKD population is needed to establish evidence-based recommendations. Beyond its impact on sleep, jet lag can also disrupt daily routines, including the management of complex medication regimens required by patients with CKD. Time zone changes may interfere with medication schedules, whereas storage requirements for medications, such as insulin or erythropoiesis-stimulating agents, present additional challenges during travel.<sup>21</sup> Furthermore, international travelers must navigate regulations regarding the transport of prescription medications across borders.

#### Vascular Access

For patients on hemodialysis, protection of vascular access during travel is critical. Cabin pressure changes during air travel may affect fistula or graft blood flow, and prolonged immobility increases thrombosis risk. In hemodialysis patients, long-distance travel has been associated with an increased risk of infection, and given their elevated susceptibility to venous thromboembolism, maintaining meticulous hygiene and stable hemodynamic conditions is essential to protect vascular access.<sup>8,22</sup>

## Aeromedical Considerations in Patients With CKD

Commercial aircrafts typically fly at altitudes of approximately 10,000 m (33,000 feet), where cabin pressurization systems maintain pressure equivalent to approximately 2500 m (8200 feet) above sea level<sup>11</sup> (Supplementary Figure S1). Despite this pressurization, the decreased atmospheric pressure leads to reduced oxygen partial pressure, impaired alveolar-blood gas diffusion, and compensatory increases in respiratory and heart rates. This hypobaric hypoxemia can exacerbate respiratory symptoms in patients with CKD, particularly those with concurrent cardiopulmonary disease.<sup>12</sup>

The British Thoracic Society Clinical Practice Guidelines for respiratory disease recommend pre-flight assessment for vulnerable patients, including a hypoxic challenge test that monitors respiratory parameters during 20 minutes of exposure to a low-oxygen environment with blood gas analysis before

and after exposure.<sup>23</sup> Studies have shown that patients with New York Heart Association class II–III heart failure can remain asymptomatic while breathing 15% oxygen for up to 1 hour.<sup>24</sup> The Aerospace Medical Association guidelines recommend supplemental oxygen during flight for patients with sea level partial pressure of oxygen < 70 mmHg or anticipated in-flight arterial partial pressure of oxygen < 55 mmHg.<sup>25</sup> Although these guidelines were not developed specifically for anuric patients on dialysis and research targeting this population is lacking, the guidelines provide a framework for clinical decision-making. The International Air Transport Association offers disease-specific guidelines for various conditions, including recommendations that low-risk patients wait at least 3 days post-myocardial infarction before flying, whereas medium-risk patients should rest for at least 10 days.<sup>26</sup>

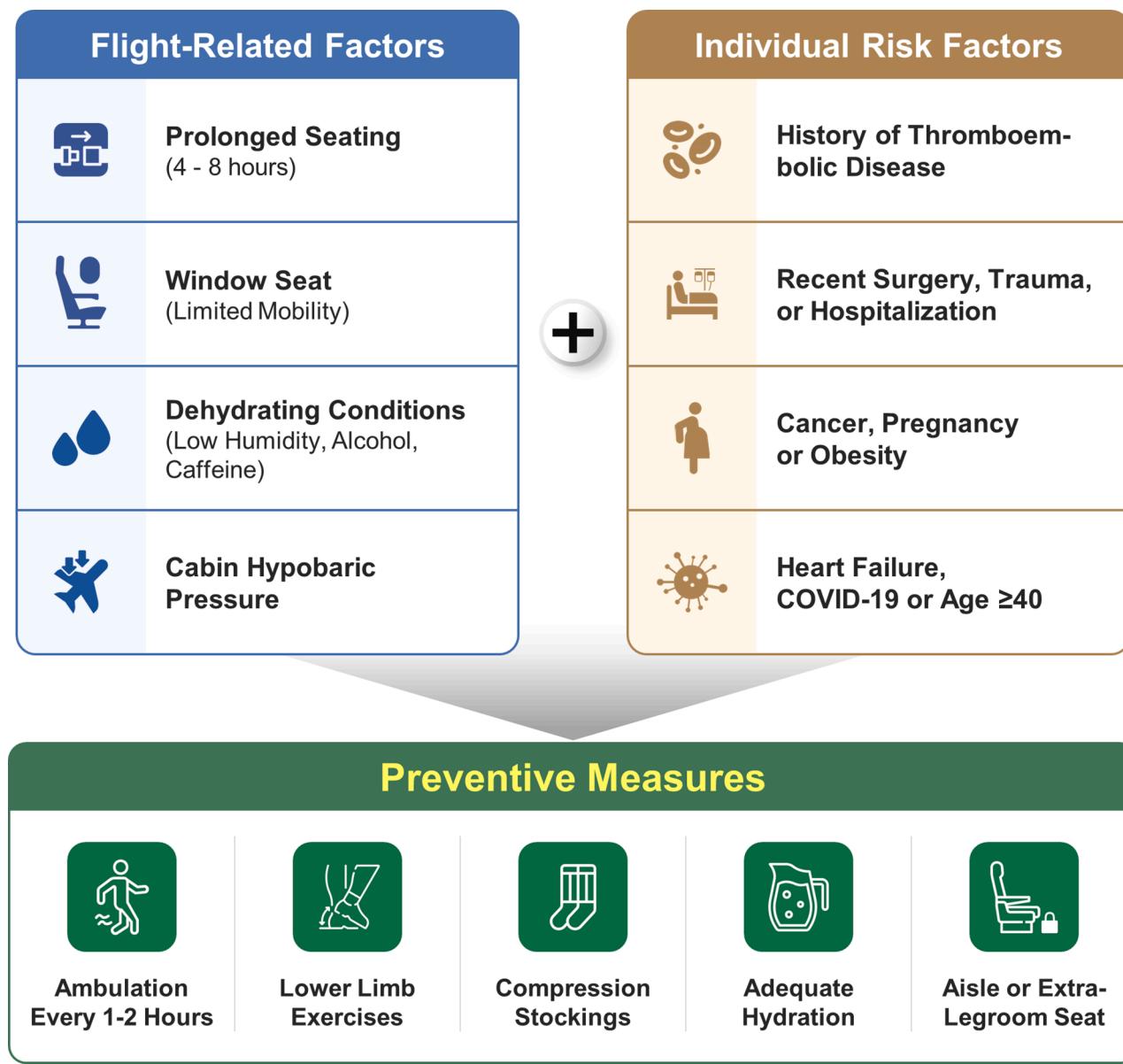
Among the aeromedical complications, VTE—often referred to as “economy class syndrome”—is of particular concern in patients with CKD because of their pro-thrombotic state and reduced mobility. The risk of VTE during long-haul flights (> 4 hours) is approximately 2 to 4 times higher than that at baseline for the general population. A systematic review found an association between VTE and length of travel, with odds ratios ranging from 1.1 to 4.0.<sup>27</sup> A clear dose-response relationship exists between VTE and travel time, with a 26% higher risk for every 2 hours of air travel ( $P = 0.005$ ) starting after 4 hours.<sup>28</sup> Seating position significantly impacts risk, with window seats increasing VTE risk by 2-fold compared with that observed with aisle seats.<sup>29</sup> A study reported that patients with CKD have up to a 2-fold higher risk of thromboembolism than individuals with normal kidney function.<sup>30</sup>

For prevention strategies, compression stockings have shown significant effectiveness in VTE prevention during travel.<sup>31</sup> Although prophylactic anti-coagulation may seem beneficial, current evidence does not support its effectiveness specifically for travel.<sup>32</sup> Current guidelines recommend against routine prophylaxis for travelers without known thrombosis risk factors; however, for high-risk patients (such as those who have undergone recent surgery and undergone hormone replacement therapy, with VTE history, active malignancy, or multiple risk factors, and are pregnant or in the postpartum period), graduated compression stockings or low-molecular-weight heparin is recommended for a travel of > 4 hours.<sup>33</sup> Figure 2, we provide a visual summary of risk factors for economy class syndrome in patients with CKD, along with practical and evidence-based strategies to mitigate these risks during air travel.

## Medical Clearance and Travel Preparation for Patients With CKD

The International Air Transport Association provides standardized protocols to assess medical fitness for air travel; however, it does not offer disease-specific guidelines tailored to patients with kidney disease, and medical clearance is determined based on general clinical risk factors, such as cardiopulmonary compromise, anemia, or fluid overload conditions, which frequently occur in individuals with advanced CKD<sup>34</sup> (Table 1). According to the International Air Transport Association guidelines, medical clearance is warranted for passengers whose health status may deteriorate during a flight, those requiring in-flight medical support or equipment, and individuals necessitating substantial assistance throughout the journey. Given the pathophysiological vulnerabilities and treatment-related demands of ESKD, including dependence on dialysis and a heightened risk of hemodynamic instability,<sup>35</sup> such patients commonly fall within these criteria.

The Medical Information Form (MEDIF) represents the standardized documentation approved by International Air Transport Association for communicating medical clearance information between healthcare providers, patients, and airlines. The MEDIF generally consists of 2 key components. The first involves information provided by the passenger or their representative, including travel details and a general description of the medical condition. The second is completed by the attending physician, documenting specific medical information relevant to air travel safety. For patients with ESKD, critical information in the physician section includes current clinical status, stability assessment, recent dialysis parameters, anticipated in-flight needs, and specific recommendations regarding supplemental oxygen, mobility assistance, or other accommodations. Standard MEDIFs typically expire after 10 to 14 days for chronic conditions such as ESKD, necessitating completion of new documentation for subsequent travel. However, some airlines have implemented Frequent Traveler Medical Cards for passengers with stable chronic conditions, which may remain valid for up to 1 year, substantially reducing the administrative burden for regular travelers. To address the unique clinical and logistical challenges of air travel in patients on dialysis, a suggested algorithm incorporating key considerations, such as cardiopulmonary stability, dialysis access status, recent complications, and airline-specific requirements, is illustrated in Figure 3.<sup>36–39</sup> A comparative summary of representative Asian, US, and European airlines is provided in Table 2. This highlights both common elements—documentation, oxygen, device approval, and escort needs—as well as regional differences.



**Figure 2.** Risk factors and preventive strategies for economy class syndrome in patients with chronic kidney disease during air travel.

Overall, Asian carriers emphasize detailed MEDIF and procedural clearance, whereas US and European airlines tend to rely more on physician statement, device approval systems, and equipment certification, though exceptions exist among major European carriers requiring MEDIF forms as well.

#### Recommendations for Safe Travel for Patients With CKD

Patients with kidney disease face unique challenges when traveling, particularly related to maintaining continuity of kidney replacement therapy, managing increased cardiovascular and infection risks, and navigating physiological stressors in aircraft environments. The complex documentation requirements for international travel and variable accessibility of

dialysis facilities worldwide further complicate mobility for this growing patient population. The availability and standards of dialysis facilities vary substantially worldwide, presenting additional challenges for traveling patients with CKD. In many regions, particularly in low- and middle-income countries, dialysis facilities are limited to or concentrated in urban centers, restricting travel destinations.<sup>40</sup> Despite these obstacles, careful pre-travel planning, appropriate medical documentation, and strategic coordination with healthcare providers can significantly mitigate risks and enable safe travel experiences for patients with kidney disease.

Effective pre-travel preparation is essential for patients on dialysis to ensure safe and enjoyable journeys. Travel itineraries should be carefully planned,

**Table 1.** Components of the International Air Transport Association guidelines for air travel

Category	Summary
Medical clearance responsibility	Airlines are responsible for determining medical fitness to fly and may require completion of the MEDIF for assessment.
General indications for clearance	Clearance is typically required for passengers with conditions that may deteriorate during a flight and for those requiring medical equipment, supplemental oxygen, or special assistance.
Passenger categories	Passengers are categorized as: <ul style="list-style-type: none"> <li>– Healthy individuals</li> <li>– Those with temporary conditions</li> <li>– Patients with chronic illness</li> <li>– Medically unstable individuals. Assessment and required support vary accordingly.</li> </ul>
Logistics of clearance	Coordination is required across reservation, check-in, airport transfer, and in-flight seating arrangements, based on medical needs.
Special services	Airlines may offer stretcher transport, onboard oxygen, medical escorts, special meals, and wheelchair services, depending on the passenger's needs.
Specific medical conditions	Certain conditions require prior assessment or impose restrictions on air travel, including pneumothorax, recent surgery, respiratory failure, communicable disease, and late-stage pregnancy
MEDIF	A standardized form used to document a passenger's medical status and required in-flight support, completed by the treating physician, and reviewed by airline medical personnel.
Decision criteria	The key criterion is whether the in-flight environment (e.g., low cabin pressure, low humidity, and prolonged immobility) may pose a risk to the passenger's health.
Final authority	The final decision rests with the airline's medical department or designated aviation medical examiner. Additional documentation or an onboard medical escort may be requested.

MEDIF, Medical Information Form.

with adequate rest periods incorporated between activities, to prevent excessive fatigue. For air travels, special dietary arrangements may need to be made in advance with airlines to accommodate kidney dietary restrictions. Consultation with a primary nephrologist is crucial before finalizing travel plans to assess clinical stability and identify potential medical concerns. Vaccination recommendations should be thoroughly discussed, because immunocompromised patients may require modified vaccination schedules or additional prophylactic measures depending on the destination, while avoiding potentially harmful vaccinations, such as live vaccines, among transplanted patients.

In addition to general pre-travel preparation, specific timing and prescription adjustments are often necessary before departure. For patients on hemodialysis, it is generally recommended that the final dialysis session be scheduled within 24 hours of travel, ideally with adjusted ultrafiltration targets to optimize volume status without inducing hypotension. For patients on PD, a dry abdomen is typically preferred during flight to minimize intra-abdominal pressure and discomfort, unless contraindicated. Timing of PD exchanges should be planned in consultation with a nephrologist,

considering flight duration, airport logistics, and time zone differences. A comprehensive timeline of preparatory steps for patients on dialysis is presented in **Table 2**, outlining key actions from 8 weeks prior to travel through arrival at the destination.

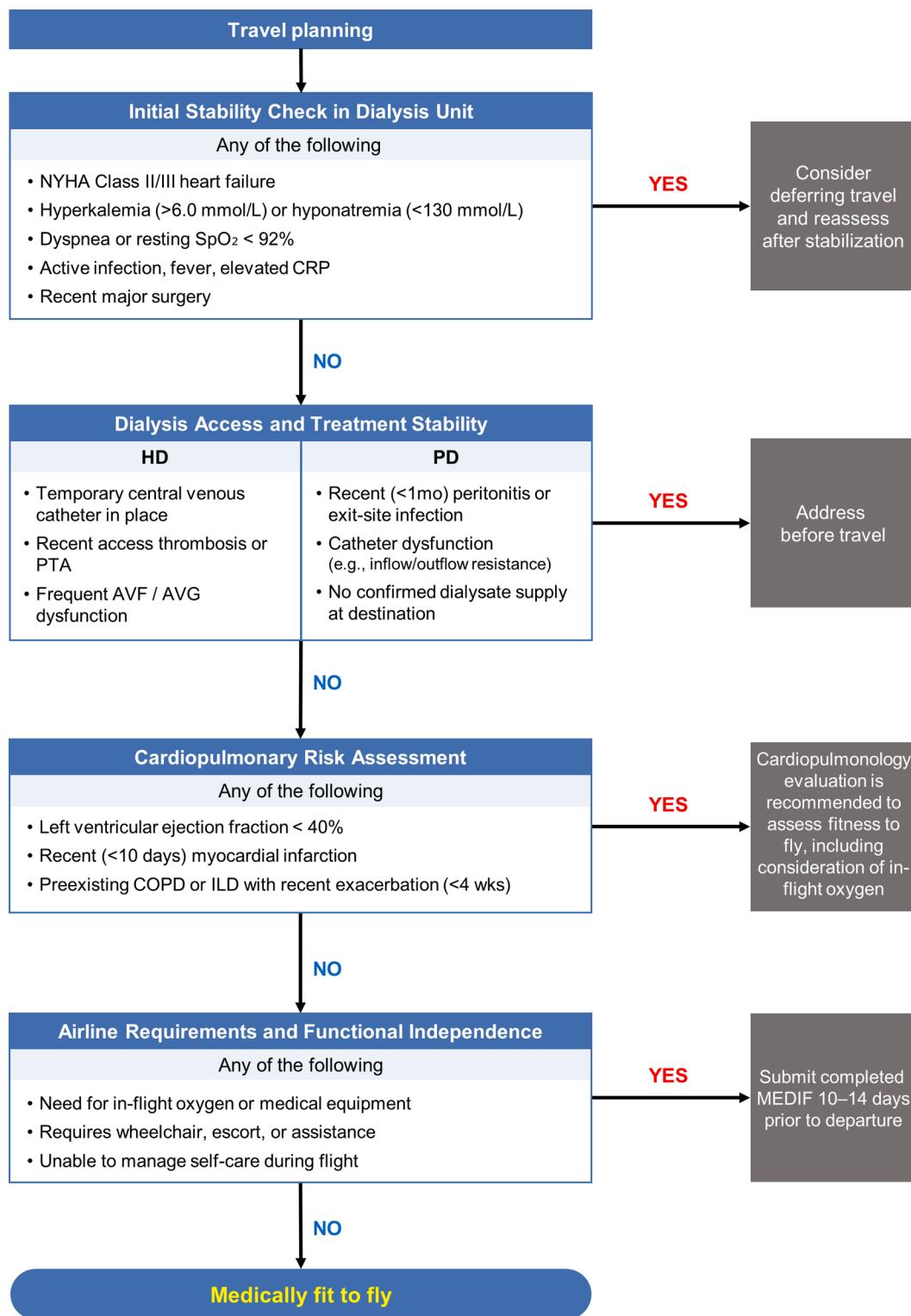
### Hemodialysis

Patients should compile a comprehensive list of emergency contacts for temporary medical services at their destination, including local nephrology specialists and dialysis facilities. Carrying recent laboratory results and medical records is essential; these should include recent dialysis prescriptions, medication lists, and pertinent clinical information, such as access type and dialysis schedule. Patients should inform their travel companions about the location of these medical records in case of emergency. Medication preparation requires careful attention, with patients advised to pack sufficient quantities for the entire journey, as well as reasonable surplus to account for unexpected delays. Medications should be kept in their original labeled containers and placed in their hand luggage to prevent loss during transit. It would also be helpful if the physician could provide a formal list of prescriptions to facilitate the patient's custom inspection processes.

Perhaps the most crucial part of pre-travel preparation is arranging dialysis at the destination (unless the patient is on self-care PD or home hemodialysis and can perform the procedure themselves while away on their trip). The patient's renal unit can assist in finding a dialysis center at the travel destination; this process should begin months in advance for international trips, because securing a temporary slot can take time. Typically, at least 4 to 8 weeks' notice is recommended to schedule in-center hemodialysis abroad. The patient's medical records, including recent laboratory results and dialysis prescription, should be sent to the temporary clinic. It is important to confirm the dates and times of sessions and ideally have the information in writing before departure. Dialysis protocols, water quality standards, and infection control practices vary internationally. Patients accustomed to specific standards may encounter facilities that use different dialyzers, dialysate compositions, or anticoagulation protocols.<sup>41</sup> Furthermore, natural disasters can disrupt local healthcare infrastructure, posing peculiar risks for dialysis-dependent travelers. The Kidney Community Emergency Response Coalition has documented numerous instances where traveling patients on dialysis required emergency intervention during natural disasters.<sup>42</sup>

### PD

Patients on PD require careful pre-travel planning to ensure safe and uninterrupted treatment during



**Figure 3.** Suggested medical clearance algorithm for air travel in dialysis patients. AVF, arteriovenous fistula; AVG, arteriovenous graft; COPD, chronic obstructive pulmonary disease; CRP, C-reactive protein; HD, hemodialysis; ILD, interstitial lung disease; MEDIF, medical information form; NYHA, New York Heart Association; PD, peritoneal dialysis; PTA, percutaneous transluminal angioplasty;  $\text{SpO}_2$ , peripheral capillary oxygen saturation.

travel. Essential steps include clinical clearance from the attending nephrologist, advanced logistical coordination with the PD supply provider, and verification of dialysis feasibility at the travel destination.

Special attention must be paid to destination accessibility, availability of medical support, and possibility of supply delivery, particularly for international travel.

**Table 2.** Summary of airline medical clearance policies for dialysis patients

Airline	MEDIF submission	Oxygen policy	Medical devices supplied	Escort requirements
Korean Air	48 h before departure	Medical oxygen available (needs advance booking)	Oxygen bottles, stretcher equipment	Medical escort required for stretcher passengers
Cathay Pacific	48–72 h before departure (72 h for oxygen)	2 or 4 L/min constant flow, 72 h advance notice	Oxygen cylinders (2/4 L/min), stretcher, incubator	Medical escort required based on condition
Japan Airlines	14 d including departure date	Medical oxygen cylinders available with MEDIF	Oxygen cylinders, stretchers, incubators	Physician/nurse/approved person for stretcher
Thai Airways	48 h before departure	Oxygen available with medical clearance	Medical equipment as needed with clearance	Medical escort as determined by medical assessment
Delta Air Lines	48–72 h before departure	No compressed oxygen - only POCS allowed	No airline-supplied devices - passengers bring own	Escort requirements assessed case-by-case
Lufthansa	48 h before departure	Medical oxygen cylinders up to 5 kg, 200 bar max	Medical oxygen cylinders, stretcher equipment	Medical escort required for serious conditions
British Airways	7 d before departure	Long-haul: 4 L/min only, Short-haul: own POCS/cylinders	Long-haul oxygen (pulse dose on A380/787), stretcher	Medical escort requirements assessed individually

A380/787, Airbus A380 / Boeing 787; FAA, Federal Aviation Administration; FREMEC, frequent traveler's medical card; MEDIF, medical information form; POCS, portable oxygen concentrator.

In the case of companies, such as Vantive, which maintains branch offices in multiple countries, international shipment of dialysis supplies is available. According to current logistics guidelines, a flat service fee of approximately 10,000 KRW (~ \$7 USD) per shipment request is applied for international deliveries. Patients are advised to initiate this process at least 1 to 2 months in advance, because delivery timelines may be prolonged depending on the destination country. To ensure a safe journey, it is strongly recommended that patients confirm the successful arrival of dialysis solutions at the travel destination before departure. In addition to coordinating the bulk delivery of dialysate solutions to the travel location (e.g., hotel or host residence), patients should carry a minimal set of PD essentials in their hand luggage to allow at least 2 to 3 days of uninterrupted therapy in the event of shipment delays or loss of checked baggage. Notably, only dialysate and associated consumables may be shipped in advance; other critical items, such as disinfectants and additional accessories, must be carried directly by the patient in quantities sufficient to last the entire travel period (Table 3).

An additional concern for PD travelers is the risk of peritonitis. The International Society of Peritoneal Dialysis peritonitis guideline (2022) recommends that PD effluent be collected for cell count and culture before starting empiric antibiotics.<sup>43</sup> Where feasible, some dialysis units may provide patients with a “peritonitis travel pack” containing pre-prescribed empiric intraperitoneal antibiotics and instructions for specimen collection; however, the feasibility of such an approach differs by region and regulatory context. Thus, this should be considered a conditional measure, applied when local policies and resources permit. A detailed checklist of recommended items is provided in Table 4.

The process of arranging dialysate supply shipment requires coordination between the patient and supplier. Although logistics differ slightly between domestic and international travel, core steps include medical clearance, destination verification, paperwork submission, and delivery confirmation. For international travel, additional considerations, such as customs clearance and country-specific documentation, must be well-addressed in advance.

### System-level Considerations

Private sector innovations have begun addressing these needs, with specialized companies developing networks specifically designed to facilitate travel for patients on dialysis. For example, one prominent dialysis provider based in South Asia has established a comprehensive “Guest Dialysis” program that enables patients to access dialysis care while traveling domestically or

**Table 3.** Travel preparation checklist by timeline

Time before travel	HD	PD
8 wks	Assess travel feasibility with nephrologist; confirm clinical stability. Select travel destination with access to temporary dialysis facilities.	Assess travel feasibility with nephrologist; confirm clinical stability. Select travel destination with PD supply delivery availability
7 wks	Contact home clinic to begin referral process to an in-center HD unit abroad. Begin gathering necessary medical documents (e.g., dialysis prescription, access info, and lab results).	Contact PD supply provider to confirm support and delivery options for the chosen country. Begin collecting required documents (e.g., prescriptions, labs, customs forms, and medical clearance).
6 wks	Send medical records to the receiving HD center abroad via your dialysis unit coordinator. Communicate preferred dialysis dates and times to host center; confirm potential slot availability.	Coordinate document submission through home clinic to PD provider. Ensure address and delivery window are clearly communicated to the supplier.
5 wks	Receive provisional booking from the host center; confirm appointment schedule in writing. Arrange backup transportation to the dialysis facility abroad	Submit official delivery request with detailed address and expected arrival date. Confirm order processing and expected delivery timeline with provider.
2 wks	Finalize all logistics (transportation and translation of medical records if needed).	Pack 2–3 d of emergency PD supplies for carry-on (dialysate, antiseptic cap, disinfectant, etc.).
1 wk	Reconfirm dialysis appointments and clinic contact details at destination.	Contact destination to confirm that shipment has arrived and is properly stored.
1–3 d	Recheck hand-carry items: medications, access dressing kits, prescription copy, and recent labs. The final HD session should ideally be completed within 24 h before departure to ensure optimal metabolic status.	Confirm whether carry-on bag contains necessary emergency dialysis items and documents.
Day of departure	Carry personal medical summary and dialysis-related documents; wear medical alert if available.	Carry essential PD supplies in hand luggage; ensure they comply with airline safety and storage regulations. Complete a final drain before boarding, leaving the abdomen empty to reduce discomfort and pressure during the flight.

HD, Hemodialysis; PD, Peritoneal dialysis.

internationally across their network of over 300 centers. Through integrated online platforms, these services coordinate international dialysis arrangements, facilitate medical record transfers between facilities, standardize treatment protocols, provide multilingual patient information, assist with insurance navigation, and offer emergency response protocols for travel-related complications. Although these services currently remain limited in geographical coverage and accessibility, particularly in resource-limited regions, they represent a promising model for future development of global dialysis networks. The development of more integrated global dialysis networks represents a critical advancement needed to enhance travel accessibility for patients with kidney disease. Current disparities in the distribution, standards, and interconnectedness of dialysis

facilities worldwide create significant barriers to patient mobility. A standardized international system for dialysis facility certification, patient record sharing, and treatment coordination would substantially improve travel feasibility.

### Future Directions

From a mobility and travel freedom perspective, initial steps have been made with transportable hemodialysis systems, although portability remains a significant challenge.<sup>44</sup> The development of lightweight, dialysate-regenerating systems that weigh less < 12 kg represents a promising advancement that could substantially increase travel freedom for patients on dialysis.<sup>45</sup> However, the full realization of travel autonomy depends on the further development and technological

**Table 4.** Suggested checklist for patients on peritoneal dialysis preparing for travel

Category	CAPD	APD
Dialysate solutions	1.5%: ____ boxes 2.5%: ____ boxes 4.25%: ____ boxes 7.5%: ____ boxes	1.5%: ____ boxes 2.5%: ____ boxes 4.25%: ____ boxes 7.5%: ____ boxes
Catheter accessories	Antiseptic cap: ____ boxes	Antiseptic cap: ____ Boxes Disposable Cassette: ____ Boxes Drainage Bag: ____ Boxes Backup CAPD supplies: ____ boxes
Disinfectants	Sterile cotton swabs: ____ boxes Gauze: ____ boxes Antiseptic solution: ____ boxes Adhesive tape: ____ boxes	
Other essential items	Blood pressure monitor Glucometer Drainage belt Dialysate warmer Digital scale (Conditional) sterile sampling kit and unit-specific empiric IP antibiotics	Hand sanitizer Surgical mask Dialysis notebook Blue clamp (Kelly forceps) PO medication

APD, automated peritoneal dialysis; CAPD, continuous ambulatory peritoneal dialysis; IP, intraperitoneal; PD, peritoneal dialysis; PO, per oral.

advancement of wearable and partially-implantable systems. These innovations would eliminate the need for fixed dialysis schedules and locations, fundamentally transforming the quality of life for patients with kidney disease.<sup>46</sup>

Comprehensive, evidence-based guidelines for both healthcare providers and patients would significantly improve travel safety and accessibility. Current recommendations are often fragmented, region-specific, or based on limited evidence. Future guideline development should incorporate input from nephrology specialists, travel medicine experts, aerospace medicine professionals, and patient representatives to address the multifaceted challenges faced by traveling patients with kidney disease.

## Conclusion

Despite significant physiological and logistical challenges, travel can be made safer and more accessible for patients with kidney disease through thorough pre-travel planning, appropriate medical documentation, and dialysis technological advancements that enhance mobility. The trend toward transportable, portable, and eventually wearable or implantable systems represents a promising trajectory that could fundamentally transform travel freedom for dialysis-dependent individuals. Coordinated efforts between healthcare providers, industry innovators, and policy makers are essential to developing standardized protocols and innovative solutions that will enable patients with kidney disease experience the important psychological and social benefits of travel.

## APPENDIX

### List of Members of the Korean Society of Nephrology Disaster Preparedness and Response Committee

Young-Ki Lee, Kyung Don Yoo, Kiwon Kim, Minah Kim, Sihyung Park, Hayne Cho Park, Nara Shin, Min Seok Seo, Hyun Ho Oh, Hye Eun Yoon, Sunhwa Lee, Sua Lee, Jin Seon Jeong, Ajin Cho, Hyun-Jeong Cho, Ran-Hui Cha, Ji-Young Choi

## DISCLOSURE

All the authors declared no competing interests.

## Funding

This study was supported by a cooperative research fund from the Korean Society of Nephrology (2023). The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the funding institutions.

## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

## SUPPLEMENTARY MATERIAL

### Supplementary File (PDF)

**Figure S1.** Altitude-associated cabin pressure and clinical risk considerations during air travel.

## REFERENCES

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