

Patient Perspectives on Clotting in the Extracorporeal Circuit and Decision-Making Regarding Anticoagulation Therapy

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Summary

Clotting of the extracorporeal circuit is a complication in the process of hemodialysis that can result in missed or shortened dialysis sessions, higher nursing workload, and elevated cost of treatment. Repercussions of inadequate dialysis may include patient blood loss, fluid overload, build-up of minerals, higher hospitalization rates, and poor quality of life, contributing to increased patient distress. Preventing clotting through anticoagulation therapy is the key to maintaining patency of the dialysis circuit and supporting dialysis adequacy. Despite the severe consequences of clotting in the extracorporeal circuit patients encounter, their perspectives on decision-making regarding anticoagulation therapy are not well known. In this article, we discuss patients' perspectives and priorities around clotting and anticoagulation therapy and outline ways to support their treatment through shared decision-making. Insights into patients' perspectives on addressing thrombotic complications of the extracorporeal circuit can inform strategies to improve care and outcomes for patients receiving hemodialysis.

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INTRODUCTION

The process of hemodialysis includes the creation and maintenance of vascular access and the circulation of blood through an extracorporeal circuit to remove excess solutes and fluid from patients with kidney failure. Anticoagulation agents provided throughout hemodialysis treatment play a critical role in the safety and viability of hemodialysis¹ by ensuring adequate blood flow through the extracorporeal circuit and preventing thrombotic events during the treatment.^{2,3} Clotting of the extracorporeal circuit during the treatment can result from mechanical problems in the circuit (i.e., insufficient priming, dialyzer malfunction) or be initiated by circulating factors in the patient's blood related to the disease, hereditary factors, and medication.^{4,5} Clotting in the extracorporeal circuit is deemed one of the most common causes of inadequate dialysis, with complications varying from mild to life-

threatening events, including thrombosis.^{3,6} Discarding of blood leading directly to blood loss of as much as 200-300 mL for each episode (depending on the total volume of the extracorporeal circuit)¹ and missed or shortened dialysis sessions are typical consequences of clotting in the circuit.⁷ Inefficiencies in the dialysis dosage are associated with serious health impacts and severe patient anxiety, increased hospitalizations, and inpatient costs in this population, which already has a very high mortality rate.^{1,7,8} Missed dialysis treatments, resulting in patients receiving a lower dialysis dose, are correlated with an even higher mortality rate in patients receiving hemodialysis.⁸

However, measures for preventing clotting through systemic anticoagulation therapy may increase the frequency and severity of bleeding in these patients.⁹ A recent study has reported that the risk of bleeding in patients receiving hemodialysis is 1.5 times greater compared with those receiving peritoneal dialysis.¹⁰ This is of particular concern, as patients requiring dialysis (peritoneal dialysis or hemodialysis) already have several risk factors for bleeding (e.g., platelet dysfunction) with the use of anticoagulation, further exacerbating the risks to patients receiving hemodialysis. Effective anticoagulation therapy during hemodialysis can be challenging since adequate anticoagulation, while reducing clotting, can elevate the risks of bleeding, whereas inadequate anticoagulation can result in clotting of the extracorporeal circuit.¹¹ Knowledge regarding anticoagulation therapy and associated bleeding risks may therefore influence the choice of treatment modality for patients with kidney failure.

There is a need to understand patients' perspectives on clotting and anticoagulation therapy given the

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physical and psychosocial consequences of clotting of the extracorporeal circuit in patients receiving hemodialysis. In this article, we outline the potential impact of interventions to treat clotting in patients as well as the priorities and perspectives of patients that may be relevant to clotting and anticoagulation therapy and discuss measures to support informed shared decision-making. Insights into patients' perspectives on addressing thrombotic complications of the extracorporeal circuit can inform strategies to improve care and outcomes for patients receiving hemodialysis.⁷

PREVENTION OF EXTRACORPOREAL CLOTTING AND IMPACT ON PATIENTS

Forestalling clotting activation during hemodialysis maximizes the effectiveness of treatment by maintaining patency in the dialyzer blood compartment. Unfractionated heparin (UFH) and low-molecular-weight heparin (LMWH) remain the standard of care with regard to anticoagulants administered in maintenance hemodialysis worldwide. Although heparin is used because of its ease of administration, short half-life, and low cost, there are potential risks associated with its use. Side effects of heparin include increased bleeding risk, heparin-induced thrombocytopenia, anemia, and possibly bone mineral disease,⁵ as discussed in detail in the corresponding articles of this issue. Patients with active bleeding or a recent history of surgery or hemorrhagic episodes are considered at high risk of bleeding complications due to systemic anticoagulation.¹² Sites frequently associated with bleeding include the gastrointestinal tract, intraocular areas, intracranial structures, pericardial tissue, mediastinal space (with possible compression of the heart and lungs), and retroperitoneal areas.⁵ Direct thrombin inhibitors (e.g., argatroban and lepirudin), regional anticoagulation (e.g., citrate and nafamostat), and anticoagulation-free hemodialysis setups are alternatives to UFH and are discussed in separate articles within this issue. Patients with kidney failure, especially the elderly, have multiple comorbidities requiring anticoagulants and other drugs, which might interfere with anticoagulant therapy related to hemodialysis. Concomitant therapies, including antiplatelet agents and vitamin K antagonists, and disease-related clotting abnormalities may also increase the risk of bleeding. Additionally, circumstances that often occur during hospitalization (e.g., postsurgical period) may magnify these risks.¹¹ Selection of the appropriate anticoagulant and its dose requires consideration of the characteristics of the anticoagulant and the patient's condition.⁵

Globally, there is an absence of established protocols for administering anticoagulants,¹³ with practices varying across countries and dialysis centers.¹⁴ The European Best Practice Guidelines for hemodialysis recommend LMWH over UFH, with recommendations on UFH

dosing, but no such UFH dosing recommendations exist in the United States or Japan. LMWH remains in limited use in the United States but is administered in Europe and Japan for hemodialysis treatment.⁵ Alternative anticoagulants, including thrombin inhibitors and regional anticoagulants, and strategies that are safe and effective in ensuring smooth progress of hemodialysis are increasingly gaining evidence.¹⁵ However, in patients at high risk of bleeding, low-dose (UFH) or heparin-free dialysis with frequent saline flushes is still most frequently used for anticoagulation.^{5,12} Many facilities have developed protocols for heparin administration, but variances in dosing schedules can be attributed not only to differences in patient conditions but also to the heterogeneity in practice patterns of health care providers.^{14,16} Patient-related factors affecting a clinician's dosing decision include patient characteristics (height, weight), type of vascular access (fistula versus graft), inherent bleeding conditions, and comorbidities. Facility-level factors associated with variation include size of the facility, location, rurality, and individual unit practices. However, a study found that only a small proportion of the variation in dosing was explained by patient- and facility-level factors, with a large proportion of the variation (75%) remaining unexplained.¹⁴ Patient-centered care therefore requires insights into factors that include an understanding of patient priorities and consideration of the best decisions benefiting the patient and aligning with their preferences, needs, and goals over labor and cost-saving alternatives.^{14,16}

PATIENT PERSPECTIVES AND PRIORITIES RELEVANT TO CLOTTING AND ANTICOAGULATION THERAPY

There is a reasonable body of evidence on patient perspectives and priorities in hemodialysis in general. Studies have shown that patients undergoing hemodialysis consistently prioritize outcomes related to pain and discomfort or those that are disabling or associated with devastating consequences.¹⁷ Through the global Standardized Outcomes in Nephrology—Hemodialysis initiative, which involved over 1,000 patients, caregivers, and health professionals from more than 70 countries, outcomes including mortality, anemia, dialysis adequacy, hospitalization, anxiety, and stress were identified as important outcomes to be measured and reported in trials in patients receiving hemodialysis.¹⁸ These outcomes relate to the risks and complications that patients encounter and the distress they endure because of clotting of the extracorporeal circuit and its management.

Despite the severe consequences of clotting of the dialysis circuit, there remains sparse information on patients' perspectives and preferences specifically regarding anticoagulant therapy. One study reported

patients' perspectives on "bad runs" in hemodialysis where patients were concerned about missing or shortened dialysis sessions due to thrombosis.⁷ Dialysis instability and ensuing suffering were of concern to patients. They felt that much of the distress was avoidable and were taking actions to prevent bad runs in collaboration with their teams. They had insights into management of several factors, including postdialysis weight gain and cramping. However, patients felt unable to discern a role for themselves in the prevention of clotting. The study highlighted the need for education to promote patient involvement and participation in their own treatment.

To gain further insights into patient experiences and perspectives regarding clotting and anticoagulation, we provide the following personal accounts from four patients/caregivers who are also co-authors of this article.

Account #1, Daniel Gallego: After 28 years attending an in-center hemodialysis center and now doing home hemodialysis, clotting is a major issue for kidney patients and is underestimated. Many times, you have to finish your dialysis session before the recommended time is over due to clotting problems. This affects the quality and effectiveness of your dialysis treatment. Errors and omissions of anticoagulants can happen, so the problem of clotting can occur after several hours of treatment. The most important concerns are the quality of the treatments without clotting, to find the proper balance between the heparin dose and hemostasis without spending a huge time waiting.

Usually, health professionals are prescribing treatment without asking the patient about the clotting. In my opinion, patients doing dialysis should be asked about the symptoms and adherence related to clotting. This is a very important matter related to clotting, how it is affecting your daily life activities. We have uncertainty and fear, particularly when we have a cut or damage in our body, and how things can interfere with other drugs in case we need a surgery or other unexpected treatments. We received very little information on clotting. This may be limited to knowledge that the blood needs to be more fluid [thinner] for dialysis, so we need heparin. We wish to be informed about pros and cons about using heparin, which kind of heparin interventions are available, and which dose is appropriate to minimize harmful effects for the rest of the day.

Usually, there is no real shared decision-making with patients about anticoagulating agents, and health professionals do not seem to appreciate how important to us it is to ask us about this. We need to know there are several and different options to choose from, and we need to be involved in the final decision. The key to

empowering people is education, not only information, so we need to create adapted material for patients receiving hemodialysis to raise awareness about clotting, options, and highlight the importance of anticoagulation for a good quality of dialysis sessions.

Daniel Gallego is president of the European Kidney Patient's Federation and president of ALCEER Federation since 2018 (Spanish Association Fighting Against Kidney Diseases). He has been a kidney patient since 1993, undergoing hemodialysis since 1995. He received a transplant in 1998, but the transplant failed in 2003, so he is undergoing hemodialysis as of today.

Account #2, Madeleine Warren: I have been on dialysis for 25 years, since I was a teenager, the first 5 on peritoneal dialysis and 20 so far on home hemodialysis. I absolutely thrive on dialysis and have always had fantastic care from my renal unit team. We work in partnership to agree to all aspects of my health management, and I am very knowledgeable and independent with my dialysis. However, on reflection, I realize that even when I first started on hemodialysis, there was never any discussion about anticoagulation choices or possible side effects related to heparin. It was just administered during my first dialysis, and I have been using it ever since. As I do extended-hour nocturnal treatments at home, my understanding is there isn't much choice other than low-molecular-weight heparin anyway for me. But I was never aware of the possible side effects of heparin until I looked them up myself a few years ago because my hair was falling out and another patient suggested it could be the cause. I never worked out if it was related to the hair loss, but I was very surprised to see a huge list of possible drug interactions and side effects which I had definitely never been made aware of and would otherwise never have known about. This is very unusual for me, as I like to know absolutely everything, and I do think that when dialysis is being started the anticoagulation should be fully explained, including any side effects to look out for and alternative options.

I find being on home dialysis extremely smooth going. I am very lucky that it works so well and enables me to have such a normal life. In particular, I have always worked full time in a career that I love, and I am extremely ambitious. I am also really lucky to have had the same fistula, which I have used continually for 20 years, but there have been a couple of occasions when it has stenosed and twice when it has fully clotted. Whilst I do understand that it's to be expected that such an old fistula will run into problems from time to time, nonetheless, it was hugely disruptive to

my work and my dialysis schedule when this did happen, and I would do anything to minimize the chances of it happening again. It also really conjured up the fear of what if this access can't be saved and there isn't another viable vein for a new fistula, which for me is a realistic risk and probably the only thing that worries me about being on long-term dialysis. If adjusting or changing my anticoagulation regime would reduce the risk of another access clot I would certainly do it, and I think it's really important that health care professionals regularly discuss and review anticoagulation during regular vascular access clinics. On the other hand, I have never struggled with clotting in my blood lines even running treatments for up to 8 h long, so I generally take the approach that if it's not broken then don't try to fix it. But knowledge is power, and anticoagulation is such a fundamental aspect of our dialysis regimes it does seem like an oversight to never discuss it.

Madeleine Warren (alias Queen of Dialysis) is from the UK. She went into kidney failure when she was 14 years old and has been on home dialysis for 25 years since. She is a consultancy director working with MedTech and Pharma clients, a TEDx speaker, a passionate campaigner and advocate in the kidney community, and a member of a woman's formation sky diving team.

Account #3, Amanda Grandinetti: I started dialysis when I was 22 and in my last semester of my undergraduate degree. I crashed into dialysis even though I had had kidney disease for 8 years. Going on dialysis was a complete surprise to me, and I was not prepared for it. I wanted to pursue transplant, so my team gave me a permacath hemodialysis catheter on the right side of my chest. My hemodialysis catheter clotted many times, and it made my treatment times even longer. My treatment time was 3-1/2 h, but with connecting and disconnecting it took closer to 4-1/2 h. Treatment took even longer when my catheter was clotted. I was spending more time at the center than I wanted, and more time was being taken away from me from things I wanted to do, such as hanging out with friends and going out to social events. The most important concerns to me regarding my dialysis catheter clots were that I would need another dialysis catheter and it would further scar and disfigure me. I also was concerned that I was spending way too much time at the dialysis center. I thought hemodialysis was my only option since I was not informed of peritoneal dialysis, and therefore I felt very alone and trapped by needing to be at my center even longer than I already was.

My clotting was managed by adding an anticlotting treatment into my catheter and letting it sit inside of it

anywhere from 30 min before treatment to a day after treatment. At one point, I needed my catheter completely replaced because it could not be fixed. This resulted in another surgery, more time recovering, more time in pain, and more time spent away from friends and activities I enjoyed. Fortunately, the clotting medications did not interfere with my other medications. I did not receive any information regarding clotting when I received my dialysis catheter. I would have liked to know this could be an issue so I could be completely informed about the care I was receiving. I was not given a choice about which anti-clotting agents would be used for me. I had no knowledge of what other options there were for anticlotting agents. I had crashed into hemodialysis even though I had had kidney disease for 8 years and was very uninformed about anything related to dialysis. My center did not provide me any education on dialysis. I had to rely on my own research and other patients who had been on dialysis or currently were.

Patients should be informed of all options for anticlotting. They should know all the benefits and risks of the anticlotting agents and treatments. Physicians should listen to patients' concerns regarding different treatments so both the patient and physician can come to an agreement on the best treatment. Physicians should also have a conversation with patients on what their most important values regarding their care are so the best treatment can be used. Patients should also be made aware of what can happen if the anticlotting agents do not work so it does not come as a surprise to patients.

Amanda Grandinetti is a research methodologist, current PhD candidate, member of the Kidney Health Initiative Board of Directors, and kidney transplant recipient from the United States. She has had focal segmental glomerular sclerosis since she was 14 years old. Her kidneys failed 8 years later, and she was on dialysis for 2-1/2 years. She has received two kidney transplants from her friends.

Account #4, Chandana Guha: I am the primary caregiver of my daughter, who was diagnosed with childhood kidney disease leading to kidney failure before receiving a kidney transplant. She required both peritoneal and hemodialysis as part of her treatment for kidney failure. My daughter experienced episodes of severe bleeding and frequent vascular access complications during the hemodialysis sessions. As is common in children with chronic kidney disease, she had delicate, hard-to-access veins, and it was challenging to maintain patency of her permacath. She required multiple surgeries to treat the repeated vascular access complications, frequent hospitalizations, long periods

away from school and family to recover from surgery or infections and was often in pain. During one of the hemodialysis sessions post-transplant surgery, she had an episode of hemorrhaging that resulted in a rapid fall in her hemoglobin levels. This was alarming and caused significant distress to her and the family.

As her primary caregiver, I received very little information on the challenges, especially around clotting or vascular access interventions. No information on anticoagulation was provided, which I now understand plays a critical role in managing clots and maintaining patency of the catheters. Prior knowledge of the therapy and information on what to expect when the treatment sessions were interrupted due to malfunctions of the catheter or clotting of the dialysis circuit would have enabled better management of my daughter's distress and pain. The loss of blood was particularly distressing and concerning since I knew that she was already undernourished and anemic from kidney failure.

Patients and caregivers have a right to information about their kidney replacement therapy, the options available to them, and the potential challenges and barriers that they might encounter. Information on anticoagulants, mode of administration, and risks associated would help patients and caregivers make informed choices about the treatment of their child. Parents of children must be educated on how best to prepare children for such challenges. The information needs to be provided even prior to commencement of the therapy. Education that is free of medical jargon, easy to understand, and shared through a trusted source would be valuable to us. As caregivers, knowledge of what to expect during the treatment would help in navigating through the child's distress and anxiety, facilitating the administration of the treatment and improve outcomes.

Chandana Guha is a researcher, PhD candidate from Australia, and caregiver of her daughter, who was diagnosed with childhood chronic kidney disease. Her daughter's kidneys failed in 2007, when she was 10 years old, and she subsequently received a transplant after 2 years of treatment with dialysis. Chandana is passionate about research that translates into policy and practice to address the needs and priorities of consumers.

These accounts highlight several areas of concern for the patients. Patients felt disempowered because of a lack of knowledge about treatment options, risks, and benefits of anticoagulants and the treatment they were undergoing for clotting and believed they were not consulted by their physicians about their own care with

regard to anticoagulation therapy. Patients revealed that they had no choice but to endure the discomfort, anxiety, and suffering related to complications with clotting. There were also concerns about the repercussions of anticoagulation therapy, including interactions with drugs and repeated clotting. Clotting of the dialysis lines decreased the quality of treatment received while increasing treatment time at the hemodialysis unit, adding to feelings of isolation and further preventing them from participating in key activities of daily living and socializing.

SUPPORTING INFORMED SHARED DECISION-MAKING

Globally, there is an increasing emphasis on empowering patients to make informed decisions and in self-management, with shared decision-making recognized as a critical aspect of patient-centered care.¹⁹ Shared decision-making is a "consultation process where a clinician and patient jointly participate in making a health decision, having discussed the options and their benefits and harms, and having considered the patient's values, preferences, and circumstances. Shared decision-making is not a single step to be added into a consultation but can provide a framework for communicating with patients about health care choices to help improve conversation quality."²⁰ Shared decision-making is also supported by international guidelines on the management of kidney disease;^{21,22} however, specific recommendations on shared decision-making regarding clotting and anticoagulation therapy are lacking. We suggest multiple strategies to encourage and enable partnership with patients in the delivery of their care. [Figure 1](#) captures key patient-centered outcomes associated with clotting and its treatment. [Table 1](#) provides a summary of our suggestions for supporting shared decision-making among patients and clinicians regarding clotting in hemodialysis.

Although literature on patient perspectives on hemodialysis adequacy lacks information on patient-directed efforts to prevent clotting, our accounts highlight a need for improved understanding of clotting and anticoagulation therapy. Patient education is needed on the diverse causes of clotting, including blood-related factors (e.g., thick blood due to underlying disease or kidney failure, blood disorders, use of pharmacologic agents), mechanical or dialyzer-related problems, inefficient or suboptimal use of anticoagulants, and vascular access complications.¹ Identifying symptoms and the consequences of clotting (e.g., dark-colored blood in the machine, interruptions of dialysis session, short dialysis sessions, clotting in the circuit, and ensuing blood loss) may prepare patients for what to expect during their treatment. Knowledge of administrable anticoagulants for prevention of clotting, appropriate modes of administration, and interactions of anticoagulants with drugs used for other comorbid conditions may assist patients in

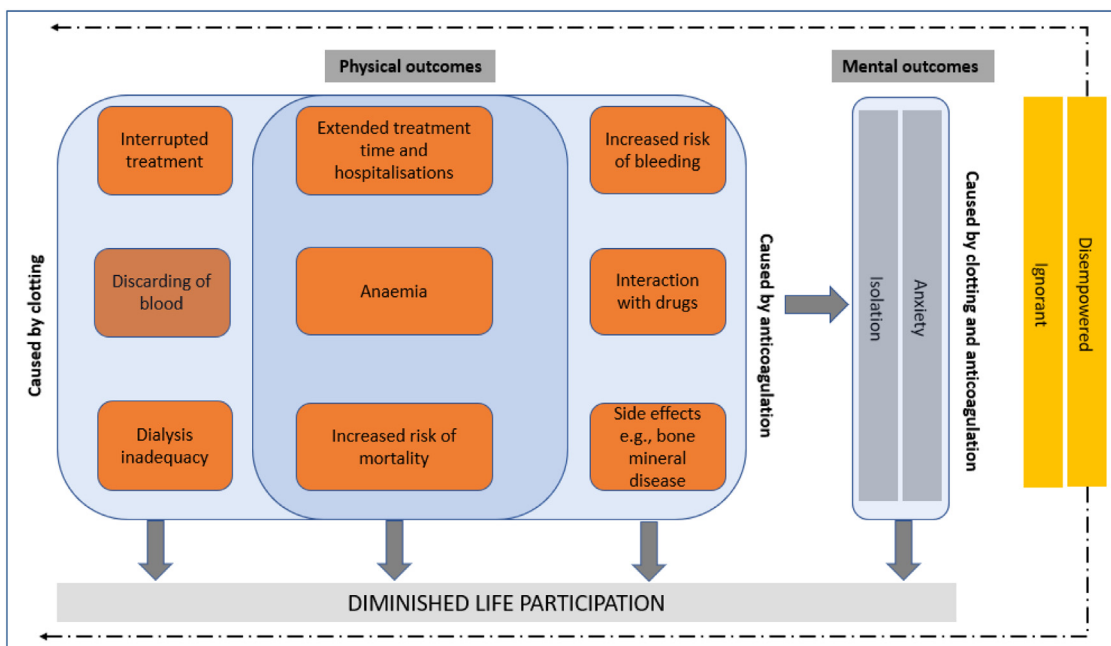


Figure 1. Potential impacts of clotting of the extracorporeal circuit on patient-centered outcomes.

Table 1. Strategies for Improving Patient-Centered Care

Strategy	Domain
Provide comprehensive education for patients	<p><i>Causes of clotting:</i></p> <ul style="list-style-type: none"> • Blood-related • Mechanical problems with the dialyzer, priming of the extracorporeal circuit • Vascular access complications • Inefficient anticoagulation <p><i>Consequences of clotting:</i></p> <ul style="list-style-type: none"> • Dialysis inadequacy • Blood loss <p><i>Anticoagulation therapy:</i></p> <ul style="list-style-type: none"> • Choice of anticoagulation agents • Managing vascular access complications <p><i>Risks associated with anticoagulation therapy:</i></p> <ul style="list-style-type: none"> • Bleeding • Interactions of anticoagulants with other drugs • Painful surgeries (Do you mean additional access surgeries? How is this related to circuit clotting prevention?) • Hospitalizations • Long periods of recuperation • Isolation
Facilitate shared decision-making	<ul style="list-style-type: none"> • Ascertain patient perspectives, priorities, and goals with regard to clotting, clotting prevention, vascular access complications, and management • Develop, evaluate, and implement decision-making tools and resources that address clotting and assist in shared decision-making in its management • Present all treatment options (e.g., different options for anticoagulation, including available anticoagulants and dosing, vascular access sites)
Provide access to psychosocial support	<ul style="list-style-type: none"> • Support mental health • Alleviate loneliness and isolation

prioritizing their preferences and goals for treatment and enable engagement in the decision-making process of their own care. Patient education on treatment outcomes, including risks of bleeding, drug interactions, surgeries, and hospitalizations, is vital for setting patient expectations and improving satisfaction with their care.²³

Since patients experience considerable psychosocial sequelae, including anxiety, distress, and isolation, associated with the treatment of clotting, there is a need to support patients who may have higher incidences of clotting, repeated hospitalizations, and long periods of recuperation with limited opportunities for social interaction. Providing psychosocial support specific to the needs of patients to build psychosocial functional capacity may have a positive impact on their quality of life. For example, interventions that improve peer relationships, including connecting patients with peer support groups, may abate feelings of isolation, loneliness, and the perceived impact of the disease.²⁴ Our patient accounts highlight their frustrations at their limited capacity to participate in daily activities of life and social activities. This is reflective of the findings by the Standardized Outcomes in Nephrology initiative, where patients on hemodialysis prioritized highly activities that represent life participation, including ability to work, ability to travel, and dialysis-free time.¹⁸ Further research is therefore required to determine the interventions that support life participation in these patients.

For clinicians to understand patients' priorities and goals and to integrate the preferences of their patients into their care, they need to be educated on effective ways of communicating and providing information that is simplified and comprehensible, enabling a balanced exchange of information between them. Patients have suggested that open conversations could help them anticipate and mitigate complications in vascular access, whereas clinicians have expressed a need for tools, such as decision aids, to assist with shared decision-making.²³ Eliciting patients' perspectives and understanding of their disease through effective communication helps in promoting care that aligns with patients' goals and values.²⁵ However, communication alone may not be sufficient to support shared decision-making. A systematic review of decision aids for people facing health treatment found that decision aids improved patient–clinician consultation.²⁶ Decision aids that were used within the consultation and the majority of those that were used in preparation for the consultation were found to be beneficial for patient–clinician communication. A study on complex decision-making among cancer patients has made several recommendations on strategies that improve patient understanding and assist with decision-making; for example, pictographs and summary tables outlining risks and benefits of each treatment option, presenting natural frequencies rather than relative risks, were recommended.²⁷ The study also highlighted how

perceptions of risks of the treatment can be affected by the way information is presented. Discussions, information, and education on clotting of the extracorporeal circuit need to be integrated into the overall care plan of patients. For example, information on the risks and side effects associated with anticoagulation may influence the choice/modality of treatment (peritoneal dialysis versus hemodialysis). We suggest the provision of up-to-date information from reliable sources presented in a patient-friendly manner to enable and support shared decision-making. Further research to determine patient perspectives, priorities, and preferences regarding treatment of clotting and anticoagulants used in the extracorporeal circuit will help in determining interventions aimed at promoting shared decisions.

CONCLUSIONS

Clotting of extracorporeal circuits has serious consequences in patients on hemodialysis. In the absence of standardized recommendations on anticoagulation therapy, provision of patient-friendly information and education, clinician training on communication, and shared decision-making are key to achieving patient-centered care.

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