

Exploring health literacy and self-management after kidney transplantation: A prospective cohort study

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ABSTRACT

Objective: Investigate the influence of health literacy and self-management on complications, kidney function and graft failure after kidney transplantation.

Methods: We included patients who received a kidney transplant between May 2012 and May 2013 and monitored outcomes until December 2018. Health literacy was measured using the Newest Vital Sign and self-management using the Partner in Health scale (before discharge, and after 6 and 12 months). Subscales are aftercare & knowledge, coping, recognition and management of symptoms, healthy lifestyle. Complications were categorized as rejection, viral infections, and bacterial infections. Kidney function was measured using eGFR and graft survival using days until failure.

Results: We included 154 patients. Higher health literacy at baseline and at 12 months was related to more viral infections ($p = 0.02$; $p < 0.01$). Lower 'coping' at baseline was related to more bacterial infections ($p = 0.02$). Higher 'after-care and knowledge' at 6 months ($p < 0.01$), and 'recognition and management of symptoms' at 6 months were associated with lower graft failure ($p < 0.01$).

Conclusion: Health literacy did not influence kidney transplant related outcomes. Higher knowledge and management of symptoms were related to lower graft failure.

Practice implications: Self-management support is a key focus for health care providers in the multi-disciplinary team.

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1. Introduction

Health literacy has received increasing attention in the medical literature over the past decade. Sørensen et al. [1] described one comprehensive definition, 'health literacy is linked to literacy and entails people's knowledge, motivation and competences to access, understand, appraise, and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course'. In addition, health literacy can be divided into the categories of functional, interactive and critical health literacy. It is likely that the ability to understand health information is highly related to how this information is used in managing illness in daily life [2]. For example, adequate health

literacy was related to higher self confidence in self-care among heart failure patients [3].

Self-management incorporates medical, social and emotional aspects of chronic disease management [4]. Barlow and Wright [5] formulated the following definition which is widely used: 'the individual's ability to manage the symptoms, treatment, physical and psychosocial consequences and lifestyle changes inherent in living with a chronic condition'. Subsequently, Lorig and Holman [4] also describe that when a patient decides not to engage in healthful behavior and is not active in managing the disease, this also reflects a management style. These authors describe five core self-management skills: problem solving, decision making, resource utilization, forming of a patient/health care provider relationship and taking action. For example, patients who experience more medication side-effects may use a disengagement coping style and may be more likely to disengage from treatment which in turn may have negative consequences for outcomes including health related quality of life [6].

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The description and use of functional, interactive and critical health literacy contain similarities with several self-management skills. Both concepts of health literacy and self-management contain aspects of the use and interpretation on health related information and application to promote health in daily life and as such have some overlap. They can however be distinguished as separate concepts as health literacy focusses on information processing while self-management is broader as it encompasses emotional, psychological and social elements. Both concepts are important for dealing with chronic conditions, and therefore may influence clinical outcomes. Given that health literacy is likely to be associated with self-management, it is important to investigate these factors together when considering the impact on medical outcomes [7].

Chronic kidney disease is one such condition requiring long-term management. Kidney transplantation improves quality of life and life-expectancy compared to other renal replacement therapies, however, recipients remain lifelong patients who must follow lifestyle guidelines and a stringent medication regime. Due to the complexity of self-care after kidney transplantation, patients with low health literacy and inadequate self-management skills may be vulnerable for poorer outcomes [8]. A potential consequence of poor adherence to this regime is rejection of the graft [9,10]. This often leads to increased re-hospitalizations after kidney transplantation [11,12]. Several studies focus on health literacy and access to kidney transplantation, e.g. patients with limited health literacy skills were less likely to be listed for transplantation, were more likely to be removed from listing, and less likely to receive a transplant [12,13]. One study investigated the relationship between health literacy and kidney transplant related knowledge and kidney function [14]. They initially found a relationship between low health literacy and higher serum creatinine levels (considered as decreased kidney function). After controlling for demographic, clinical characteristics and socioeconomic data there was only a significant relationship between health literacy and serum creatinine.

There have been significant gains in short term transplant outcomes, however long term outcomes are still an area for improvement. In particular, investigating modifiable factors, such as health literacy and self-management, that may influence long-term outcomes is a priority. Despite the need for such research, this area has received attention mainly in the United States of America (USA). There is a paucity of research on health literacy and self-management among kidney transplant recipients in Europe where the health care system differs considerably to that in the USA. One systematic review among chronic kidney disease patients, included only one study on patients from multiple countries, all other patients were from the USA [11]. This review mainly discussed (pre) dialysis patients and only 3 studies included transplant recipients. Furthermore, the review contained only 2 prospective cohort studies, all other studies were cross-sectional highlighting methodological limitations in this area.

In order to address the need for prospective research in the European setting, we designed a prospective cohort study among kidney transplant recipients with the aim of investigating the relationship between health literacy and self-management on the one hand, and complications, kidney functioning and graft survival on the other. We hypothesized that patients with low health literacy and self-management skills would experience more complications and have a lower graft functioning.

2. Material and methods

2.1. Design

We performed a prospective, quantitative, observational cohort study using a combination of (self-reported) questionnaires and information obtained from the medical records.

2.2. Participants

Patients who received a kidney transplant between May 2012 and May 2013 were approached for participation. Inclusion occurred after an educational consultation with the nurse practitioner prior to discharge. This standard consultation contained instructions on recognizing symptoms of infections and rejection, actions that need to be taken if these symptoms occur, nutritional advice, monitoring of fluid balance, medication regime, and personal hygiene.

Inclusion criteria were sufficient understanding the Dutch language, no cognitive disorders, no visual handicaps which would impede data collection and age over 18 years. No restrictions were placed on type of donor, previous number of transplantations, and type of renal replacement therapy prior to transplant.

2.3. Data collection

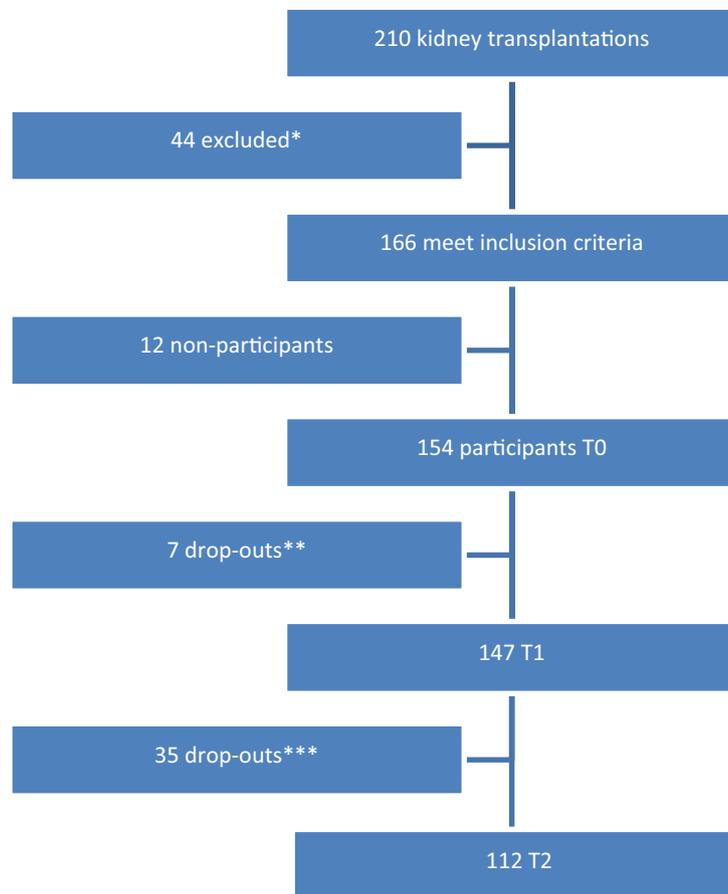
Those willing to participate were asked to complete the self-management questionnaire and answer questions in the health literacy assessment immediately after the educational consultation. During outpatient follow-up at approximately 6 months as well as 12 months post-transplantation, participants were asked to complete the same questionnaires and interview again. Patients received a telephone reminder 1–2 weeks before their appointment and were asked if they were still willing to participate in the study. Data on complications and kidney function up to 12 months post-transplant and on graft loss up to 5 years post-transplant were collected from medical records. Participants who experienced graft failure during the first year were no longer approached for the 6 and/or 12 month follow-up measures nor included in the follow-up of clinical outcomes. Cause of death or graft failure were registered in the database.

2.3.1. Health literacy

To date, there is no golden standard to measure health literacy. Many studies used the 'test of functional health literacy in adults' (TOFHLA) and 'rapid estimate of adult literacy in medicine' (REALM), particularly studies conducted in the USA. However, the TOFHLA and REALM focus mainly on reading skills while the Newest Vital Sign (NVS) also incorporates numeracy and interpretation skills. Furthermore, a benefit of the NVS is that it measures health literacy in a way that is more applicable to daily life with a chronic illness. We concluded that the NVS most comprehensively measures the concept of health literacy. Therefore, to assess health literacy we chose the Dutch Newest Vital Sign (NVS-D), a 6-item nutrition label that measures reading and numeracy skills. Answering the questions on the label is comparable to reading and understanding a medication prescription. The nurse practitioner posed 6 questions to the participant resulting in a sum score between 0 and 6. A score of 0–1 suggests high likelihood (50% or more) of limited literacy, 2–3 indicates the possibility of limited literacy, and 4–6 almost always indicates adequate health literacy [15]. The Dutch version was translated and tested by Fransen et al. [16]. Their study concluded that the Dutch version showed an acceptable internal consistency (Cronbach's alpha 0.78) and was very reliable.

2.3.2. Self-management

To measure self-management we used an expanded version of the most recent Australian Partners in Health scale (PIH) [17]. The scale is also available in Dutch [18]. We added 13 items to increase the relevance to transplantation. To analyze this expanded PIH we performed a factor analysis. The resulting 4 factors were comparable with the subscales of PIH from Petkov et al.: knowledge, coping, recognition and management of symptoms, and adherence to treatment. We altered some names of the subscales slightly to better reflect the content of the added items, e.g. knowledge became



* *follow-up elsewhere, language barrier, visual handicap, mental retardation*

** *transplant failure (n=3), death (n=2), other reasons (n=2)*

*** *transplant failure (n=2), back to peripheral hospital < 1 year (n=28), did not want to anymore (n=5)*

Fig. 1. Inclusion.

aftercare and knowledge, and adherence to treatment became healthy lifestyle. Our version was piloted among 5 patients and found to be acceptable in length and well understood. Patients were asked to report on a scale of 0 (very poor) to 8 (very good) how well they were able to manage the post-transplant regime, e.g. recognizing symptoms or skills to track fluid intake, urine production and temperature. The sum of the scores per subscale were used in the analysis, higher scores indicate better self-management skills. The reliability of the original Dutch PIH was investigated by Lenferink et al. [18] and showed a Cronbach's Alpha of 0.84 for the total scale.

2.3.3. Outcomes after kidney transplantation

All complications that occurred up to 12 months after transplantation were obtained from the medical records of the participants. Complications were operationalized as the number of, and reasons for re-hospitalizations. These reasons were categorized as (suspected) rejection, viral infection and bacterial infection.

Kidney function after 12 months (estimated glomerular filtration rate; higher clearance indicates better kidney functioning) was also obtained from medical records. Graft failure up to 5 years after transplantation was recorded as the number of days the patient had a functioning graft.

The following socio-demographic and medical characteristics were collected from the medical records: donor type (living / deceased), prior treatment modality (dialysis / none), gender, age,

education level (low contains only primary and secondary school/higher contains also completed further education), and descent (European / non-European), human leukocyte antigen (HLA) mismatching, count panel reactive antibodies (PRA).

2.4. Ethical considerations

Participants were asked to complete a written information letter and sign an informed consent if they decided to participate. This written information and study protocol was in accordance with the Declaration of Helsinki. The study proposal was approved by the research ethics board of the Erasmus MC (MEC-2012-120).

2.5. Data analysis

We used SPSS (version 25) for data analysis. Normality of the outcome distributions were ascertained with Shapiro-Wilks tests. Depending on the distribution Pearson's or Spearman's correlations, independent *t*-tests or Mann-Whitney *U*-tests, were performed to analyze the relationship between socio-demographic data (gender, descent, education, employment, prior treatment modality and donor type) and health literacy and self-management. Baseline data of socio-demographic variables between patients with or without complications (rejection, viral or bacterial infections or other) were analyzed the same way. The course of health literacy and self-management between T0 and T2 was analyzed with Wilcoxon's

signed rank tests. The relationship between health literacy and self-management and type of complications was analyzed with Mann-Whitney *U* tests. The relationship of health literacy and self-management with kidney function after kidney transplantation was analyzed with Spearman's rank correlations. Multivariate Cox proportional hazard analysis was used to analyze the influence of health literacy and self-management on graft failure up to 5 years after transplantation, controlling for age, gender, prior treatment modality, HLA mismatch, highest PRA and donor type. Multilevel regression analysis was also performed, but findings remained the same so we present only the univariate analysis from this study.

3. Results

3.1. Patient characteristics

Inclusion took place during one year, in which we performed 210 kidney transplantations at our center. We excluded 44 patient who did not meet the inclusion criteria. Of the 166 patients approached 12 did not want to participate. At baseline 154 patients were included in the study. At the 6 months follow-up 7 patients dropped out due to graft failure ($n = 3$), death ($n = 2$) or due to other reasons ($n = 2$). At the 12 months follow-up 35 patients dropped out because they did not want to participate anymore ($n = 5$), had been referred to their local hospital for aftercare ($n = 28$) or dropped out due to graft failure ($n = 2$) (Fig. 1). Variable response rates per measure were due to the fact that patients sometimes skipped questions for unknown reasons.

3.2. Health literacy and self-management

Health literacy and self-management were not normally distributed, so we performed non-parametric analyses. Health literacy was significantly higher among European recipients, recipients with a higher education level, those transplanted pre-emptively, those who received a living donor transplant, and younger recipients (Table 1). The median score of health literacy showed a significant increase over time (Table 2). Regarding self-management skills, 'aftercare and knowledge' was higher among European recipients, those with a higher education level, and younger recipients. Scores on 'recognition and management of symptoms' and 'coping' were also higher among European recipients (Table 1). The median scores for 'aftercare and knowledge', and 'coping' showed a significant increase over time, while 'healthy lifestyle' showed a significant decrease over time (Table 2).

3.3. Complications after kidney transplantation

We did not find a relationship between health literacy or self-management and the number of re-hospitalizations. Patients who scored higher on health literacy at baseline and at 12 months, experienced significantly more re-hospitalizations because of viral infections ($p = 0.02$ and < 0.01 respectively, Table 3). With regard to self-management skills, patients who scored lower on 'coping' at baseline experienced more often re-hospitalization because of bacterial infections ($p = 0.02$; Table 3). There was no influence of health literacy and self-management skills on re-hospitalization because of rejection.

3.4. Kidney function

Neither health literacy nor self-management were related to kidney function at any time point (data not shown).

3.5. Graft failure

There was no relationship between health literacy and graft failure (Table 4). Regarding self-management skills we found that the higher the score of 'aftercare and knowledge' at 6 months, the lower the risk of graft failure up to 5 years after transplantation ($p = 0.003$). This relationship was not found with 'aftercare and knowledge' at 12 months. Furthermore, a higher score on 'recognition and management of symptoms' at 6 months, was related to a lower risk of graft failure ($p = 0.009$). Also, 'recognition and management of symptoms' at 12 months was not related to graft failure up to 6 years after transplantation. There was no relationship between 'healthy lifestyle' or 'coping' and the risk of graft failure (Table 4).

4. Discussion and conclusion

4.1. Discussion

Adequate health literacy levels and better self-management skills were found among patients who were younger, of European descent, more educated, pre-emptively transplanted, and received a kidney from a living donor. These findings were in line with other studies [8,19,20].

We found a significant increase in health literacy levels over time, namely from limited literacy to adequate health literacy. The cause of this finding is unclear, perhaps due to the fact that participants recognized the questionnaire the second and third time. However, the findings cannot be attributed to an intervention as this study was purely observational. This study adds insights into potential fluctuation in health literacy among kidney transplant patients and there have been no other prospective observational studies to date. There was no relationship between health literacy and the number of re-hospitalizations, which is in contrast to the finding reported by Taylor et al. [11] and Miller-Matero et al. [12]. In the present study, higher health literacy was related to a greater number of re-hospitalizations due to viral infections, but was unrelated to kidney function and graft failure. Thus we have not confirmed the finding of Gordon and Wolf [14] that a lower health literacy was associated with decreased kidney function. We also did not confirm the findings that health literacy is an important factor for the prevention of rejection and other co-morbidities such as diabetes, hypertension or infections during the post-transplant follow-up [20]. Although we measured diabetes and cardiovascular complications during follow-up, the incidence was too low to allow for statistical analysis. Other studies found that poorer health literacy levels were associated with lower adherence to immunosuppressive regimes which was not measured in this study and deserves further investigation [21,22].

While health literacy was in general not related to the clinical outcomes measured, there was evidence for the importance of self-management. Greater knowledge about aftercare 6 months after transplantation was significantly related to lower graft failure in the subsequent 5 years. This effect was no longer found for 'aftercare and knowledge' measured at 12 months of follow-up, which could be explained by the fact that most knowledge is gained within the first months after transplantation. We found the same effect of 'aftercare and knowledge' over time, scores improved significantly within 6 months after transplantation. Previous research showed that patients' knowledge about transplantation could result into improved management and effective communication after kidney transplantation [23]. The subscale 'recognition and management of symptoms' measured at 6 months after kidney transplantation, was significantly related to lower graft failure. Healthy lifestyle, also one of the elements of self-management, was not predictive of complications after transplantation in

Table 1
Socio-demographic data and health literacy and self-management scores.

	N %	NVS-D Health literacy		PIH self management								
		Median [IQ range]	p-value ^a	PIH – aftercare and knowledge		PIH – recognition and management of symptoms		PIH – coping		PIH – healthy lifestyle		
				Median [IQ range]	p-value ^a	Median [IQ range]	p-value ^a	Median [IQ range]	p-value ^a	Median [IQ range]	p-value ^a	
Baseline scores												
Gender	101 (66%)	3[1–5]	0.80	7.0[6.5–7.7]	0.95	7.8[7.3–8.0]	0.11	7.0[6.6–8.0]	0.78	7.7[7.0–8.0]	0.32	
Male		3[2–5]		7.0[6.1–7.8]		8.0[7.5–8.0]		7.3[6.7–8.0]		8.0[7.3–8.0]		
Female	53 (34%)											
Descent	123 (80%)	3[2–5]	<0.001	7.2[6.7–7.7]	0.01	7.9[7.5–8.0]	0.01	7.2[6.7–8.0]	0.02	7.7[7.0–8.0]	1.00	
European		1[1,2]		6.3[4.7–7.5]		7.5[6.9–8.0]		6.8[4.8–8.0]		8.0[7.0–8.0]		
Non-European	31 (20%)											
Education	46 (58%)	2[1–4]	<0.001	6.7 [5.3–7.4]	0.005	7.8[7.0–8.0]	0.35	7.0[6.0–8.0]	0.92	7.4[7.0–8.0]	0.72	
Low (elementary and/or high school)	34 (42%)	4[3–6]		7.3 [6.8–8.0]		7.9[7.4–8.0]		7.0[6.7–7.9]		7.9[7.3–8.0]		
High (college)												
Employment	32 (41%)	4[2–6]	0.80	7.0 [6.7–7.7]	0.35	8.0[7.5–8.0]	0.31	7.4[6.9–8.0]	0.36	8.0[7.3–8.0]	0.10	
Employed	48 (59%)	4[3–6]		7.1 [6.6–8.0]		7.8[7.5–8.0]		7.0[6.7–8.0]		7.3[7.0–8.0]		
Unemployed												
Medical history	65 (42%)	4[2–5]	0.01	7.0 [6.7–8.0]	0.13	8.0[7.5–8.0]	0.17	7.3[6.7–8.0]	0.33	7.7[7.0–8.0]	0.61	
Pre-emptive	87 (58%)	2[1–4]		7.0 [6.0–7.5]		7.7[7.2–8.0]		7.0[6.5–8.0]		7.7[7.0–8.0]		
Dialysis												
Donor type												
Living donor	110 (71%)	3[2–5]	0.02	7.0[6.4–7.9]	0.73	7.9[7.3–8.0]	0.48	7.0[6.5–8.0]	0.82	7.7[7.0–8.0]	0.99	
Deceased donor	44 (29%)	2[1–4]		7.1[6.0–7.5]		7.0[7.2–8.0]		7.0[6.7–8.0]		7.7[7.0–8.0]		
Age ^b	55.1 (± 13.1)	-0.38	<0.001	-0.24	0.003	-0.05	0.56	-0.05	0.55	0.009	0.91	

IQ range - interquartile range.

^a Mann-Whitney U-test.

^b Spearman correlation.

our study, but did decrease significantly over time. Comparable findings have been reported before in the literature among heart transplant recipients [24]. They found that healthy lifestyle fluctuated among participants. Stress was one of the factors that influenced healthy lifestyle negatively. We found an association between subscale ‘coping’ and clinical outcomes, namely lower baseline scores on coping were related with increased bacterial infections. There is evidence that patients who experience anger and anxiety were less likely to be capable of self-observation after kidney transplantation. Also, in another study patients who were described as optimists and emotionally in control, showed a strong relationship with health promoting skills [25]. Our findings appear to be in line with these earlier reports on the impact of coping and therefore we emphasize the importance of the effect of coping with the emotional and social consequences of the kidney transplantation. The subscale ‘coping’ showed a significant improvement over time during 12 months of follow-up. The promotion of patient empowerment, a holistic approach and shared decision making, could improve medical outcomes after kidney transplantation [26].

During the process of this study, health literacy research has evolved, for example new questionnaires have been developed. The contradictory findings on health literacy found here when compared to other studies that used alternative measures requires further investigation. With regard to methodology, kidney transplant recipients may question the relevance of questions on a nutrition (ice-cream) label used in this clinical setting. More research is needed on validity and reliability of these measures when used repeatedly. Furthermore, not all components of health literacy were measured that are relevant for post-transplant treatment. The NVS-D does not assess functional health literacy, how individuals act on health information. Jordan et al. [27] describe several instruments that measure health literacy and their main finding was that there is limited empirical evidence on reliability and construct validity. Use of various instruments also makes it difficult to compare health literacy outcomes.

A strength of this study is that we investigated a large cohort among kidney transplant recipients over time. This is a unique investigation in the European setting. A limitation of this study was

Table 2
Course of health literacy and self-management.

	n	Health literacy			Self-management											
		Health literacy		p	Aftercare and knowledge			Recognition and management of symptoms			Coping			Healthy lifestyle		
		Md	IQR		Md	IQR	p	Md	IQR	p	Md	IQR	p	Md	IQR	p
Baseline	152	3.0	[2.0–5.0]	<0.001 ^a	7.0	[6.3–7.7]	<0.001 ^a	7.9	[7.4–8.0]	0.13 ^a	7.0	[6.7–8.0]	0.04 ^a	7.7	[7.0–8.0]	0.04 ^a
6 months	137	4.0	[2.0–5.0]		7.3	[6.7–7.7]		7.7	[7.0–8.0]		7.1	[6.3–8.0]		7.3	[7.0–8.0]	
12 months	111	4.0	[2.0–6.0]		7.2	[6.7–8.0]		7.7	[7.0–8.0]		7.5	6.7–8.0]		7.3	[7.0–8.0]	

^a Wilcoxon sign rank test for difference between baseline and 12 months. Md = median; IQR = inter quartile range.

Table 3
Differences in health literacy and self-management for type of complications after kidney transplantation.

	n ^a	Health literacy			Aftercare & knowledge			Recognition and management of symptoms			Coping			Healthy lifestyle			
		Md	IQR	p	Md	IQR	p	Md	IQR	p	Md	IQR	p	Md	IQR	p	
Rejection	Baseline	132	3.0	[2.0–5.0]	0.32	7.0	[6.3–7.7]	0.18	7.9	[7.4–8.0]	0.37	7.0	[6.6–7.9]	0.09	7.7	[7.0–8.0]	0.59
	no	20	3.0	[1.3–3.0]		7.5	[6.5–8.0]		8.0	[7.3–8.0]		7.8	[6.7–8.0]		7.7	[7.3–8.0]	
	yes																
	6 months	118	4.0	[2.0–5.0]	0.34	7.1	[6.8–7.8]	0.93	7.7	[7.0–8.0]	0.69	7.1	[6.3–8.0]	0.64	7.3	[7.0–8.0]	0.68
	no	19	3.0	[1.0–4.0]		7.3	[6.5–8.0]		7.7	[7.0–8.0]		7.0	[6.5–8.0]		7.1	[7.0–7.7]	
	yes																
Viral infection	Baseline	140	3.0	[1.0–5.0]	0.02	7.0	[6.3–7.8]	0.66	7.9	[7.4–8.0]	0.52	7.0	[6.7–8.0]	0.64	7.7	[7.0–8.0]	0.11
	no	12	4.5	[3.0–6.0]		7.0	[6.9–7.6]		7.7	[7.3–8.0]		6.9	[6.4–7.9]		6.9	[6.8–7.9]	
	yes																
	6 months	127	4.0	[2.0–5.0]	0.16	7.3	[6.7–7.8]	0.32	7.7	[7.0–8.0]	0.46	7.1	[6.3–8.0]	0.43	7.3	[7.0–8.0]	0.44
	no	10	4.5	[3.0–6.0]		7.0	[6.3–7.8]		7.7	[6.7–8.0]		7.0	[5.6–8.0]		7.0	[7.0–7.7]	
	yes																
Bacterial infection	Baseline	113	3.0	[1.0–5.0]	0.32	7.0	[6.3–7.7]	0.93	7.8	[7.3–8.0]	0.25	7.2	[6.7–8.0]	0.02	7.7	[7.0–8.0]	0.99
	no	39	3.0	[2.0–5.0]		7.0	[6.3–7.8]		7.8	[7.5–8.0]		6.9	[6.0–7.7]		7.7	[7.0–8.0]	
	yes																
	6 months	104	4.0	[2.0–5.0]	0.94	7.3	[6.8–7.8]	0.29	7.7	[7.0–8.0]	0.08	7.2	[6.5–8.0]	0.12	7.3	[7.0–8.0]	0.74
	no	33	4.0	[2.0–5.0]		7.0	[6.4–7.8]		7.5	[7.0–8.0]		7.0	[6.0–7.8]		7.3	[7.0–8.0]	
	yes																
Bacterial infection	Baseline	113	3.0	[1.0–5.0]	0.32	7.0	[6.3–7.7]	0.93	7.8	[7.3–8.0]	0.25	7.2	[6.7–8.0]	0.02	7.7	[7.0–8.0]	0.99
	no	39	3.0	[2.0–5.0]		7.0	[6.3–7.8]		7.8	[7.5–8.0]		6.9	[6.0–7.7]		7.7	[7.0–8.0]	
	yes																
	6 months	104	4.0	[2.0–5.0]	0.94	7.3	[6.8–7.8]	0.29	7.7	[7.0–8.0]	0.08	7.2	[6.5–8.0]	0.12	7.3	[7.0–8.0]	0.74
	no	33	4.0	[2.0–5.0]		7.0	[6.4–7.8]		7.5	[7.0–8.0]		7.0	[6.0–7.8]		7.3	[7.0–8.0]	
	yes																
Bacterial infection	Baseline	113	3.0	[1.0–5.0]	0.32	7.0	[6.3–7.7]	0.93	7.8	[7.3–8.0]	0.25	7.2	[6.7–8.0]	0.02	7.7	[7.0–8.0]	0.99
	no	39	3.0	[2.0–5.0]		7.0	[6.3–7.8]		7.8	[7.5–8.0]		6.9	[6.0–7.7]		7.7	[7.0–8.0]	
	yes																
	6 months	104	4.0	[2.0–5.0]	0.94	7.3	[6.8–7.8]	0.29	7.7	[7.0–8.0]	0.08	7.2	[6.5–8.0]	0.12	7.3	[7.0–8.0]	0.74
	no	33	4.0	[2.0–5.0]		7.0	[6.4–7.8]		7.5	[7.0–8.0]		7.0	[6.0–7.8]		7.3	[7.0–8.0]	
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	no	33	4.0	[2.0–5.0]		7.0	[6.4–7.8]		7.5	[7.0–8.0]		7.0	[6.0–7.8]		7.3	[7.0–8.0]	
	yes																

p-values Mann-Whitney U tests between no and yes. Md = median; IQR = inter quartile range.

^a Not all participants administered all questionnaires at all time points.

Table 4
Cox proportional hazards model for the influence of health literacy and self-management on graft failure (censored for death), controlled for gender, age, dialysis vs. pre-emptive donor type, number of mismatches and PRA.

	Events/n	Health literacy			Self-management											
		HR	IQR	p	Aftercare & knowledge			Recognition and management of symptoms			Coping			Healthy lifestyle		
					HR	IQR	p	HR	IQR	p	HR	IQR	p	HR	IQR	p
Baseline	17/147	1.03	[0.76–1.39]	0.857	0.74	[0.52–1.04]	0.085	1.20	[0.60–2.40]	0.615	1.12	[0.72–1.73]	0.622	1.48	[0.66–3.34]	0.341
6 months	17/132	0.87	[0.65–1.16]	0.343	0.48	[0.29–0.78]	0.003	0.56	[0.37–0.87]	0.009	0.80	[0.54–1.15]	0.215	0.84	[0.54–1.30]	0.436
12 months	14/107	0.89	[0.64–1.24]	0.502	0.78	[0.41–1.48]	0.451	0.47	[0.21–1.05]	0.067	0.78	[0.52–1.16]	0.213	0.66	[0.37–1.17]	0.152

HR - hazard ratio; IQR- inter quartile range; 95% CI - 95% confidence interval.

that foreign patients with language barriers or patients with cognitive disorders were not included in this study, while they may be more vulnerable for low health literacy and self-management. Furthermore, there is a chance that patients gave socially desirable answers whereby patients over-estimate their self-management skills on the self-report Partner in Health scale. This may have been enhanced by the fact that their health care provider included them in the study and conducted the measurements. Another limitation was the way that we registered and monitored complications. We did not include for example the duration of re-hospitalizations.

4.2. Conclusion

In our study health literacy did not influence kidney transplant related outcomes, which contradicts earlier studies and requires further investigation. Patients with lower self-management skills such as knowledge and the ability to recognize and manage symptoms of complications, were more likely to have graft failure. Our findings showed the importance of self-management, in particular during the first six months after kidney transplantation. Knowledge of kidney transplant related complications and recognition as well as management of these complications, are modifiable factors. These

can be targeted in interventions, particularly among patients who may be more vulnerable for poorer outcomes due to limited knowledge and low health literacy. Future research among transplant recipients should consider methodological issues, e.g. type of health literacy and self-management measures as well as following patients over time. Future studies should investigate not only post-transplant patients but also patients on dialysis and pre-dialysis patients to gain a better understanding of the importance of and relationships between health literacy and self-management on the one hand and access to transplant and clinical outcomes at various stages of kidney disease on the other.

4.3. Practice implications

Health care professionals need to be aware of those needing more support in learning about the post-transplant lifestyle and medication regime, especially within the first six months after transplantation. They may be more vulnerable for poorer outcomes. This requires close cooperation within the multidisciplinary team who need to have access to self-management support interventions to achieve improvement. In addition, we should not underestimate the effect of coping with the emotional and social consequences of

the kidney transplantation and these psychosocial aspects deserves our attention. In this study we focused on the post-transplant period however it may be more effective to initiate self-management support in the period prior to transplantation. During this phase, it is common that patients receive extensive amounts of written and verbal information. Previous research among end stage renal disease patients opting for kidney transplantation, described a specially designed preparatory program [28]. They found an increase in transplant knowledge, communication efficacy and skills, and encouraging discussions about transplantation. Given this, we believe research on health literacy and self-management during the pre-transplant work-up is needed. Furthermore, previous research shows that health literacy is indeed modifiable and suggests that professionals should focus to a greater extent on tailoring the delivery of information and organization of care offered to promote better understanding among all patients [27].

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Conflict of Interest

The authors declare no conflict of interest.

CRediT authorship contribution statement

Louise Maasdam: term, conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing original draft, visualization, project administration
Reinier Timman: validation, formal analysis, writing original draft, data curation
Monique Cadogan: investigation, resources, writing review & editing
Mirjam Tielens: investigation, resources, writing review & editing
Marleen van Buren: investigation, resources, writing review & editing
Willem Weimar: conceptualization, methodology, data curation, writing review & editing, visualization
Emma Massey: term, conceptualization, methodology, validation, formal analysis, data curation, writing original draft, visualization, supervision.

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