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# The dynamics of the general practitioner-nephrologist collaboration for the management of patients with chronic kidney disease before and after dialysis initiation: a mixed-methods study

Maxime Raffray , Cécile Vigneau, Cécile Couchoud, Laetitia Laude, Arnaud Campéon, François-Xavier Schweyer and Sahar Bayat

## Abstract

**Background:** Effective collaboration between general practitioners (GP) and nephrologists is crucial in CKD care. We aimed to analyse GPs' and nephrologists' presence and involvement in CKD care and assess how they intertwine to shape patients' trajectories.

**Methods:** We conducted a mixed-methods study that included all patients with CKD who started dialysis in France in 2015 (the REIN registry) and a sample of nephrologists and GPs. We quantified professionals' presence through patients' reimbursed healthcare from the French National Health Data System, 2 years before and 1 year after dialysis start. Involvement in CKD care was derived from the nephrologists' and GPs' interviews.

**Results:** Among 8856 patients included, nephrologists' presence progressively increased from 29% to 67% of patients with a contact during the 2 years before dialysis start. However, this was partly dependent on the GPs' referral practices. Interviews revealed that GPs initially controlled the therapeutic strategy on their own. Although unease grew with CKD's management complexity, reducing their involvement in favour of nephrologists, GPs' presence remained frequent throughout the pre-dialysis period. Upon dialysis start, nephrologists' presence and involvement became total, while GPs' greatly decreased (48% of patients with a contact at month 12 after dialysis start). Collaboration was smooth when GPs maintained contact with patients and could contribute to their care through aspects of their speciality they valued.

**Conclusions:** This mixed-methods study shows presences and forms of involvement of GPs and nephrologists in CKD care adjusting along the course of CKD and unveils the mechanisms at play in their collaboration.

**Keywords:** care trajectories, chronic kidney disease, collaboration, general practitioner, healthcare data, mixed methods

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## Introduction

Chronic kidney disease (CKD) is an important public health issue with high morbidity and mortality.<sup>1</sup> In the long care trajectory of patients with CKD, the work performed by nephrologists and

general practitioners (GP), who often intervene simultaneously,<sup>2</sup> is crucial. It encompasses screening, referring, monitoring, slowing down CKD progression, and preparing the patient for kidney replacement therapy. In different

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countries, this medical work is formalised in guidelines (e.g. monitoring content and frequencies, referral criteria), and the primary care-specialist co-management or collaboration is an essential part of the integrated CKD care model.<sup>3,4</sup> However, these guidelines do not explicitly describe this collaboration, that is, who is in charge of what and when. Moreover, literature evidence shows that in practice, the GP-nephrologist collaboration is limited and suboptimal, with poor communication and unclear delineation of roles, for example.<sup>5-9</sup> Consequently, late referral to specialists and emergency dialysis start remain frequent.<sup>10-13</sup> In 2018 in France, 30% of incident dialysis patients initiated dialysis in an unplanned manner.<sup>11,14</sup>

Previous studies,<sup>5,6,9</sup> mostly from North America, evaluated the collaboration between GPs and nephrologists strictly through the lens of their medical specialty. Data on the barriers to optimal collaboration in CKD care are lacking from other countries with different healthcare systems and organisations. Specifically, little is known on the GPs and nephrologists' perceived place and role of each other in CKD care (i.e. limited in time or continuous involvement throughout the disease course). Discrepancies between their own perceived role can become barriers in the smooth implementation of coordinated care, as observed for other healthcare professionals in different settings, such as cancer care.<sup>15-17</sup>

The aim of this study was to evaluate the CKD co-management dynamics of GPs and nephrologists through their form of involvement and presence in the care trajectory, using their views collected through interviews and also exhaustive nation-wide data on healthcare utilisation by patients with CKD. We hypothesised that nephrologists and GPs share a continuous form of involvement in CKD care, leading to a competition on the therapeutic strategy that affects the care trajectory of patients with CKD. Using a mixed-method sequential design,<sup>18</sup> our objectives were to (1) qualitatively describe the forms of involvement of both professionals in the care of patients with CKD, and (2) quantitatively characterise their presence in the care of patients with CKD, informed by the previous qualitative data, and (3) assess how their presence and forms of involvement interact to shape care trajectories.

## Materials and methods

*Qualitative component: to describe the GPs and nephrologists' forms of involvement in the care of patients with CKD*

Semi-structured interview guides were developed with the goal of determining the GPs and nephrologists' views on CKD care, their roles and the perceived roles of the other, and CKD co-management. These guides were pilot tested using a convenience sample and then revised accordingly (available as supplementary material 1). Interviews were carried out in the Brittany region (western France). GPs and nephrologists were identified and contacted using professional lists. The maximum variation sampling method was used to ensure sufficient diversity of gender, years of practice, and settings (i.e. rural and urban areas, private practice alone, multidisciplinary group practice, public or private not-for-profit setting). A written information document to present the study and to ask whether the physician agreed to be interviewed was sent to the identified healthcare professionals and if they agreed, an interview was scheduled. At the start of the interview, verbal consent was sought for the audio recording of the conversation. Between April 2020 and April 2021, semi-structured interviews by telephone were carried out by one of the authors (M.R., PhD with 3 years of qualitative research experience and with no prior relationship with participants). Interviews and data collection continued until data saturation was reached (i.e. when additional data did not lead to any new theme or development).<sup>19</sup> During that data collection process, only one GP refused the interview when solicited.

## Analyses

After the initial reading of the full transcripts, iterative rounds of reading, word by word, were performed and data were categorised into themes to describe all aspects of the content.<sup>20</sup> The analysis was carried out by M.R. using NVivo v.12.4. Coded themes were refined after feedback and discussion with A.C., F-X.S., and L.L. These themes were then used to describe the forms of involvement in CKD care by both professionals. These qualitative findings were presented at several national healthcare congresses to externally validate them through discussions with professionals (outside of Brittany).

*Quantitative component: to describe the GPs and nephrologists' presence in the care of patients with CKD using healthcare data utilisation*

A quantitative analysis was carried out using data on healthcare utilisation by all patients with CKD who started dialysis in France in 2015 to validate the previously determined forms of involvement of GPs and nephrologists. The aim of this quantitative analysis at the nationwide level was to determine how many patients saw a GP and a nephrologist during the period of transition to dialysis and to identify who prescribed what and in which relative proportion.

First, all  $\geq 18$ -year-old 2015 incident dialysis patients were identified in the REIN registry. The REIN registry records all patients who start maintenance kidney replacement therapy in France and collects baseline data on patients, treatments, and outcomes (e.g. death, transplantation) (ethical approvals CCTIRS 03-149 and CNIL N° 903188).<sup>21</sup>

Then, healthcare utilisation data were obtained from the French National Health Data System (SNDS) database. This nationwide medico-administrative database contains data on all care utilisation in inpatient (e.g. hospitals, hospices, clinics) and outpatient (i.e. community-based, office-based) services.<sup>22</sup> To this aim, a deterministic indirect record linkage was performed to retrospectively link the SNDS healthcare data and the REIN data of all incident dialysis patients in 2015.<sup>23</sup> Unmatched patients and patients without information on dialysis start were excluded. The study population was previously described elsewhere<sup>11</sup> (flowchart available in supplemental material 2). All reimbursements of consultations, laboratory tests, and drug prescriptions were extracted as well as the prescribers' medical specialty. The study period included the two years before and the first year after dialysis start.

### Analyses

The percentage of patients who had a consultation with a GP and/or a nephrologist, and the percentages of laboratory tests and drugs prescribed to these patients by a GP or a nephrologist were reported for each quarter of the study period. We also examined separately drugs acting on the renin-angiotensin system (angiotensin-converting enzyme inhibitors, ACEi, and

angiotensin receptor blockers, ARB, ATC code C09). All analyses were carried out with R v3.6.

The Results section describes the two qualitative and quantitative components together (i.e. integration process). In addition, a sensitivity analysis was carried out to ensure that the quantitative data (patients from the entire France) could be compared with the same data for the subset of patients from Brittany (the region where the interviews were carried out for the qualitative component) (available in supplemental material 3).

## Results

### Study population

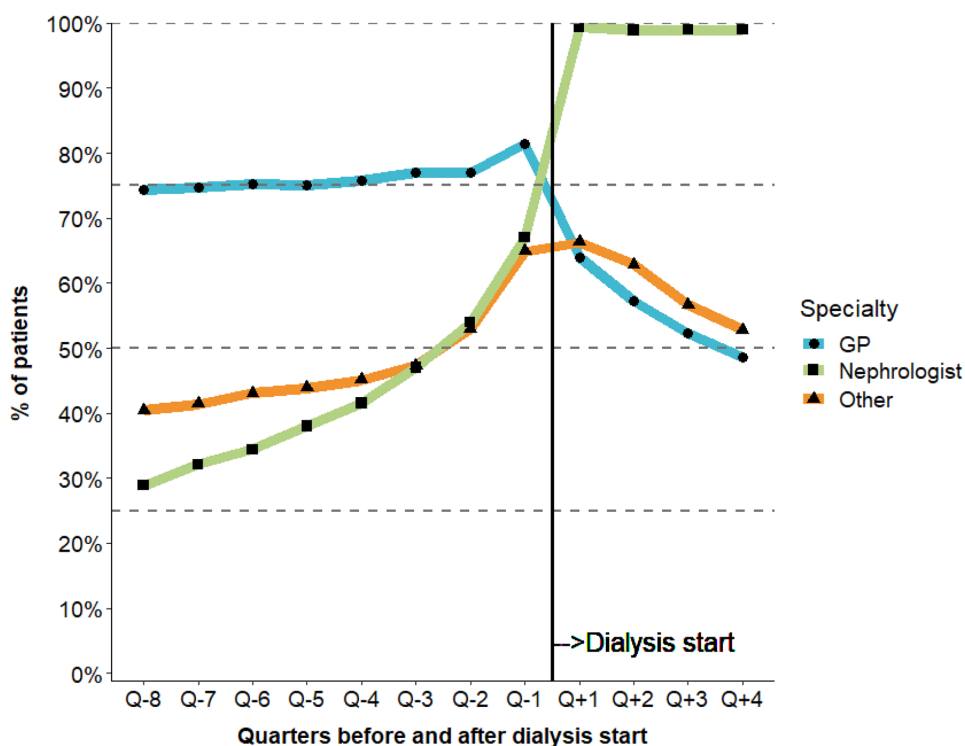
For the quantitative component, 10,667 patients who started dialysis in France in 2015 were extracted from the REIN registry. Among them, 8856 were matched with healthcare utilisation data in the SNDS database. The inclusion flowchart and patient's characteristics were previously described in Raffray *et al.*<sup>11</sup> (Supplemental material 2 and 4). The mean age at dialysis start was 68.7 years (standard deviation:  $\pm 15$ ). For the qualitative component, 18 nephrologists and 12 GPs from the Brittany region were interviewed (mean interview duration = 36 minutes). Their characteristics are presented in Table 1 (individual characteristics in supplemental material 5).

### *Presence and forms of involvement in the care of patients with CKD: a constant adjustment throughout the disease course*

*From a progressively increasing presence of nephrologists to their care takeover after dialysis start.* As dialysis start approached, the nephrologists' presence in the patients' care progressively increased. Specifically, the percentage of patients who saw a nephrologist at least once increased from 28.9% in the 8th quarter before dialysis start to 67% in the last quarter before dialysis start (Figure 1). During the same period, the part of laboratory tests prescribed by nephrologists was important (50.3% of all prescribed tests) and progressively increased [Table 2 and Figure 2(a) and (b)]. In the year following dialysis start, 74.5% of all prescribed tests was prescribed by a nephrologist, and 99% of patients saw a nephrologist at least once. Conversely, the percentage of patients who saw a GP at least once per quarter progressively decreased to reach 48% in the last

**Table 1.** Characteristics of GPs ( $n = 12$ ) and nephrologists ( $n = 18$ ) interviewed.

	General practitioners ( $N = 12$ )	Nephrologists ( $N = 18$ )	Total ( $N = 30$ )
<b>Gender</b>			
Women	6 (50.0%)	9 (50.0%)	15 (50.0%)
Men	6 (50.0%)	9 (50.0%)	15 (50.0%)
<b>Years of practice</b>			
< 10	4 (33.3%)	5 (27.8%)	9 (30.0%)
10–25	4 (33.3%)	7 (38.9%)	11 (36.7%)
> 25	4 (33.3%)	6 (33.3%)	10 (33.3%)
<b>Practice setting</b>			
GPs group	2 (16.7%)	0 (0%)	2 (6.7%)
Medical office	6 (50.0%)	0 (0%)	6 (20.0%)
Primary healthcare network	4 (33.3%)	0 (0%)	4 (13.3%)
Public hospital and private non-profit dialysis centre	0 (0%)	7 (38.9%)	7 (23.3%)
Private non-profit dialysis centre	0 (0%)	4 (22.2%)	4 (13.3%)
Public hospital	0 (0%)	7 (38.9%)	7 (23.3%)



**Figure 1.** Percentage of patients who saw a GP and nephrologist (including during dialysis sessions) at least once in a quarter before and after dialysis start ( $N = 8856$  patients who started dialysis in France in 2015).

Other medical specialties included anaesthesiology (16.8% of the total), cardiology (9.3%), internal medicine (7.6%), general surgery (7.4%), vascular surgery (7.3%) and endocrinology (5.5%).

**Table 2.** Total number of laboratory tests and drugs prescribed to 8856 patients with CKD who started dialysis in France in 2015 according to the prescriber's medical specialty.

	2 years before dialysis start number of items prescribed (%)	1 year after dialysis start number of items prescribed (%)	Total number of items prescribed (%)
<b>Laboratory tests prescribed by:</b>	<b>n = 1661945</b>	<b>n = 2247025</b>	<b>n = 3908970</b>
GP	450609 (27.1%)	134653 (6.0%)	1198500 (32.7%)
Nephrologist	835658 (50.3%)	1675129 (74.5%)	2510787 (64.2%)
Other	244116 (14.7%)	156591 (7.0%)	400707 (10.3%)
Unknown	131549 (7.9%)	281166 (12.5%)	412715 (10.6%)
<b>Drugs prescribed by:</b>	<b>n = 1444323</b>	<b>n = 814923</b>	<b>n = 2259246</b>
GP	1111782 (69.0%)	304476 (33.8%)	1416258 (56.4%)
Nephrologist	346120 (21.5%)	499628 (55.5%)	845748 (33.7%)
Other	134927 (8.4%)	84248 (9.4%)	219175 (8.7%)
Unknown	18831 (1.2%)	11872 (1.3%)	30703 (1.2%)

quarter of the year after dialysis start (Figure 1). The progressively less important GPs' role in the follow-up was confirmed by most of the interviewed GPs:

*It is true that once patients reach dialysis, we lose control completely. Because they are seen around three times a week during dialysis, it is the dialysis services that take care of everything, including comorbidities. (GP04)*

Before dialysis start, two key factors strengthened the nephrologists' involvement in the care of patients with CKD: (1) the holistic nature required by CKD care according to the nephrologists, and (2) the long-term care linked to CKD course, during which nephrologists seek to know the patients and their environment, mainly to choose the most appropriate kidney replacement therapy:

*Unlike cardiology or other specialties that cut the patient into slices, here we truly need to take care of all CKD consequences on the organism. (N11)*

*We do not only practice nephrology when we manage CKD, we also do some cardiology, angiology, sometimes oncology, some pneumology, some rheumatology, some dermatology. . . (N05)*

*CKD affects many aspects of the individual; there is the social, emotional, diet aspects, the lifestyle change. (N06)*

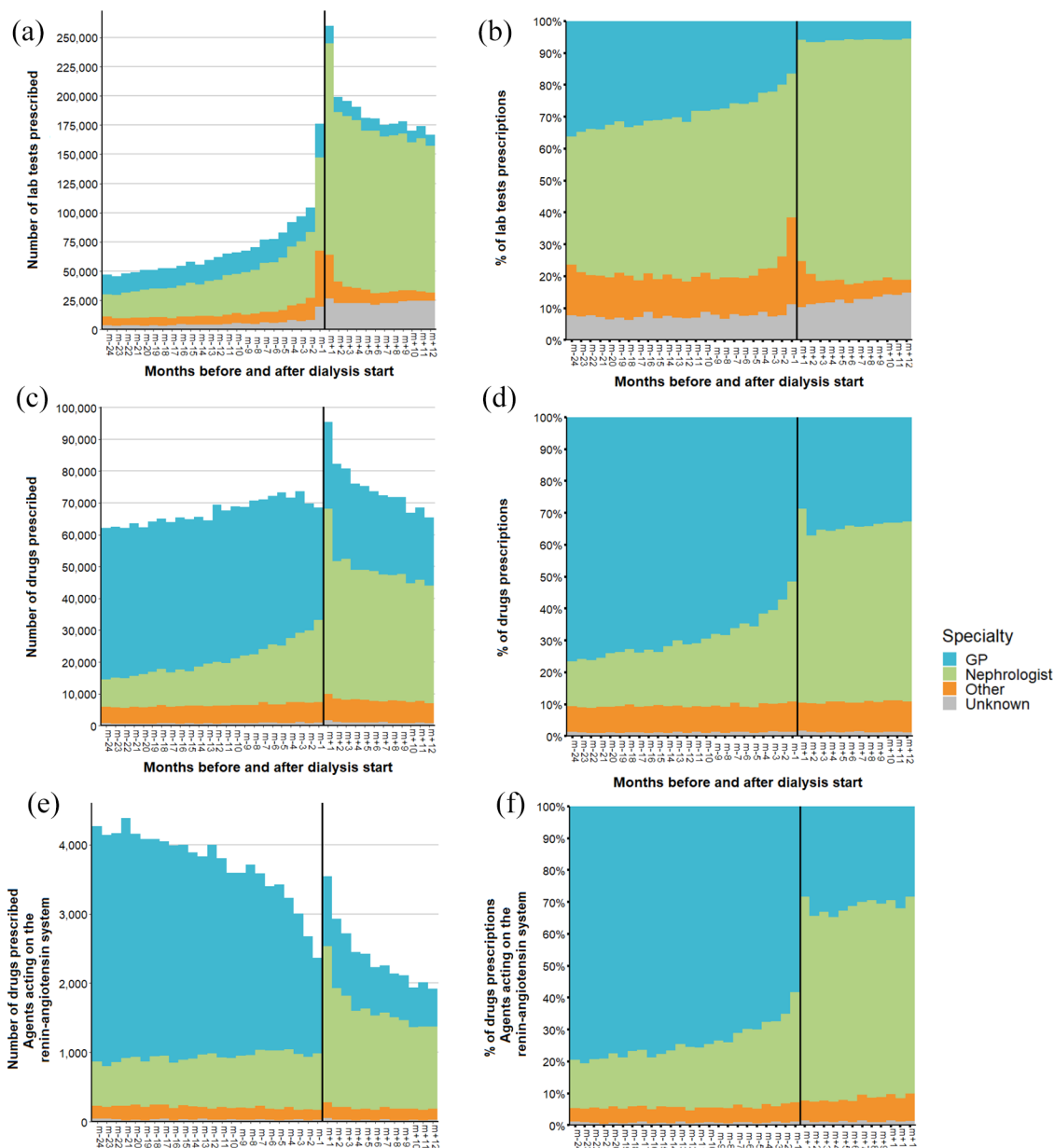
*It is a long road with patients [. . .], we follow families with polycystic kidney disease (sisters, brothers, kids and parents). . . And then there is the dialysis-transplantation journey, so these are rather complex trajectories. (N01)*

These two characteristics of the care provided by nephrologists were reminiscent of the usual care provided and described by GPs, characterised by a close and continuous relationship with their patients:

*In theory, yes [we should regularly see the patients], in practice not so much because nephrologists become more or less their GPs. Sometimes, we see them for some other problems that are outside the "nephrology sphere", but when they say 'nephrology sphere': blood pressure, drugs for the heart, it is often related to kidneys, so they really do everything [. . .] Sometimes one year, one year and a half can go by without us seeing these patients. (GP02)*

*The strong and continuous form of involvement by GPs until the delicate referral period. The observed trend of an increasing presence of nephrologists as dialysis start approached also*





**Figure 2.** Number and percentages of laboratory tests (a, b), total drugs (c, d) and drugs acting on the renin-angiotensin system (e, f) prescribed to the 8856 patients with CKD who started dialysis in France in 2015 according to the prescriber’s medical specialty in the 24 and 12 months before and after dialysis start, respectively.

Reading example: During the last month before dialysis start (m-1), 175,000 laboratory tests were prescribed (a) of which 45% were prescribed by a nephrologist (b). During the last month before dialysis (m-1), ~70 000 drugs were prescribed (c) of which 50% were prescribed by a GP (d).

depended on the GPs’ referral practice. During the 2 years before dialysis start, GPs had an important and steady presence, not only in term of contacts with patients but also through drug prescriptions. Among the 8856 patients included in the analysis, approximately 75% saw a GP regularly (i.e. at least once every quarter) during that

period (Figure 1). Although the GPs’ care share progressively decreased, GPs remained the predominant drug prescribers before dialysis start (69% of all prescriptions) and partly maintained this role in the year following dialysis start (33.8% of all prescriptions) [Figure 2(c) and (d) and Table 2].

Indeed, before referral to a nephrologist, and for a variable amount of time, the majority of interviewed GPs ( $n = 11/12$ ) controlled by themselves the care of patients with CKD (alone or with other specialists for patients with severe comorbidities). This consisted mainly in monitoring closely kidney function and controlling cardiovascular risk factors with prevention messages and drug prescriptions.

The timing and relevance of referral to a nephrologist were delicate for GPs. Most ( $n = 10/12$ ) decided to contact a nephrologist not when a blood creatinine clearance cut-off value was reached, but upon the occurrence of specific events or contexts (e.g. unexplained decline of kidney function or doubts about a drug prescription). Some GPs ( $n = 4/12$ ), on the basis of their previous or current experiences with patients transitioning to dialysis, expressed doubts on the added value of the care provided by nephrologists, particularly when patients are very old or live far away from specialised care centres:

*I have some patients with clearly deteriorated clearance but I don't send them because I practice in a rural area. Every consultation outside [the rural area] is complicated for them, they don't like it and if they don't have an immediate treatment they say: "why do I go back there?" And I don't have much to reply [ . . . ]: the nephrologist sees them, prescribes more advanced laboratory tests, but the treatment remains the same, so it doesn't change much for them. (GP07)*

CKD as an exception to GPs' continuous form of involvement in the care of patients. The initial 'acquisitive' form of involvement by GPs in CKD care was eventually reduced, although at different speed depending on the GP, due to two key reasons.

First, although estimating the number of patients with CKD was difficult for the majority of GPs, CKD represented a small and limited part of their global activity, which consists in providing care to 'all-comers'. Overall, present or past patients starting dialysis (or undergoing kidney transplant) were a very rare occurrence for all GPs interviewed:

*For severe CKD, I don't have many . . . maybe two. For others, mild to moderate, I have a few more [ . . . ] I could not give you a range. Maybe . . . well . . . I don't know, 40 to 50 maybe. Dialyzed patients, I don't have any currently. (GP08)*

*It is rare, [patients starting dialysis], I would say one per year, maximum [ . . . ]. Nephrology is a specialty we do not often deal with, compared with cardiology, endocrinology, pulmonology . . . (GP02)*

*During my work day, I will see one patient with CKD, one patient with chronic respiratory disease, one with type 1 diabetes, a lady developing gestational diabetes, a kid with a parvovirus infection, and hypnosis sessions. (GP06)*

Second, although the initial CKD screening was part of their routine work, most GPs declared that they were not at ease with the ensuing CKD management. At some point during CKD course, the usual control of cardiovascular risk factors was not sufficient, and CKD, with its increasingly numerous metabolic complications, became too complex to manage on their own. The number of drugs acting on the renin-angiotensin system (ACEi and ARBs) prescribed by GPs decreased when approaching dialysis start while the number prescribed by nephrologists remained stable [Figure 2(e)]. Specifically, monitoring advanced laboratory parameters (e.g. calcium or parathyroid hormone) and balancing drug prescriptions with the risk of nephrotoxicity were a source of unease.

*We are specialists in general medicine, like we call it, but we are not omnipotent. So it is true that. . . this [CKD management] is extremely technical, monitoring . . . all the electrolytes and everything. (GP04)*

*They [patients with CKD] usually have an extremely large collection of drugs, that's why we are not necessarily much at ease. (GP03)*

*We cannot lose sight of them [the patients] because if we miss one blood test for 3 or 6 months, we get fooled. (GP01)*

*We know about the main criteria, renal function assay, searching for proteins in the urine but besides these criteria, we are a bit helpless. (GP02)*

The quantitative analysis of the laboratory test prescriptions during the 2 years before dialysis start (Table 3) supported the GPs' statements. Blood urea and creatinine tests were routinely prescribed by GPs to patients who were seen or not by a nephrologist (65.8% and 66.8% of GPs' laboratory test prescriptions, respectively). The



**Table 3.** Laboratory tests prescribed by GPs and nephrologists 2 years before dialysis start to 8856 patients with CKD who started dialysis in France in 2015.

Laboratory test <sup>a</sup>	Number of prescriptions by GPs		Number of prescriptions by nephrologists			
	for patients without nephrologist follow-up <sup>b</sup>	%	for patients with nephrologist follow-up	%		
	Total = 10315		Total = 50450	Total = 59316		
Blood urea and creatinine <sup>c</sup>	6893	66.8	33,211	65.8	50,640	85.4
Serum electrolytes (Na + K + Cl optional)	5754	55.8	27,599	54.7	24,614	41.5
Blood count	5647	54.7	26,133	51.8	46,635	78.6
Lipid panel and Blood glucose	4445	43.1	18560	36.8	26619	44.9
Coagulation	2839	27.5	13,808	27.4	11,183	18.9
C reactive protein	3085	29.9	13,601	27.0	23,288	39.3
Calcium and phosphate <sup>c</sup>	1615	15.7	10,468	20.7	40,799	68.8
Liver function panel	2910	28.2	10,335	20.5	13,236	22.3
Blood uric acid	1902	18.4	9256	18.3	25,967	43.8
Sedimentation rate	2261	21.9	9158	18.2	2260	3.8
Complete serum electrolytes (Na + K + Cl + CO <sub>2</sub> + proteins) <sup>c</sup>	1426	13.8	9099	18.0	43,341	73.1
Blood iron panel <sup>c</sup>	1476	14.3	7012	14.3	18,588	31.3
Urinalysis	1013	9.8	5716	11.3	12,792	21.6
Blood natriuretic peptides	1333	12.9	5163	10.2	6665	11.2
Proteinuria <sup>c</sup>	732	7.1	4837	9.6	16,221	27.3
Blood thyroid-stimulating hormone	1322	12.8	4563	9.0	2534	4.3
Serum albumin <sup>c</sup>	764	7.4	4486	8.9	18,710	31.5
Alkaline phosphatase	1129	10.9	4253	8.4	10,535	17.8
Blood calcifediol <sup>c</sup>	611	5.9	3775	7.5	12,869	21.7
Blood parathyroid hormone <sup>c</sup>	223	2.2	2251	4.5	14,516	24.5
Prostate-specific antigen test	633	6.1	2089	4.1	2206	3.7

Reading example: 85.4% of laboratory test prescriptions from nephrologists during the 2 years before dialysis start included blood urea and creatinine assay.  
 Liver panel = transaminases, gamma-glutamyl transferase, bilirubin.  
 Blood iron panel = ferritin, iron and transferrin and iron-binding capacity.  
 Lipid panel and Blood glucose include haemoglobin A1c.  
<sup>a</sup>Laboratory tests ordered by decreasing frequency in GPs' prescription, the top 21 most frequently prescribed are displayed (90% of the total frequencies).  
<sup>b</sup>n = 1936/8856, 21.9%.  
<sup>c</sup>Laboratory tests included in the French CKD care management guidelines.

complete serum electrolyte test (including CO<sub>2</sub> and proteins) was found in 18% of GPs' laboratory test prescriptions (13.8% for patients without nephrologist follow-up) and in 73.1% of nephrologists' prescriptions. However, a more basic version of the test was more frequent among the GPs' prescriptions. All laboratory parameters listed in the French CKD management guidelines were detected more frequently in the nephrologists' prescriptions. In addition, the measurement of more advanced parameters (i.e. proteinuria, serum albumin, blood calcifediol, parathyroid hormone) was rare in GPs' prescriptions (<10% of prescriptions), especially for patients who had seen only the GP and not a nephrologist in the 2 years before dialysis.

Indeed, the monitoring of a wide range of laboratory parameters was the nephrologists' prerogative. Consistent with the laboratory test prescription data [Table 2 and Figure 2(a) and (b)], nephrologists described this monitoring as an essential and core part of their practice and the specificity of their specialty, which was an additional strengthening factor to justify their involvement in CKD care:

*In the end, [nephrology] is just laboratory test interpretation. Blood and urine tests, there is no . . . Clinical examination is rather poor, except for blood pressure and oedema. (N17)*

*Nephrology is a bit off-putting because it is not clinical examination, it consists of interpreting laboratory tests. (N16)*

Reaching nephrologists, through a call or a referral, was a way for GPs to reduce the uneasiness and by doing so, they relinquished part of their usual strong and continuous form of involvement. This was facilitated by the fact that these patients represented only a small part of their patient base.

*Now she is completely cared for in dialysis services [. . .], they do all the general medicine work. I even forgot I had her [as a patient], I do nothing for her. But, honestly, I do not regret it, I think it is better that way, it is too specialised for me. (GP11)*

**Nephrologists' control of the therapeutic strategy and GPs' valued place in the care.** In an emergent form of involvement in the care, GPs interviewed

valued their place in CKD care through the work of screening, guiding the patients through their care, coordinating (i.e. repeating and reviewing messages coming not only from the nephrologist but also from other specialists), and through the unique trust they developed with their patients:

*We centralise all the information, we are like a database: all the specialists' notes end up with us and sometimes there are some messages that are not necessarily well understood, because it goes fast, it's complicated, and there is a lot of information coming in one go. Afterward, we can review these messages with a cool head. (GP02)*

*I think the relationship with the GP is different, patients will not necessarily ask the same question to a GP whom they see regularly, and to a specialist whom they see less often. (GP04)*

All interviewed nephrologists agreed that CKD initial screening was the GPs' responsibility. Once the patient was referred to them, some nephrologists ( $n = 6/18$ ) had difficulties in recognising the GPs' place in the pre-dialysis care. However, most ( $n = 12/18$ ) agreed that GPs were, before dialysis start, a partner on whom they could rely to reach the therapeutic objectives they set, to retrieve information on patients, and to alert on emergencies. This was coherent with the quantitative data indicating the GPs' constant presence in the care before dialysis initiation (Figure 1). Although nephrologists claimed the control of the therapeutic strategy, they acknowledged that they were not the only actor in the care of patients with CKD:

*The place [of GPs] is rather small. . .once a patient with CKD is referred to me, I think I take care of many things GPs took care before . . . We are very much decision-makers and they are the performers. (N04)*

*Sometimes, I call them to get their point of view on a patient, because they had known them for a longer time than me. . .If I have doubts about a patient's compliance or understanding, or if I feel that I lack information. (N12)*

*I try to integrate them as much as possible, particularly concerning the treatment balance, and I often give them a blood pressure target, I write in my notes what to do if that target is not reached, I suggest therapeutic changes. (N14)*

## Discussion

### *Principal findings*

Here, we investigated the presence and forms of involvement of GPs and nephrologists in the care of patients with CKD and assessed how they interact to shape the care trajectory before and after dialysis start. We observed different forms of involvement that changed during CKD course, with a clear shift from GPs to nephrologists upon dialysis start.

During CKD course, nephrologists became progressively the drivers of the care strategy with a strong involvement in laboratory test prescription and interpretation, their defining activity and a crucial process to anticipate and prepare the patient for kidney replacement therapy. However, the nephrologists' presence before dialysis start depended on the GPs' practices. Our initial hypothesis of a competition between these healthcare professionals was not confirmed. Indeed, CKD progression eventually led to uneasiness by GPs and to the relinquishment of their initial 'acquisitive' form of involvement. Care competition was not observed when, after reaching out to nephrologists, GPs managed to maintain a close contact with the patients before dialysis start by practicing aspects of their specialty that they particularly value (i.e. care coordination and being the preferred trusted professional by patients). Behind the homogeneity and trends in patient follow-up highlighted through the reconstruction of the patients' care trajectories, the interviews with GPs indicated that some of them relinquished the strong and continuous form of involvement faster than others, mainly when precipitating events led them to refer their patients to the specialist, rather than on the basis of creatinine clearance values. After dialysis initiation, GPs accepted to lose their main role in the care of patients with CKD due to the complexity of its management and because it represented only a small part of their activity. However, some GPs regretted the lack of communication (i.e. patient's news) from the dialysis services.

### *Strengths and limitations of the study*

This mixed-methods study has several strengths. The combined use of quantitative and qualitative data brought robustness to the findings. The use of a nationwide healthcare database linked to an exhaustive cohort of patients with CKD

who started dialysis allowed the precise reconstruction of their care trajectory and the thorough description of the healthcare professionals' presence in these trajectories. In-depth interviews with healthcare professionals working in different settings explained and enriched the observed trends that led to the description of their different forms of involvements in CKD care and their interactions. The quantitative analysis of prescription patterns and content supported this description.

The findings presented here and their generalisation must be considered cautiously. First, all reported trends concerned patients with CKD who progressed to dialysis. Second, many studies on this topic used the term 'primary care providers' that sometimes includes also 'internal medicine' specialists in addition to family physicians. It is important to note that in France, GPs are generally family physicians and the primary care coordinators. Conversely, internal medicine physicians and geriatrician work mostly in specialised healthcare centres or hospitals, and usually see patients sent by another physician, usually GPs. Third, GPs and nephrologists' practice patterns and opinions may vary in the entire France compared with the Brittany region. Fourth, the research question concerned the GP-nephrologist pair. However, patients with CKD are considered the most complex patients<sup>24</sup> because they require the intervention of several medical specialties concomitantly with GPs and nephrologists. More research is required to determine their form of involvement. Similarly, the patients' views and implication in the care decision making are critical in shaping the care trajectory.

### *Comparison with other studies*

The GPs' uneasiness observed in this study is in agreement with previous reports on some aspects of CKD<sup>25-27</sup> and cancer care.<sup>16,28,29</sup> CKD as an exception to GPs' usual strong and continuous form of involvement can be opposed to diabetes care, which remains within the GPs' scope.<sup>30,31</sup> Greer and al. highlighted that GPs view CKD as 'so closely linked to diabetes or hypertension that they did not distinguish it as a separate chronic disease requiring additional management'.<sup>32</sup> This contributes to explain their initial strong form of involvement, reflected by the high percentage of drug prescriptions by GPs in the 2 years before dialysis start.

Some studies in cancer care found that GPs would like to remain involved in all care phases and express frustration about the ‘swallowing-up’ of their patients by oncologists.<sup>16,17</sup> This was not observed in the present study on CKD care. Lack of communication is another commonly reported barrier to collaboration.<sup>5,6,9,33,34</sup> In our study, GPs regretted the lack of news once dialysis was initiated. Moreover, the pre-dialysis CKD co-management communication, mainly through written notes, was not always bi-directional, and consequently did not promote a long-lasting cooperation.

Greer *et al.*<sup>5</sup> reported that some GPs perceived a lack of respect from nephrologists, as observed also for other specialties.<sup>35</sup> Such suggestion of a lower esteem for the primary care discipline did not emerge in our study. Only rarely GPs complained that they could not prescribe some drugs directly and had to wait for the specialist’s initial prescription (e.g. anaemia treatment). Similarly, nephrologists complained occasionally that GPs referred patients too early, when they could not do anything more than the GP, or too late, when it was not possible to slow down CKD progression or with limited benefits. Receiving the ‘right patient at the right time’ is an important condition for a durable collaboration between healthcare professionals, especially for CKD care.

### *Health policy implications*

Effective collaboration between GPs, as primary care providers, and specialists is crucial to deliver high quality care to patients. This is especially true for chronic diseases where the care can span for several years and involves different professionals. Our findings suggest that the way healthcare professionals see their position, and that of their colleagues, must be taken into account when trying to identify barriers to a smooth (or with minimal frictions) collaboration.

Our findings in the context of CKD care suggest that although the two health professionals seem to have found a balance, this was reached more often implicitly (e.g. first referral to the nephrologist guided by the patient’s worsening) rather than explicitly (i.e. guidelines and tools, such as Care Coordination Agreements).<sup>36</sup> Local training sessions on CKD management organised by teaching hospitals and local nephrologists could be an opportunity for GPs to increase their awareness

on CKD, to obtain updated information on CKD care/therapeutic innovations (e.g. sodium-glucose cotransporter-2 inhibitors and non-steroidal mineralocorticoid receptor antagonists for slowing down CKD course), and to become acquainted with the nephrologists they will collaborate with. This could help to develop a shared CKD management culture and to alleviate the uneasiness surrounding it, thus optimising the timing of referral to a nephrologist.

Our results also showed that the GPs’ presence is not negligible, although it decreases after dialysis initiation. Moreover, some GPs regretted the lack of updates after dialysis initiation. To ensure a durable collaboration and optimal referral timing by GPs, nephrologists should regularly keep GPs updated on their patients’ fate.

Another barrier to frictionless collaboration emerged not at the GP-nephrologist level but at the healthcare organisation level: the local shortage of specialists that concerns not only nephrology but all specialties. Although this was observed in very specific territories, it made it difficult for some GPs to timely reach nephrologists for advice or referral, and was a factor guiding the construction of GPs’ professional network (i.e. working preferentially with more geographically distant but accessible nephrologists). To improve the collaboration and consequently the care provided, policy-makers and relevant authorities must foster the link between primary care and hospital-based care.

### *Perspectives*

Payment reforms that incentivise multidisciplinary care could improve the care and outcomes of patient with CKD.<sup>37,38</sup> In France, a recent bundled payment system has been implemented. Payment to nephrology services is conditioned to visits to dieticians and nurse care coordinators for non-dialysis patients with CKD. The implementation of such system raises questions about the GP’s involvement in the framework of this new nephrology care organisation in which the implicated healthcare professionals (dietician, nurse care coordinators, and nephrologists) are often hospital- or dialysis centre-based. Our findings show that care competition and patient dispossession did not happen because GPs and nephrologists managed to find a balance. It is unclear whether and how this new bundled payment

system will affect this balance, but this should be considered when evaluating these reforms.

### Conclusion

By combining quantitative (healthcare utilisation) and qualitative data (interviews with GPs and nephrologists), this mixed-methods study described the presences and forms of involvement of GPs and nephrologists in CKD care and how they changed during the disease course and the transition period to dialysis. This study unveils the mechanisms at play in the collaboration between these healthcare professionals. The development of a shared CKD management culture through local nephrologists' initiatives could alleviate some of the barriers that limit the smooth collaboration and facilitate the deployment of therapeutics innovations, all for the benefit of patients with CKD.

### Declarations

#### *Ethics approval and consent to participate*

This study obtained the ethics approval required. The quantitative component of this study was approved by the French Data Protection Authority (Commission Nationale Informatique et Liberté; n 917021). The qualitative study is compliant with the methodological frameworks defined by the French Data Protection Authority and has been registered by the French National Institute of Health Data (n 0609030619). Participants gave informed consent regarding the participation to this study before taking part.

#### *Consent for publication*

Not applicable.

#### *Author contributions*

**Maxime Raffray:** Conceptualisation; Formal analysis; Investigation; Methodology; Visualisation; Writing – original draft.

**Cécile Vigneau:** Conceptualisation; Methodology; Supervision; Validation; Writing – review & editing.

**Cécile Couchoud:** Data curation; Methodology; Validation; Writing – review & editing.

**Laetitia Laude:** Methodology; Supervision; Validation; Writing – review & editing.

**Arnaud Campéon:** Methodology; Supervision; Validation; Writing – review & editing.

**François-Xavier Schweyer:** Methodology; Supervision; Validation; Writing – review & editing.

**Sahar Bayat:** Conceptualisation; Funding acquisition; Investigation; Methodology; Project administration; Supervision; Validation; Writing – review & editing.

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#### *Competing interests*

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: All authors have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.


In addition, the results presented in this paper have not been published previously in whole or part, except in abstract format.



### Availability of data and materials

The ethics approvals prevent sharing the data, including patients' healthcare data and healthcare professionals' interviews transcript.

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### Supplemental material

Supplemental material for this article is available online.

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