Initial Implementation of a Web-Based Consultation Process for Patients With Chronic Kidney Disease

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ABSTRACT

PURPOSE A Web-based consultation system (telenephrology) enables family physicians to consult a nephrologist about a patient with chronic kidney disease. Relevant data are exported from the patient's electronic file to a protected digital environment from which advice can be formulated by the nephrologist. The primary purpose of this study was to assess the potential of telenephrology to reduce in-person referrals.

METHODS In an observational, prospective study, we analyzed telenephrology consultations by 28 family practices and 5 nephrology departments in the Netherlands between May 2009 and August 2011. The primary outcome was the potential reduction of in-person referrals, measured as the difference between the number of intended referrals as stated by the family physician and the number of referrals requested by the nephrologist. The secondary outcome was the usability of the system, expressed as time invested, the implementation in daily work hours, and the response time. Furthermore, we evaluated the questions asked.

RESULTS One hundred twenty-two new consultations were included in the study. In the absence of telenephrology, 43 patients (35.3%) would have been referred by their family physicians, whereas the nephrologist considered referral necessary in only 17 patients (13.9%) (P <.001). The family physician would have treated 79 patients in primary care. The nephrologist deemed referral necessary for 10 of these patients. Time investment per consultation amounted to less than 10 minutes. Consultations were mainly performed during office hours. Response time was 1.6 days (95% CI, 1.2-1.9 days). Most questions concerned estimated glomerular filtration rate, proteinuria, and blood pressure.

CONCLUSION A Web-based consultation system might reduce the number of referrals and is usable. Telenephrology may contribute to an effective use of health facilities by allowing patients to be treated in primary care with remote support by a nephrologist.

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INTRODUCTION

In 2002 the National Kidney Foundation released the Kidney Disease Outcomes Quality Initiative guideline for the evaluation and treatment of patients with chronic kidney disease,[1] which has been instrumental in improving the care of patients with this disease. According to the guideline definition the prevalence of chronic kidney disease in the United States has increased from 10% in 1994 to 13% in 2004[2]; in Western Europe it is only slightly less prevalent.[3,4] The widely implemented default laboratory reporting of estimated glomerular filtration rate (GFR) has raised the awareness of chronic kidney disease in primary and secondary health care and, together with increased prevalence, has increased the economic burden on the health care system.[5-7]

Cost-effective management of patients with chronic kidney disease requires that care should be given in a primary care setting where possible and in a secondary care setting where necessary. In the United Kingdom, the National Institute for Clinical Excellence guidelines on chronic kidney disease provide family physicians with tools to decide which health care setting—primary or secondary—is best suited for providing the patient's required care.[8] In the Netherlands, the interdisciplinary guideline for primary care and nephrology on chronic kidney disease serves the same purpose.[9] To facilitate good care in a primary care setting, the advice of a nephrologist may be helpful and would limit referrals for only those that need an in-person referral.

Consultation between a family physician and a nephrologist is traditionally performed by telephone or e-mail. The first may be inconvenient because a lot of detailed information has to be communicated, a report of the consultation is lacking, and a time slot that suits both physicians has to be found.[10,11] The latter is impractical because all relevant data must be transferred from the medical record to the e-mail message, and most e-mail services are not sufficiently protected. Studies have reported electronic consulting where nephrologists had full access to the electronic health record of the patient.[12,13] Access issues may raise privacy concerns, however, as more information is available to the nephrologist than is necessary for the consultation.

To overcome these shortcomings, the Radboud University Nijmegen Medical Centre (RUNMC) Department of Primary and Community Care and Department of Nephrology have devised a Web-based consultation system: telenephrology. Family physicians upload defined data that are relevant to chronic kidney disease. These data are automatically extracted from the patient's electronic health record to a secured digital environment. Family physicians and nephrologists can use the system independently and at a convenient time. The nephrologist gives treatment advice to the physician based on the patient's information, and by so doing, the need for referral may be reduced.

We describe an observational study and analyze the use of telenephrology by family physicians and nephrologists. The primary objective was to assess the potential of telenephrology to affect referral rates. A secondary objective was to examine the usability of telenephrology by judging time investment, implementation in daily work, and the nephrologist's response time. Finally, we explored the areas of patient care about which physicians were likely to consult through telenephrology.

METHODS

The content of telenephrology was developed in the RUNMC by the Department of Primary and Community Care and the Department of Nephrology. TeleMC, a company in telemedicine applications, was responsible for the technical development of the system. Telenephrology was introduced in 2009 in the RUNMC and 5 family practices. In 2011 it was expanded to a total of 28 family practices and 5 hospitals with nephrology care. In this observational prospective study we describe and analyze Web-based consultations between May 2009 and August 2011 by 42 family physicians and 5 nurse practitioners in 28 family practices and 14 nephrologists from 5 participating hospitals. Nurse practitioners worked on behalf of the family physicians. We included all new consultations. If the consultation resulted in a recommendation for additional (diagnostic) testing, we also used the follow-up consultations to establish the outcome of the process. Data extraction was conducted by TeleMC for the patients' age, sex, estimated GFR values, and albuminuria. TeleMC further provided the times of consultation and time investments of the clinicians and physicians, as well as the nephrologists' response times. Data categorization was performed by two of the authors (V.A.G., N.D.S).

The usual referral process consisted of a face-to-face consultation between patient and nephrologist. The primary care clinician wrote either a paper or electronic referral letter to inform the nephrologist and to request an appointment for the patient. In addition to these regular referrals, a clinician could telephone the nephrologist for advice. The clinicians in our study had the choice to either refer the patient in the usual way or to consult a nephrologist by telenephrology and then, based on the advice given, decide how and where to manage the patient.

The clinician could enter the telenephrology system directly from the patient's file in the electronic health record by logging on with a user name and password. Essential patient data on medical history, medication, laboratory results, and blood pressure were automatically extracted from the patient's electronic health record and displayed in an orderly manner. If the clinician judged part of the displayed information not to be applicable, for example privacy-sensitive information, that information could be removed. Mandatory information consisted of the actual question(s), whether the patient would have been referred if telenephrology were not available, and time investment per consultation.

The nephrologist, who was notified by e-mail or text message that a consultation had arrived, logged onto the website and, based upon the patients' information, advised the clinician how to treat the patient

in primary care, whether to refer, or whether to refer if additional diagnostic information met conditions specified by the nephrologist. The nephrologist could request additional information and defer management advice until this information was available. Subsequently, the patient's primary care clinician was informed in a similar manner when a reply, which was automatically noted in the electronic health record of the patient, arrived. The clinician could then adjust patient care or refer the patient according to the nephrologist's advice. Requested additional information could be provided in a follow-up consultation when new results had arrived. At that time, the clinician could ask for clarification or pose additional questions. A consultation about the same patient but addressing a new topic was considered a new consultation. An example of a telenephrology consultation can be viewed in Supplemental Appendix 1, available online at http://annfammed.org/content/11/2/151/suppl/DC1.

For the analysis, we compared the clinicians' referral decisions had there not been the possibility of telenephrology with the nephrologists' referral advice, which was considered the reference standard. The nephrologists' advice to refer was collected from their entries in the online program. When the nephrologist had requested additional information, the entry was taken from the follow-up consultation after receiving these data. We asked the clinicians at every consultation whether the patient would have been referred to the nephrologist had telenephrology not been available and, after the nephrologists' responses, whether they would follow the referral advice given. We compared the referral rates for chronic kidney disease with the recommendations as advocated by the Dutch interdisciplinary guideline for primary care and nephrology. To determine outcome significance between the clinicians' intention to refer and the nephrologists' referral advice, we conducted a McNemar's test to compare paired proportions using PASW 18.0 (SPSS Inc).

To assess usability we investigated time investment, implementation in daily work hours, and nephrologists' response time. Time investment was reported by the clinicians and physicians. Implementation in daily work hours was defined by the time slot during which the consultation took place (6:00-8:00, 8:00-17:00, 17:00-19:00, or 19:00-6:00), which enabled us to evaluate use during office hours, just before and after office hours, and at a later time during the day. The response time of the nephrologist was calculated in days.

For analysis of the questions asked, we firstly analyzed the individual questions with the intention to find categories and subcategories. We subsequently allocated the questions to these subcategories. Each consultation could contain 1 or more questions.

To assess the satisfaction of the clinicians with the system, we sent an online questionnaire in 2011 to the 5 practices that had used telenephrology during the pilot phase in the previous year.

Ethics approval was not required according to the accredited Medical Research Ethics Committee Arnhem/Nijmegen (ABR NL16590.091.07).

RESULTS

Between May 2009 and August 2011, 125 recorded new consultations were performed by 42 family physicians and 5 nurse practitioners from 28 family practices. Three consultations were excluded because the clinicians used the system to get information on patients that had already been referred. The final 122 consultations included 116 patients. In 24 patients a total of 52 follow-up consultations were performed. Clinical characteristics of the patients are displayed in Table 1.

Table 1. Patient Characteristics and Time Investment in Telenephrology Consultations

Characteristics	Distribution
New consultations (n = 122)	
Age (range), y	73.6 (34-96)
Sex, % (No.)	
Male	40 (49)
Female	60 (73)
Estimated GFR (range), mL/min/1.73 m^2	46 (22-128)
Albuminuria	
Normoalbuminuria, % (No.)	49 (48)
Microalbuminuria, % (No.)	38 (38)
Macroalbuminuria, % (No.)	13 (13)
Time of consultation, family physician, % (No.)	
06:00-08:00	1 (1)
08:00-17:00	73 (89)
17:00-19:00	17 (21)
19:00-06:00	9 (11)
Time of consultation, nephrologist, % (No.)	
06:00-08:00	1 (1)
08:00-17:00	61 (74)
17:00-19:00	25 (31)
19:00-06:00	13 (16)
Time investment, family physician, No. (95% CI), min	9:27 (8:29-10:25)
Time investment nephrologist, No. (95% CI), min	8:45 (8:04-9:27)
Days until response, No. (95% CI)	1.6 (1.2-1.9)
Follow-up consultations (n = 52)	
Time investment, family physician, No. (95% CI), min	6:43 (5:48-7:38)
Time investment nephrologist, No. (95% CI), min	6:47 (5:55-7:40)

GFR = glomerular filtration rate.

Notes: Consultations performed by 42 family physicians and 5 nurse practitioners in 28 family practices, between May 2009 and August 2011.

Table 2. Intended Referral by Primary Care Clinicians and Referral Advice From Nephrologists

	Nephrologist		
Primary Care Clinician	Advises Referral No. (%)	Advises Primary Care No. (%)	Total No. (%)
Intends to refer	7 (5.7)	36 (29.5)	43 (35.3)
Wants to treat in primary care	10 (8.2)	69 (56.6)	79 (64.8)
Total	17 (13.9)	105 (86.1)	122 (100.0)

Note: McNemar's test comparing family physician's intention to refer and the nephrologist's referral advice: $P < .001$.

Referral

We compared the primary care clinicians' intention to refer with the final referral advice of the nephrologists (Table 2). The clinicians intended to refer 43 patients. The nephrologists concluded that referral was not necessary and care could be delivered in primary care in 36 of these patients (84% reduction).

The opposite was seen in 10 patients, who according to the clinicians could be treated in primary care. The nephrologists advised referral for the following reasons: relatively young age (n = 3), comorbidity (n = 1), proteinuria (n = 2), rapid decline in renal function (n = 2), and unspecified reason (n = 2). The clinicians agreed with all the referral advice given, which meant a net referral reduction from 43 to 17 (60.5%) referrals.

For comparison we also applied the recommendations given by the Dutch interdisciplinary guideline on for primary care and nephrology. Explanation of the guideline and comparison results are given in online-only Supplemental Appendixes 2 and 3, available at http://annfammed.org/content/11/2/151/suppl/DC1.

Usability

Time investment per consultation amounted to 9 minutes for primary care clinicians and nephrologists. Seventy-three percent of the clinicians' use of telenephrology was between 8:00 and 17:00. Sixty-one percent of the consultations were answered between 8:00 and 17:00.

The nephrologists' average response time was 1.6 days (95% CI, 1.2-1.9 days); 43% (n = 52) of all consultations were answered on the day of submission, and 84% (n = 102) were answered within 3 days. The full results are given in Table 1.

Nine clinicians answered the questionnaire. They all judged the amount and content of information that was sent by telenephrology to be appropriate. Ease of use was judged as reasonable (2 clinicians) to good (7 clinicians). Four of the clinicians found it reasonably easy and 5 found it easy to fit the use of telenephrology within daily practice work. Eight of 9 users said that their knowledge of nephrology had increased by the use of telenephrology. The 2 nephrologists found the data supplied was sufficient to get a good understanding of the patient's case. In the future they would prefer the data to be presented graphically. The nephrologists could see a learning curve in the way physicians asked questions.

Consultation Content

The result of the categorization of question topics is displayed in Table 3.

The nephrologist addressed the question in a broader context and provided advice not specifically asked for in 35% (n = 43) of the answers. This advice mainly considered medication safety in relation to renal function and advice to check the patient for mineral and bone disorders (secondary hyperparathyroidism and issues associated with calcium, phosphorus, vitamin D) or for anemia.

DISCUSSION

Our data provide support for the introduction of telenephrology in primary care. The intended referral rate by the primary care clinicians was far higher than that advised by the nephrologist. Receiving advice from a nephrologist through telenephrology could result in more convenient care at lower health care costs.

Table 3. Categorization and Distribution of the Primary Care Clinicians' Questions

Question by Group	Subject	No.
Intrinsic kidney disease, 60% (n = 124)	Decreased estimated GFR	19
	Decreasing estimated GFR	30
	Microalbuminuria	14
	Macroalbuminuria	6
	Blood pressure in relation to CKD	23
	Unspecified	32
Metabolic complications, 27% (n = 55)	Bone and mineral metabolism	42
	Hemoglobin	12
	Acid-base homeostasis	1
Cardiovascular risk management, 4% (n = 9)	Diabetes	5
	Cholesterol	4
Comorbidity in relation to CKD, 8% (n = 16)	Gout	1
	Urinary tract infection	1
	Patients condition	3
	Drugs that interact with impaired kidney function	11
Other, 1% (n = 3)	Cardiomyopathy	2
	Urinary tract infection	1

CKD = chronic kidney disease; GFR = glomerular filtration rate.

Telenephrology and Other Electronic Consultation Systems

Several other studies have described the use of electronic consultation technology in the management of patients with chronic kidney disease. In Hawaii, nephrologists proactively intervened in primary care by using data from Kaiser Permanente's electronic medical system and by providing unsolicited advice to family physicians.[12] Their intervention lead to an increase in timely referrals and a reduction in low-risk referrals. This initiative was nephrologist driven and was possible only because nephrologists had entry to all electronic health records, which meant that they had access to irrelevant data. Such access is not desirable from the perspective of efficiency and privacy.

In the United Kingdom, Stoves et al set up an e-mail referral system for patients with chronic kidney disease: if the general practitioner referred the patient by e-mail, the patient was asked to provide consent for the nephrologist to look in the electronic health record.[13] Based on the information read, the nephrologist advised referral or gave management advice to be carried out in the primary care setting. This effort lead to a reduction in referrals from 30 to 8 patients (73% reduction), similar to our primary outcome. The mean response time was 7 days and mean time needed for the consultation was 15.5 minutes. The time required in our study was less, which is probably because only relevant preformatted information was displayed.

Patient Benefits

Depending on the extent to which family physicians pose questions by telenephrology, patients might receive more adequate care in relation to blood pressure, hyperparathyroidism, anemia, and medication safety. This increased care will most probably affect patient survival and morbidity.[14-16] Furthermore, patients can be referred for more timely predialysis care if family physicians and nephrologists monitor the progress of chronic kidney disease as a team.[17] The convenience for patients lies in specialist responses that are faster than with a usual referral, prevention of time-consuming hospital visits, and not needing to see another doctor. Although we did not study patient satisfaction, we expect greater satisfaction if treatment can be given in a patient's own environment, as was found in a study on joint teleconference consultations.[18]

Economic Benefits

Telenephrology has the potential to reduce referrals and so could contribute to a cost reduction. A usual referral costs €600. Our telenephrology consultation cost €107, including a nephrology tariff and the online facilities. Each prevented referral meant a saving of €493. Additional costs in primary care should be evaluated. Pan et al examined telehealth models in a simulation study and found that physician-to-physician consultation systems can contribute to a substantial cost reduction.[19]

As indicated by our data, the introduction of telenephrology may also lead to referrals that, although not initially intended by the family physician, were deemed necessary by a nephrologist. In these cases, the higher costs of referrals are likely to be balanced by lower costs related to earlier detection and treatment of kidney disease.

Broadening the Concept

We think that e-consultation offers the ability to break down walls between primary and specialist care. It facilitates shared care for patients with chronic disease conditions, and it might enable effective use of expensive secondary care facilities. Joint teleconference medical consultation is a promising development as well, but it has the disadvantage that both the family physician and specialist must be available at the same time. Furthermore, a joint consultation does not provide documentation in the electronic health record. Where interprofessional consultation relies mainly on measurable and preformulated data, Web-based consultation seems more practical and effective than a referral or teleconferencing.

Limitations

We must consider some limitations of this study. The Web-based consultation aimed to lead to more appropriate referrals to the nephrologist, and the primary outcome measure was whether the intended referral rate in primary care decreased. It will be important to assess how robust this initial outcome is, or whether at a later date patients are referred despite the nephrologist's recommendation not to refer. On the subject of referrals we merely analyzed the intention to refer. There were no data available on the actual number of referrals following this advice. These data will be generated in a cluster randomized controlled trial on the influence of telenephrology on the actual rate of referrals: the CONTACT study (Consultation Of Nephrology by Telenephrology Allows optimal Chronic kidney disease Treatment in primary care, Netherlands Trial Registration code 2368). In this trial the effect of telenephrology on the actual referral rate and the quality of care will be evaluated. This study will enable a direct comparison between referrals in practices using and not using telenephrology and will provide better evidence than the current study, which used an internal reference standard.

Data on professional behavior (for example referral) are subject to clustering within professionals, for which we did not correct in this usability study.

The generalizability of the telenephrology technique depends on local settings. At the very least, the primary care physician must use an electronic health record that allows automatic data extraction. Although it might be possible to create a similar system that allows direct data entry by the family physicians, such data entry is prone to errors and certainly not time efficient.

We did not evaluate patient satisfaction, which is a limitation. The satisfaction of the professionals was measured in an early stage of the study, so only included 5 practices. The data are too few to interpret, but the opinion tended to be positive. In the implementation of telehealth, the applicability in daily work proved to be very important.[20,21] With that in mind, it is likely that the telenephrology system fit in well during the daily work routine; most clinicians and physicians used the system during office hours, spending less than 10 minutes on a consultation and nephrologists responded quickly.

In conclusion, a Web-based consultation system might reduce the number of referrals by enabling family physicians to receive suitable advice from nephrologists. The system is usable for both nephrologist and family physicians and allows efficient care of patients with chronic kidney disease in primary care.

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Key words: chronic kidney disease; consultation; referral; nephrologist; primary health care

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Participating practices: Family practices and nephrologists from the following institutions participated in the study: Canisius Wilhelmina Hospital Nijmegen, Gelderse Vallei Hospital Ede, Rijnstate Hospital Arnhem, Bernhoven Hospital Oss/Veghel, and Radboud University Nijmegen Medical Centre.

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