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Effect of telemedicine for patients with chronic kidney disease who perform dialysis at home: a systematic review

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HEL-3950 Master's thesis in Public Health, July 2021

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Acknowledgement

First, I would like to thank my supervisor Professor /Department Director Rigmor C Berg at the University of Tromsø, and the Norwegian Institute of Public Health for her support and advice during this process. I made a wise choice when I asked her to be my supervisor!

Head Librarian, Grete Overvåg, responsible for the health sciences at the Science and Health Library at the University of Tromsø has helped me to develop my search strategy. She has also assisted me in gaining a better understanding of what databases to use, and how to navigate the different databases. Thank you!

My dear friend Alia Jaboori, thank you for proofreading!

Thank you to the Department of Community Medicine at the University of Tromsø for allowing me some extra time to finish my work!

The process of conducting this systematic review has been challenging but also very rewarding. I acknowledge that it is a privilege to write a master's thesis on a topic I feel so passionate about. It would not have been possible without the support, love, encouragement, and patience from several people whom I am lucky enough to have in my life.

Family

Friends

Co-workers

Fellow students

Fellow nephrology devotees

Thank you. Tusen takk. Nashukuru.

Henriette Tyse Nygård

Abstract

Introduction and background: The world's population is getting older, and the prevalence of chronic kidney disease (CKD) rises parallel with age. CKD is a major public health concern, characterised by poor health outcomes and a high economic burden for society as well as for the individual. With an aging population, there is an increasing need to organize healthcare services in alternative ways. There are two main types of dialysis, peritoneal dialysis (PD) and hemodialysis (HD), and both can be performed by the patient at home. Telemedicine (TM) gives the patient quick access to medical expertise independent of the distance to a treatment centre. The use of technology provides possibilities for thorough patient follow-up (FU), and at the same time, saving human resources.

Objective: To systematically review the effectiveness of FU by TM compared to standard care for adult patients with dialysis-dependent CKD on home dialysis, including PD and HD.

Methods: A systematic review (SR) that followed the Cochrane Handbook for Systematic Reviews of Interventions was conducted. Systematic searches included the electronic databases PubMed, EMBASE, and CINAHL. In addition, a hand search of relevant reference lists and unsystematic searches in databases such as SveMed+ were performed. Eligible participants were adult home dialysis patients, and the intervention was TM used for patient FU from a distance. The included studies were assessed for risk of bias by appropriate tools recommended by the Cochrane handbook. Whenever possible, meta-analyses were conducted, other outcomes were synthesized narratively. The body of evidence was assessed with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.

Results: The search yielded a total of 315 records, which were screened and assessed for inclusion by the author in line with pre-determined criteria. Nine studies from six countries,

including a total of 10,204 participants, were included. There were three randomized controlled trials (RCTs) and six observational studies, published from 2007-2020, with 67% within the last five years. All the studies had some risk of bias. The findings suggested that TM FU was effective in reducing hospitalizations, analysed as hospitalization days (results from the two largest studies: incident rate ratio [IRR]=0.46, 95% confidence interval [CI] 0.23, 0.92 & IRR=0.68, 95% CI 0.55, 0.83), all-cause hospitalizations (results from the two largest studies: IRR=0.74, 95% CI 0.66, 0.83 & IRR=0.61, 95% CI 0.39, 0.95), and disease-specific hospitalizations (result from the meta-analysis: relative risk (RR)=0.62, 95% CI 0.31, 1.24). The results also implied that TM FU could be effective in reducing technical failure as the cause for transfer to a different dialysis modality (RR=0.78, 95% CI 0.66, 0.93). The effects of TM FU on overall quality of life and infections were inconclusive. No studies included the outcome 'time patients used for travel'. The certainty of evidence (GRADE) was rated as very low or low for all the outcomes, and the results must be interpreted with caution.

Author's conclusions: The results presented in this SR were insufficient to make strong recommendations regarding the use of TM in FU for patients on home dialysis due to very low to low quality of evidence. The evidence suggests that there may be positive effects and no harms regarding technical failure and hospitalizations from TM patient FU. However, with only three RCTs, there is a large research gap and further research in the form of primary studies with high methodological quality (preferably RCTs) are needed to draw stronger conclusions.

Key words: systematic review, telemedicine, remote patient monitoring, home dialysis, peritoneal dialysis, hemodialysis

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List of abbreviations

CBA – Controlled before and after study

CI – Confidence interval

GRADE – Grading of Recommendations Assessment, Development and Evaluation

IRR – Incident rate ratio

MD – Mean difference

NIPH – Norwegian Institute of Public Health

RCT – Randomized controlled trial

RoB – Risk of bias/risk of bias assessment

RR – Relative risk

SoF – Summary of findings (GRADE assessment)

SPICO – Study design, Population, Intervention, Control, Outcome

SR – Systematic review

APD – Automated PD

CAPD – Continuous ambulatory PD

CKD – Chronic kidney disease

FU – Follow-up

HD – Hemodialysis

HHD – Home Hemodialysis

ICHD – In centre hemodialysis

PD – Peritoneal dialysis (includes APD and CAPD)

QoL – Quality of life (KDQOL – kidney disease QoL instrument)

RPM – Remote patient monitoring (usually relies on internet access)

RRT – Renal replacement therapy (includes dialysis, hemofiltration and renal transplantation)

SC – Standard care

TM – Telemedicine (includes all FU ‘from afar’, including regular phone)

1 Introduction and background

1.1 Description of chronic kidney disease

Between 8-16% of the world's population has some degree of chronic kidney disease (CKD) (1). It is a significant public health concern, characterized by poor health outcomes and a high economic burden for society as well as for the individual (2). CKD is defined as abnormal kidney function or structure for more than three months. The two largest portions of disease are secondary to hypertension or diabetes mellitus (1). The condition is divided into five stages, where most people are asymptomatic and unaware until the kidney function is reduced to 10-15% (3, 4). At this late stage, most people will develop symptoms that can be both trying and harmful. There is currently no curative treatment for CKD. The condition can be managed conservatively with medications to reduce symptoms and delay death, or it can be treated with renal replacement therapy (RRT) such as transplantation or dialysis (4). The prevalence of CKD is higher in females than males. However, kidney function declines faster in men. Thus, more men than women start RRT (5).

Symptoms of CKD are:

- Fatigue
- Loss of appetite
- Frequent urination (especially during the night)
- Overhydration
- Itchy skin
- Easy bruising
- Headache
- Numbness of hands and feet

- Trouble sleeping
- Reduced consciousness
- Hypertension
- Shortness of breath
- Erectile dysfunction and reduced sexual interest
- Bone pain and increased risk of fractures
- Increased risk of bleeding (6).

1.1.1 Aging population

The world's population is getting older, and CKD prevalence rises parallel with age (2). In 2017, a report from Norway showed that for every person older than 66 years, there were four persons between 22-66 years. A person older than 66 years of age is likely to be retired, whereas a person in the age group 22-66 is likely to be a taxpaying worker. In 50 years, this rate is expected to change to 2.5 'workers' per 'retired' person. A 70-year-old person needs twice as many healthcare services as a 40-year-old, and the healthcare consumption increases with age (7). This demographic shift urges for innovation and new strategies to meet future healthcare needs. The use of technology provides possibilities for thorough patient follow-up (FU), and at the same time, saving human resources (8).

1.1.2 Increasing demand for renal transplantation

According to the annual report from the Norwegian renal registry, there was a 1.9% increase of patients on RRT from 2018 to 2019. A similar increase was seen from 2017 to 2018. The patients who were not pre-emptively transplanted had been on dialysis for a median of 1.9 years (mean 2.3 years), ranging from 1 week to 13.7 years. By the end of 2019, 364 Norwegians (68.1 per mill.) were waiting for a kidney transplant from a deceased donor. This

was an increase of 8% from 2018 to 2019 (9). Globally, 2.6 million people received RRT in 2010. The number was projected to be more than doubled by 2030 (10).

1.1.3 Dialysis

There are two main types of dialysis. Peritoneal dialysis (PD) and hemodialysis (HD). Both are suitable treatment options when the kidneys are unable to filter the blood sufficiently (11).

1.1.3.1 Peritoneal dialysis

PD is a form of dialysis which uses the peritoneum as a dialysis filter. A soft catheter is surgically inserted through the abdominal wall and into the peritoneal cavity. Peritoneum has a vast surface with a magnitude of tiny blood vessels. Dialysis fluid is inserted through the catheter, and waste products such as urea and excess fluid are drawn from the blood and into the dialysis fluid by osmosis. The treatment is performed in the patient's home independently or with assistance from a carer or healthcare staff. This form of dialysis can be performed in two different ways. CAPD, or continuous ambulatory peritoneal dialysis, involves manual dialysis fluid exchanges three to four times daily. APD or automated peritoneal dialysis uses a machine for dialysate exchanges. It is usually performed at night while the patient is asleep (12).

1.1.3.2 Hemodialysis

During HD, the patient is connected to a dialysis machine to remove waste products and excess fluid from the blood through a filter. The filter is also referred to as an artificial kidney. The blood passes through the many hollow capillary tubes that are surrounded by dialysate, which contain the desired concentration of electrolytes and buffer solutions. In centre hemodialysis (ICHD) is normally performed for four hours, three times per week. A

blood access is surgically constructed, usually by inserting a soft catheter in one of the central blood vessels or as an arteriovenous fistula in the non-dominant lower arm (12).

1.1.3.3 HD versus PD

The debate about superior treatment, HD versus PD, is ongoing (13). HD used to be superior, but in recent times there have been observed better outcomes for PD compared to HD in subgroups of younger patients, non-diabetic patients, and patients with less than one year on dialysis. PD patients keep their residual function longer than HD patients, which could positively impact PD survival rates during the early dialysis period (14).

1.1.3.4 Home dialysis

Home dialysis includes HD performed at home (HHD) and PD (CAPD or APD). The patients receive comprehensive training arranged by staff at a dialysis centre to ensure that they have the skills and knowledge required to perform the treatment at home (15).

Even though studies have shown that self-management provides improved outcomes for a range of long-term conditions, the utilization of home dialysis varies greatly around the globe (16). Patients on home dialysis may experience more freedom than patients on ICHD, as they are not dependent on hospital service hours (17, 18). Dialysis is time-consuming regardless, and for patients on ICHD, the burden of time spent in commute between home and hospital can be extensive. In addition, the patients spend a substantial amount of time waiting for transport and waiting to be assisted by hospital staff for connection and disconnection from HD. Travel time to dialysis exceeding 60 minutes is associated with significantly decreased health-related quality of life (QoL) and significantly increased mortality risk compared to patients who travel 15 minutes or less. With dialysis at home, it is reasonable to expect considerable time savings for the patients as well as improved health-related QoL (19).

1.1.3.5 Economic aspect of home dialysis

RRT consumes 2% of the overall European healthcare expenditure for only 0.1% of the population. The total ‘direct’ cost is unknown, but one estimate puts it up to 15 billion euros per year. In addition, there are indirect costs such as the time patients are absent from work and the cost of transportation to and from treatments. On top of this, there are healthcare costs for interventions needed to sustain RRT and treat complications (20).

According to two studies from Canada and Norway, dialysis at home offers substantial cost savings compared with ICHD (21, 22). From a societal perspective, it was found that HHD was a better treatment option compared with all other HD modalities, including self-care ICHD. Compared with PD, HHD was more costly and more efficient, but the incremental cost-effectiveness ratio/ICER (instrument to summarize the cost-effectiveness of healthcare interventions (23)) of 2,66 million Norwegian kroners was above the suggested threshold (22).

1.1.4 Patients’ perspective

A patient focus group from Australia identified normalization of life (developing regimens that fit into daily living) as an essential factor to consider when planning research concerning CKD care (24). A qualitative study from Norway identified this as one aspect regarding what home dialysis could offer. Patients who had switched from ICHD to home dialysis also expressed that the time between treatments was too valuable to be spent in commute between home and hospital (25). Two other studies explored perceived important outcomes for HD patients: these studies also identified dialysis free time and fatigue as highly important outcomes (18, 26). Lastly, a similar international study about 'priority outcomes' identified by PD patients' showed similar results, but time flexibility was identified instead of dialysis free

time (27) (which is understandable because PD and HD differ regarding time management and time consumption).

1.2 Description of the intervention

Telemedicine (TM) is a broad term used when medical treatment, examination, or patient FU is done from a distance. The term TM has increasingly been replaced by the term e-health (28), but relative to the interventions considered in this systematic review (SR), TM is the most frequently used and seemingly most appropriate term. Homecare telehealth is another related term, and remote patient monitoring (RPM) is a subcategory thereof. RPM uses computer systems or software application technology which transfer patient-generated data to healthcare professionals (29).

The terminology related to TM is complex to navigate as there are many subgroups and a variety of related terms. In this SR, TM refers to all interventions which use technology to provide patient FU from a distance, including internet-dependent technology and systematic use of 'regular old fashion' phones. TM gives the patient quick access to medical expertise independent of the distance to a treatment centre. TM can provide healthcare teams with valuable information about the patient's condition. It can be a tool to empower patients in self-care and for health care providers to offer support from a distance (28).

1.2.1 Data security

As indicated above, TM can offer clinical benefits for home dialysis patients. However, for RPM technology, collecting, transferring, and storing treatment data can raise concerns about privacy and data security. These are aspects that demand careful consideration when weighing the potential clinical benefits and harms of RPM. To date, there are no universally agreed

standards regarding health data privacy and confidentiality, and the regulations regarding this differ from country to country (30). In Norway, these regulations are strict regarding the storage of patient data abroad. Hence, the implementation of cloud solutions can be complicated (31).

1.2.2 Ethics and remote monitoring technology

The four commonly accepted principles regarding ethics in health care are autonomy, non-maleficence, beneficence, and justice. Healthcare professionals have a duty to uphold these four equally important principles in their clinical work. However, when two or more of these principles conflict, the merits of each principle should be balanced and carefully considered to find what will be of most benefit to the patient (30).

Patient autonomy should be respected. Hence, an informed and voluntarily consent is essential before considering the initialization of RPM. Furthermore, the patient has a right to review and access their own personal treatment data (30).

Non-maleficence means that the data should be confidential and securely stored to avoid loss of data or hacking. Data security in RPM involves a complex interaction between manufacturers, telecommunications, and clinical information technology/IT systems. There should be specific considerations regarding what information will be shared, with whom, and for how long (30).

Beneficence of RPM on patients' clinical outcomes could justify the use of RPM even if it could pose a threat to the patients' privacy and data safety (30).

Justice in healthcare requires that everyone should be treated fairly and have equal access to healthcare. Resources are scarce, and clinicians may need to clearly define who may benefit more from RPM and ensure that these patients receive it at a reasonable cost (30).

1.2.3 Digitalization in Norway and lessons from the Covid-19 pandemic

In Norway, the demand for doctor's appointments as e-consultations, as opposed to in-person consultations, increased when the country 'closed down' at the beginning of the Covid-19 pandemic. After the economic compensation system was adopted, e-consultations increased from 3% pre-pandemic to more than 40% in the spring/early summer of 2020. In December 2020, 31% of the doctors' appointments were digital (31).

The pandemic brought forth the realization that there is great improvement potential regarding digitalisation in Norwegian healthcare services. Experiences from countries such as UK and Iceland, which are more advanced in this area than Norway, implied that time and healthcare resources could have been saved during the pandemic if health care technology had been utilized to a greater extent (31).

The Norwegian government recognises the value of home dialysis and has a current goal for 30% of dialysis patients to be treated at home. 26% of Norwegian dialysis patients had dialysis at home at the end of 2020, with significant regional variations (15). According to the national plan for healthcare and hospitals (2000-2023), specialist health services should be increasingly available for patients in their own homes through technology. Increased use of technology is essential to meet the demand for futuristic patient-centred healthcare services (8).

1.2.3 Current use of telemedicine for home dialysis in Norway

When no research is available on a topic, the opinion of experts is the best evidence available. Regarding the current use of TM FU for home dialysis patients in Norway, this is the case. I reached out to several experts and talked to 15 local nurses and four nurses from the dialysis industry to get information about local practices. According to my sources, there are currently (June 2021) five hospitals in Norway that use TM for patient FU regarding home dialysis. However, the use in three of them can be characterized as random. In two hospitals they use TM systematically in their FU of home dialysis patients. In one of them they use Sharesource technology from Baxter for PD, but on a very small scale. In another they use technology from Telenor for FU of both HHD and PD patients.

According to the people I spoke with, all the hospitals which currently use TM, systematically or randomly, have plans to expand the use of TM patient FU this year. Several other hospitals also have plans to integrate TM patient FU into their practice.

1.3 How the intervention might work

Qualitative studies from UK and Norway imply that patients on home dialysis have a positive attitude towards the use of TM and believe that this could decrease anxiety and make it easier for more patients to choose home dialysis (25, 32). In a recent pilot study from Italy, patients overcame physical, cognitive, and psychological barriers to PD by TM FU (referred to as videodialysis) (33).

It is recommended that patients are involved in their treatment. This may increase motivation and empowerment, which could lead to improved adherence and treatment effects (34). The demands for tools and services that enable patients to manage their illnesses are increasing.

TM FU can provide patients with new possibilities to be more involved in the management of their disease (35).

1.4 Why is it important to do this review?

A SR aims to present the best currently available evidence on a specific topic systematically and transparently. Whereas primary studies are each a piece of a puzzle, a SR is the whole current picture (36). After conducting a SR on the effectiveness of managing chronic illnesses with RPM in primary care, Muller and colleagues addressed the need for more knowledge concerning RPM in specialist health services (37). Dialysis is part of the Norwegian specialist health services (8).

Previous SRs have implied positive effects from TM patient FU on outcomes for a variety of medical conditions such as cardiovascular disease (38), chronic obstructive pulmonary disease (39), and diabetes mellitus (40).

Three previous SRs (one of them is a Cochrane review) conducted to review the effect of TM interventions for people with CKD reported on low quality, scarce data, and unknown effects. However, one of these SRs included PD patients only (41), another included ICHD patients as well as children (42), and the third (a Cochrane review) aimed to evaluate effects of e-health interventions to change health behaviours in people with CKD. In addition to differing from the current SR in inclusion criteria, the last SR completed the systematic searches in January 2019 (43). In the years since the last searches, there are published studies within this field. Furthermore, SRs on the effect of TM in people with CKD are likely to be quickly outdated as this seemingly is a field with increasing research activity.

According to a large observational study based on data from The Australia and New Zealand Dialysis and Transplant Registry, dialysis patients live longer with CKD than ever before, despite having more comorbidities. This is possibly due to improved dialysis technologies and better healthcare in general. Mortality in different dialysis modalities decreased by 21% for patients on ICHD, 27% for patients on PD, and 49% for patients on HHD within the first decade of this millennium (13). Hence, both PD and HHD are dialysis modalities with prospects of improved outcomes compared to ICHD.

It is important to do this review because strategies to empower more patients to choose home dialysis may have a positive impact on the patient's daily life (25, 44), decrease mortality (13), and offer economic savings for the patient and as well as for society (44, 45). Offering patients to connect to health care providers through TM could lead to an increased number of patients on a home modality. Furthermore, TM patient FU is seemingly expanding its reach, and there is a need for knowledge about benefits and harms before expanding even more.

To date, there are no SRs about the effect of TM FU including only adult patients with dialysis-dependent CKD on home dialysis (HD and PD). Thus, the current review is in demand.

1.5 Review question

What are the benefits and harms of TM FU, in comparison to SC, for patients with CKD who perform dialysis at home?

1.5.1 Objective

The aim is to conduct a SR on the effectiveness of TM FU compared to standard care (SC), for patients with CKD who perform dialysis at home. Included effect measures are QoL, hospitalization, technical failure as the cause for transfer to a different dialysis modality, infections not requiring hospitalization, and time patients use for travel.

2 Methods

I prepared a SR in line with Norwegian Institute of Public Health (NIPH) Division for health services methodology handbook “This is how we summarize research” (36). The NIPH handbook is based on international guidelines for SRs. Thus, in addition to the NIPH source, I also used the Cochrane handbook for systematic reviews of interventions, version 6.2 for guidance on how to develop a SR of high methodological quality (46). This chapter describes the methods that I used, and the choices that I made while working on this SR. I prepared a study protocol in cooperation with my supervisor. Here, I pre-specified the research question, search strategy, eligibility criteria, selection of studies, analyses, and write up.

Due to personal and familial issues that placed a lot of pressure on all aspects of my life during the time of the protocol development, I did not register the study protocol. I consulted Associate Professor Kristin Benjaminsen Borch at Department of Community Medicine at the University of Tromsø and she assured me that registration of the protocol is not a requirement for the thesis. However, if I conduct other SRs in the future, I will register the protocol as I understand that this is a sign of quality and transparency.

2.1 Search strategy

I prepared the search strategy in collaboration with a librarian, and I was advised to conduct the search and adapt it individually to the following databases:

- CINAHL (EBSCO)
- EMBASE (OVID)
- PubMed

The search included both subject headings (e.g. MeSH in PubMed) and text words to cover everything relevant for my research question. As decided in my protocol, I limited the search to year 2000 and later because I wanted to identify all studies relevant to the question and today's clinical situation, being cognisant that TM technology is rapidly improving. The search was completed and closed in March 2021. See appendix 1 for full search strategy.

In addition to the systematic searches in the preselected databases, I reviewed the reference lists of all the studies that met my inclusion criteria to identify other relevant studies that were not discovered in the systematic searches. I also hand searched the reference lists of five literature reviews relevant to my research question and seven studies that were relevant but excluded because of their methods. Simple searches in the databases NORA, Oria and SveMed+ was also conducted to retrieve relevant studies in a Nordic language. Google Scholar was searched for studies in English language as well as Nordic. If the searches in NORA, Oria, SveMed+, and Google Scholar yielded a high number of records, I read the first 100 titles/abstracts only.

2.2 Inclusion and exclusion criteria

The inclusion criteria for studies on effect of TM patient FU versus SC are described below. The headings show different elements that are essential when conducting a SR. SPICO stands for study design, patient, intervention, comparator, and outcome.

2.2.1 Study design

Eligible study designs were primary intervention studies with a control group. That is, randomized controlled trials (RCTs), non-randomized controlled studies, controlled before-after studies (CBAs) and cohort studies with a control group. If I had found several high

quality RCTs and non-randomized controlled studies that met my inclusion criteria I would have considered not including other study designs, but this was not the case.

Qualitative studies, non-empirical studies, case control studies, case studies, studies without a control group, and reviews were excluded.

2.2.2 Population

Study participants needed to be adults, 18 years or older with dialysis dependent CKD who performed dialysis at home (HD or PD). The patients could perform dialysis independently or with assistance of family or other carers. CKD did not have to be the only disease of the study participant. This is because patients with CKD are known to have a higher burden of comorbidities than the average population (47).

Children below the age of 18 years, patients who were not on home dialysis and patients with earlier stages of non-dialysis dependent CKD were excluded.

2.2.3 Intervention

The eligible intervention was TM, understood as technology that was used to transfer information about treatment from the patient's home to a healthcare institution. This included video consultations, the use of regular telephone or applications installed on the patient's phone, computer, or a tablet as well as technology that transferred treatment data directly from the dialysis machine to healthcare providers.

TM that was not directly treatment related was excluded. This included, but was not limited to, apps for lifestyle changes, interventions for blood pressure control, and interventions for diabetes management.

2.2.4 Comparator

The comparator was SC, understood as patients performing dialysis at home and having regular in-person consultations at a HD or PD centre.

2.2.5 Outcomes

I specified the following eligible outcomes:

- Hospitalizations (all-cause, disease-specific and number of hospitalization days)
- Technical failure as the cause of transfer to a different dialysis modality
- Registered infections that did not require hospitalization
- Self-reported QoL measured with any type of QoL assessment tool
- Time patients spent on travel

Outcomes other than the preselected were excluded.

2.2.6 Other criteria

Publications from year 2000 until March 2021, and publications in Norwegian, Swedish, Danish, and English language were included.

Publications from before year 2000 and publications in other languages than the preselected ones were excluded.

2.3 Selection of literature

I imported all records from the searches into an EndNote library and screened all titles and abstracts from the literature searches in accordance with my predetermined inclusion and exclusion criteria. All abstracts that appeared to fit my inclusion criteria or did not provide enough information regarding SPICO to exclude them, were reviewed in full. I assessed these with regard to my predetermined inclusion and exclusion criteria. I kept running lists of studies read in full text. For list of all excluded studies read in full text, with the main reason for exclusion see appendix 2.

2.4 Assessment of methodological quality (Risk of bias assessment)

To assess the included studies for risk of bias (RoB) I used three different instruments. The Cochrane risk of bias tool Effective Practice and Organisation of Care /EPOC for the CBA (48), the Newcastle-Ottowa scale for cohort studies (49), and Cochrane Risk of Bias Tool for RCTs (46). The RCTs were assessed as having low, unclear or high risk of bias on the basis of: (a) randomization sequence generation (selection bias), (b) allocation concealment (selection bias), (c) blinding of personnel and participants (performance bias), (d) blinding of outcome assessment (detection bias), (e) incomplete outcome data (attrition bias), (f) selective reporting (reporting bias) and (g) any other potential risks of bias. The CBA was assessed as having low, unclear or high risk of bias on the basis of: (a) random sequence generation, (b) allocation concealment, (c) baseline outcome measurements similar, (d) baseline characteristics similar, (e) incomplete outcome data, (f) knowledge of the allocated interventions adequately prevented during the study, (g) protection against contamination, (h) selective outcome reporting and (i) other risks of bias. The cohort studies were assessed as

having good, fair or poor quality, on the basis of number of stars the study achieved in the areas: (a) selection (four questions, a maximum of four stars), (b) comparability (one question, a maximum of two stars) and (c) outcome (three questions, a maximum of three stars).

I reviewed each study and used the appropriate tools relative to the study designs. Because the RoB assessment is an important part of the review process and I was doing the assessments alone, I reviewed my own judgement and justifications several times to assure quality of my RoB assessments.

2.5 Extraction of data

I created a standard extraction form that I used to extract data from all included studies. The information extracted from the studies was: title, authors, publication details, study design, aim of the study, study setting (location and time the study was conducted), characteristics of included participants (age, gender etc.), characteristics of the intervention, study setting, predetermined outcomes, and results. Whenever information was available, I extracted dichotomous and continuous data for all outcomes. I contacted several authors for more 'raw' data, but did not receive a reply. See appendix 3 for extraction form and more information on the included studies.

2.6 Data analysis

In this SR data were summarized narratively by text and/or tables for each comparison, as well as by meta-analyses whenever it was possible. As defined in the study protocol, for continuous outcomes group means (from the last measurement point) and standard deviations would be used to calculate the effect sizes with 95% confidence intervals (CI) using Review

Manager 5.4.1 tool (RevMan). Effect sizes would be presented as mean differences (MD) if the studies used the same scale and standardized mean differences if the scales were different (50).

For dichotomous outcomes treatment effects were expressed as relative risk (RR). Risk was calculated as the number of patients in the group who had an event divided by the total number of patients in the group. RR was the risk in one group divided with the risk in the other group. A RR greater than 1 indicated increased risk of the outcome in the treatment group, if it was less than 1 it indicated that the risk in the treatment group had decreased. RR of 1 indicated that there was no risk difference. Estimates of treatment effects were accompanied by the commonly reported 95% CI. This is the range within which we are 95% certain that the true population treatment effect will lie. The precision of the estimate can be seen on the width of the CI. If a CI is wide, it is not precise, if it is narrow, it is precise. If the CI includes 1 then we have not been able to demonstrate statistically significant difference between the two groups. If the CI does not include 1 there is a statistically significant difference (50).

If the individual studies with data on an outcome were similar enough regarding SPICO, data were pooled and combined to provide a larger total sample and thus offer stronger statistical power than the samples would do individually. This is called a meta-analysis and I used RevMan to create meta-analyses with forest plots when appropriate. A forest plot presents the results with combined and individual effects from included studies in a ‘reader friendly’ way. It shows the weight of the different studies: greater weights relate closely to the sample size of the study and how much variation there is between included studies. Statistical heterogeneity was assessed by I^2 which is from 0-100. Less than 30% was considered mild heterogeneity

and I^2 greater than 50% was considered high heterogeneity. Great variations of results and non-overlapping CIs was also considered high heterogeneity (50). In line with my protocol no subgroup analyses were conducted.

If the included studies were not similar enough regarding SPICO to be pooled and provide an overall effect, the results were presented narratively only. A narrative synthesis primary use words and text to synthesis the findings from multiple studies (51).

2.7 Assessment of the certainty of the evidence (GRADE)

Grading of Recommendations Assessment, Development and Evaluation (GRADE) is a method for assessing the certainty of the body of evidence in a SR (52). I used GRADE to evaluate the extent of certainty I have in the results for each outcome.

Evidence from RCTs start as high certainty evidence. The certainty of evidence can be downgraded depending on five criteria: risk of bias, inconsistency, indirectness, imprecision, and publication bias. Evidence from observational studies start from low certainty of evidence but can be upgraded if there are no other limitations identified within the five criteria for downgrading. Observational studies can be upgraded if there is a large effect estimate, or a dose-response gradient, or if all possible confounding factors will contribute to a reduced effect (53):

I used the standard definitions for overall certainty of the documentation as high, moderate, low or very low (54). These are:

*"**High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect*

***Moderate certainty:** We are moderately confident in the effect estimate: The true effect is*

likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: *Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect*

Very low certainty: *We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect"* (54).

2.8 Changes from the original protocol

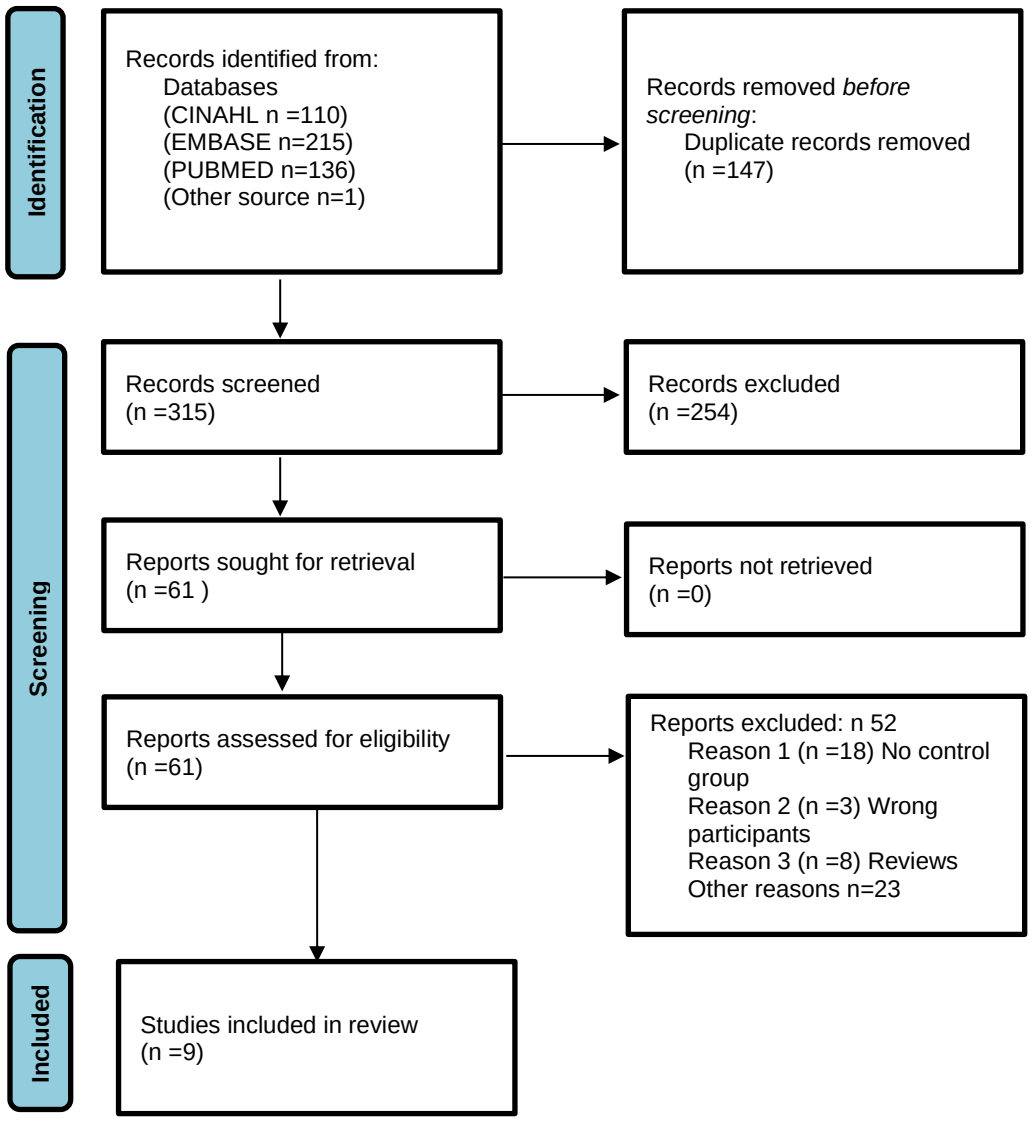
I prepared a simple protocol where I described how I would conduct my SR. I prepared this review in line with the protocol except for some minor changes regarding how I would assess certain outcomes.

3 Results

3.1 Results of the literature search

The systematic searches in the three pre-determined databases gave 315 references after removing duplicates (figure 1). The searches in SveMed+, NORA, Oria, and Google Scholar for relevant studies in a Nordic language (and English in Google Scholar) did not yield any relevant records that were not already identified in my systematic searches in the three predetermined databases. I excluded 254 references based on title and abstract. I read 61 references in full and excluded 52 based on my predefined inclusion and exclusion criteria. The hand search of reference lists led to the subsequent inclusion of one additional study. Nine primary studies were eligible for inclusion (55-63). See appendix 2 for a list of excluded studies and the justification for exclusion.

Figure 1: Prisma flow diagram for selection of studies



3.2 Description of included studies and their context

Nine unique studies were included in this SR (table 1). The studies were published from 2007-2020, with 67% published in the last five years. There were three RCTs, five retrospective cohort studies, and one CBA. For more details about each study see text below and appendix 3.

Table 1: Characteristic of the included studies (n=9)

Author, (country, setting) (study design)	Population	Intervention and comparator (follow-up time)	Outcomes
Cao 2018 (China: 1 PD centre) (RCT)	N=160, on CAPD Men 58% Mean age 52	RPM vs SC Instant messaging application (mean 11.4 mo FU)	Hospitalisations, infections, technical failure
Chaudhuri 2020 (USA: 931 renal centres) (RCS)	N=6343, on PD Men 73% Mean age 57	RPM vs SC "Patient hub" application (12 mo FU)	Hospitalizations, technical failure
Corzo 2020 (Columbia: 5 renal centres) (RCS)	N=558, on APD Men 60% Mean age 54	RPM vs SC Cloud-based software (mean 8.3 mo FU)	Technical failure
Gallar 2007 (Spain: 1 PD centre) (CBA)	N=57, on PD Men 60% Mean age 47	TM vs SC (videoconference equipment) (mean 8 mo FU)	Hospitalizations
Li 2014 (China: 2 PD centres) (RCT)	N=135, on PD Men 59% Mean age 56	TM vs SC Disease management programme by telephone vs SC (3 mo FU)	Hospitalizations, infections, QoL
Milan 2020 (Italy: 1 PD centre) (RCS)	N=73, on APD Men 75% Median age 60	RPM vs SC Cloud-based software (6 mo FU)	Hospitalizations, technical failure, QoL
Sanabria 2019 (Columbia: 28 Baxter renal care centres) (RCS)	N=360, on APD Men 66% Mean age 57	RPM vs SC Cloud-based software (Mean 9 mo FU)	Hospitalizations, technical failure
Weinhandl 2018 (USA: 55 HHD centres) (RCS)	N=2424, on HHD Men 63% Mean age 53	RPM vs SC Nx2me telehealth platform (Mean 11 mo FU)	Technical failure
Wong 2010 (Hong Kong: 2 renal centres) (RCT)	N=94, on CAPD Men 53% Mean age 62	TM vs SC Disease management programme by telephone vs SC (3 mo FU)	QoL

Legend: APD=Automated Peritoneal Dialysis; CAPD=Continuous ambulatory peritoneal dialysis; CBA=Controlled before and after study; CKD=Chronic kidney disease; FU=Follow-up; HHD=Home Hemodialysis; mo=months; N=Number; PD=Peritoneal dialysis; QoL=Quality of Life; RCS=Retrospective cohort study; RCT=Randomized controlled trial; RPM=Remote patient monitoring; SC=Standard care; TM=Telemedicine

3.2.1 Study setting

The studies were conducted in six different countries. There were two each from China, Columbia, and USA, and one study each from Hong Kong, Italy, and Spain. Three were set in a single PD centre, four took place in two or more renal care centres and the two largest studies took place in the USA with one including 55 HHD centres and another 931 Fresenius PD clinics.

3.2.2 Population

With respect to the population, all in all, there were a total of 10,204 dialysis-dependent CKD patients in the studies (study range 57-6343 patients). In all the studies most patients were male (range 53%-75%). The mean age of the study participants was about 55. In all studies except one, the patients were on PD. All participants lived at home and performed dialysis independently or with the assistance of a carer. The included participants lived in six different countries on four different continents; thus economic, sociological, and cultural factors relative to their care were likely to differ because of this.

3.2.3 Interventions

For an overview of the interventions, see table 2.

The interventions were TM FU by telephone (n=2), different types of software that collected treatment data and transferred it to a treatment centre (added by the patients or automatically recorded) (n=5), one study used an instant messaging software for FU, and one study used video conference FU. The FU time ranged from 3 to 12 months. Most studies had a FU time of around 12 months. In line with the inclusion criteria, the intervention in all studies was TM, and in addition, all patients had or were likely to receive some level of SC. However,

clearly stated information regarding SC for the TM group was scarce. For more information regarding SC see chapter 3.2.4.

Table 2: Description of included interventions

Study	Interventions
Corizo 2020 (*c) **Manani 2020** (*a,b) **Sanabria 2019** (*c)	APD: Claria™, connected to Sharesource platform, Baxter. The software collects treatment data and transmits it to the health care providers, and the prescription can be changed 'from afar'. Treatment information is not available for the healthcare provider during treatment. The patients can add some data themselves such as blood pressure and weight.
Li, 2014 **Wong, 2010**	PD: At baseline, a nurse conducted an initial assessment with the patient based on the Omaha system (originally used in the USA for community health nursing practice, but it was adopted for CKD). Followed by a nurse led disease management program via weekly phone FU.
Gallar, 2007	PD, Falcon, Vcon videoconference equipment, alternatively months in hospital and TM FU. A nurse reviewed the patients' general PD technique including, care of the exit site, early recognition (and treatment) of peritonitis, and evaluation regarding overhydration. TM was used if the patient needed additional FU.
Chaudhuri, 2020	PD: "Patient hub" application. The patients can see their prescription, laboratory results and enter treatment data, the app transmits the data to the health care providers
Cao, 2018	PD, The "kidney cleaning group" is an instant messaging software. Technical support, nurse support, physician support and support from fellow patients was available through chat and video. The patients were divided in smaller group and one experienced PD patient with few complications was the group leader. Educational resources were also available in the platform.
Weinhandl, 2018	HHD, Nx2me telehealth platform. The software collects treatment data and transmits it to the health care providers. It is possible to do real life 'troubleshooting'

Legend: APD= Automated Peritoneal Dialysis**;** CKD= Chronic kidney disease; HHD=Home Hemodialysis; FU=Follow-up; PD=Peritoneal dialysis; TM=Telemedicine. *a) used a TM program from Fresenius for half the intervention patients. *b) offered the intervention to frailer patients, resulting in a TM group with a higher Charlson Comorbidity Index. *c) the intervention was likely to be allocated based on the physicians perceived need of the patient.

3.2.4 Standard care

The control was without TM, and in all studies, that was likely to mean SC. However, SC was not identical in all countries. SC was generally described as in-person FU at the hospital. However, the frequency of SC ranged from weekly (n=1) to every three months (n=1). Two studies did not specify how often SC was, only that the patients received it. Most studies (n=5) had or were likely to have an in-person review of the patient's paper treatment log monthly.

3.2.4.1 SC for both groups

Gallar et al. (58) had alternatively monthly in-person and TM FU and no information about SC for the control group. Cao et al. (55) had weekly in-person or by phone FU for both groups. However, it was not clear how often the patients would come for in-person FU. In both Li et al. (59) and Wong et al. (63), both groups received SC with or without the intervention, but both studies were unclear regarding how often the patients would attend the clinic in person. Weinhandl & Collins (62) and Chaudhuri et al. (56) stated that SC in the USA was a monthly in-person review of the patient's paper record. Thus, even if it was not specifically stated it is likely that the study participants had monthly in-person FU. Corzo et al. (57) and Sanabria et al. (61) stated that SC was a monthly in-person FU. In Milan et al. (60), SC was every three months. These three Sharesource studies did not include information regarding SC for the intervention group. However, it is likely that patients had in-person consultations if the problem was unsolvable by TM, possibly also at the same rate as the control group.

3.2.5 Outcomes

Across the studies, there were data on four of the five pre-determined outcomes (table 3). In Li et al. (59) and Wong et al. (63), the interventions were six weeks, and the data were collected three months after baseline (referred to as last FU). For the other studies, the interventions did not have a known expiration date and FU was reported as the last point of measurement or mean FU time with a range of 6 to 12 months.

Table 3: Brief overview of outcomes reported in the included studies

Outcome	Studies with the outcome
Hospitalization	n=6
- Hospital days	n=4: Chaudhuri, 2020; Gallar, 2007; Milan, 2020; Sanabria 2019
- Hospitalizations (all-cause)	n=5: Cao, 2018; Chaudhuri, 2020; Li, 2014; Milan, 2020; Sanabria, 2019
- Hospitalizations (disease-specific) caused by infection, overhydration or access dysfunction	n=2: Milan, 2020; Sanabria, 2019
Infections not requiring hospitalization	n=2: Cao, 2018; Li, 2014
Technical failure as the cause for transfer to a different dialysis modality	n=6: Cao, 2018; Chaudhuri, 2020; Corzo, 2020; Milan, 2020; Sanabria, 2019; Weinhandl, 2018
QoL	n=3: Milan, 2020; Li, 2014; Wong, 2010
Time patients used for travel	n=0

Legend: n=number; QoL=Quality of life

3.2.6 Risk of bias (RoB) assessment of included studies

I used three different tools to assess RoB for the included studies as specified in my protocol. I used Cochrane RoB for RCTs, Cochrane EPOC for the CBA, and The Newcastle-Ottawa Scale for retrospective cohort studies. The CBA was rated as having low methodological quality, the retrospective cohort studies were rated fair to good methodological quality, and the RCTs were considered to have low methodological quality.

Figure 2, table 4 and table 5 shows the RoB in the nine included studies by design. Full RoB for all studies with justifications can be found in appendix 3. Of note, in all the observational studies except Milan et al. (60) the research was funded by medical companies which could have an economic interest in positive results from TM. There was some concern regarding allocation of the intervention in all the observational studies. In three studies the intervention was or was likely to be allocated on the basis of whom the physician considered had the greatest need for closer FU. Thus, TM was likely to be allocated to the patients with worse health. In three observational studies the patients in the TM group were likely to be healthier than the patients in the SC group. However, despite this the RoB for the five retrospective cohort studies were rated as fair to good methodological quality.

Figure 2: RoB for the RCTs

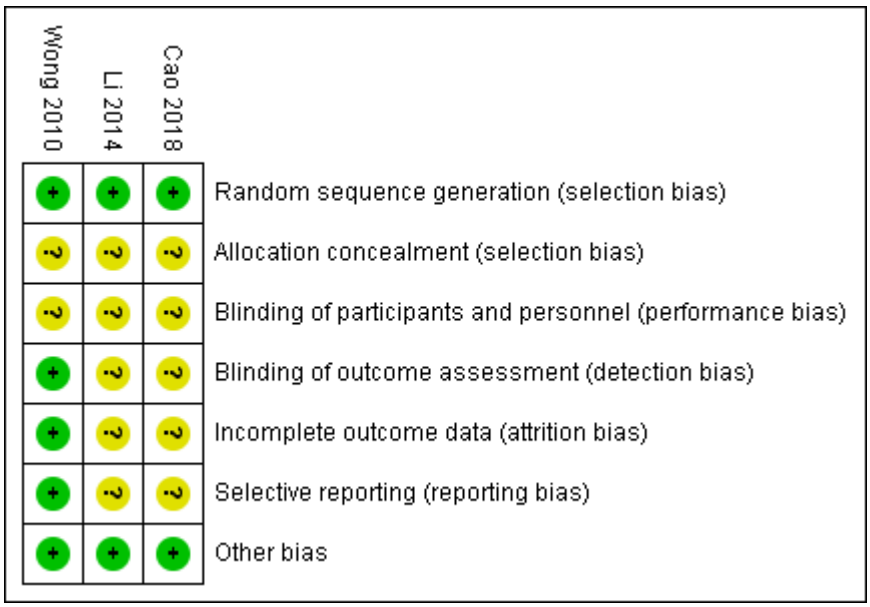


Table 4: RoB for the retrospective cohort studies

Study	Selection				Comparability	Outcome			Stars: Quality
	1	2	3	4		1	2	3	
Chaudhuri 2020	1b	2a	3a	4b	1ab	1b	2a	3d	7: Good
Corzo 2020	1b	2a	3a	4a	1ab	1b	2a	3b	9: Good
Milan 2020	1c	2a	3a	4a	1-	1bc	2a	3b	6: Fair
Sanabrina 2019	1b	2a	3a	4a	1ab	1b	2a	3b	9: Good
Weinhandl 2018	1b	2a	3ac	4b	1ab	1b	2a	3d	7: Good

Table 5: RoB for the CBA

Study	1	2	3	4	5	6	7	8	9	Method. quality
Gallar 2007	Yes	Yes	U	U	U	U	No	U	U	Low

Legend: U=Unclear

3.3 Effect of TM versus SC

All in all, the nine studies reported on four of the five eligible outcomes. For technical failure as the cause for transfer to a different dialysis modality, one category of hospitalization (disease-specific) and QoL (three questions were chosen), SPICO were sufficiently similar across studies and data were available to perform at least one meta-analysis. For some studies, standard deviation was not available, and in some, the results were presented as rates and ratios without 'raw' data. Thus, results from several studies could not be included in any meta-analyses. For infection not requiring hospitalization, results could not be statistically pooled across studies because the data were not expressed in a manner that made meta-analyses possible, thus, the results were synthesized narratively. There was no data available on the outcome 'time patients used for travel'.

3.3.1 Hospitalizations

Two RCTs and four observational studies from Italy, Spain, Colombia, China, and the USA measured hospitalizations. This outcome was reported differently across the studies, and accordingly, the outcome was analysed as hospitalization days/days admitted (n=4), all-cause hospitalizations (n=5), and disease-specific hospitalizations (caused by overhydration, access dysfunction, and infections) (n=2). The six studies ranged from being involved in one analysis to all of them. For the studies with more than one measuring point, the latest data collected from each study were analysed. In the observational studies, this was after 12 months in Chaudhuri et al. (56) and after six months in Milan et al. (60). Gallar et al. (58) and Sanabria et al. (61) had a mean FU of eight and nine months, respectively, and the data in the analyses were from the end of the studies. In the RCTs, Cao et al. (55) had a mean FU time of 11.4 months, while Li et al. (59) had a six-week intervention, however, the last point of measurement was after three months, and these data were included in the analyses. For additional data from Chaudhuri et al. (56) from three, six and, nine months FU, see appendix 4.

3.3.1.1 Effect on hospitalization days

Chaudhuri et al. (56), Gallar et al. (58), Milan et al. (60), and Sanabria et al. (61) were all observational studies, and all four studies had consistent results with fewer hospitalization days in the TM group than the SC group (table 6). Chaudhuri et al. (56) and Sanabria et al. (61) had larger sample sizes and accounted for 98% of the total sample for hospitalization days. The results in Sanabria et al. (61) were from a matched sample, as data for the whole sample were not available. This study showed the largest effect with a difference of six hospitalization days (Incident rate ratio [IRR] 0.46, 0.23-0.92) (table 6).

According to these results, there were fewer hospitalization days in the TM group than in the SC group. However, as we can see from the summary of findings (SoF) table (table 8), the overall certainty of evidence (GRADE) was rated as very low, meaning that the results should be interpreted with caution. For a more detailed GRADE assessment see appendix 5.

Table 6: Effect of TM on hospitalization days

Study	Intervention	Control	Results
Chaudhuri 2020[a]	Un. PPY 3.67	Un. PPY 6.13	Adj. IRR 0.68 (0.55-0.83)
Gallar 2007[b]	Mean PY 2.20	Mean PY 5.7	Difference in means PY 3.5 (-0.21-7.21) P 0.06
Milan 2020[c]	Median (IQR) 5 (4-11.50)	Median (IQR) 10 (7-20)	5 days difference in median days P 0.55
Sanabria 2019[d]	Adj. IR 5.59	Adj. IR 12.16	Adj. IRR 0.46 (0.23-0.92)

Legend: Adj=Adjusted; FU=Follow-up; IR=Incidence rate; IRR=Incident rate ratio; IQR=Inter quartile range; mo=Months; N=Number, PY=Person year; PPY=Per person year; Un=Unadjusted. **N**: a) N=6343; b) N=57; c) N=73; d) N=360

3.3.1.2 All-cause hospitalizations

Two RCTs and three observational studies had data on general, not cause-specific hospitalizations. Li et al. (59) and Milan et al. (60) provided data for a forest plot; however, they were not similar enough regarding SPICO to be pooled in a meta-analysis with a total effect estimate. Cao et al. (55) also had data for RR, but because of difference in FU time the result is presented in table 7. Chaudhuri et al. (56) and Sanabria et al. (61) presented their results as calculated rates and ratios. Thus, these results could not be included in a forest plot with the other studies and are presented in table 7. I contacted both authors in search of more data, but did not get a reply. The results from four of the five studies were that TM users had less all-cause hospitalizations than patients with SC only. The fifth study, Milan et al. (60), however, favoured the control group. According to the forest plot (figure 3), the results from the two studies were not conclusive with wide confidence intervals and results both in favour

of the intervention and the control. However, the two studies not included in the forest plot had larger sample sizes and accounted for 95% of the total number of participants in the analysis; hence these studies were given more weight. The ratio of all-cause hospitalizations was significantly lower in the TM group than in the SC group in these two large observational studies (table 7).

The overall result in this analysis shows that there were less all-cause hospitalizations in the TM group than in the SC group. However, the GRADE assessment for both FU 3-6 months and 9-12 months shows that the overall certainty of evidence was very low, and the results should be considered with caution (table 8). For a more detailed GRADE assessment see appendix 5.

Figure 3: Forest plot showing effect of TM on all-cause hospitalizations (FU 3-6 months)

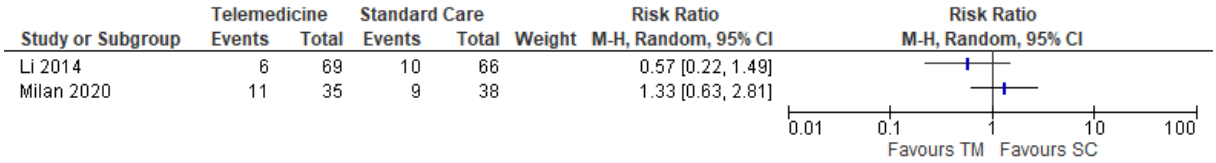


Table 7: Effect of TM on all-cause hospitalizations (studies not included in forest plot) (FU 9-12 months)

Study	Intervention	Control	Results
Cao 2018[a]	Events 4	Events 7	RR 0.57 (0.17-1.88)
Chaudhuri 2020[b]	Un. IR 0.65	Un. IR 0.95	Adj. IRR 0.74 (0.66-0.83)
Sanabria 2019[c]	Adj. IR 0.56	Adj. IR 0.92	Adj. IRR 0.61 (0.39-0.95)

Legend: Adj=Adjusted; IR=Incidence rate; IRR=Incident rate ratio; N=Number; Un=Unadjusted. **N**: a)160; b) N=6343, c) N=360

3.3.1.3 Disease-specific hospitalizations

The results on disease-specific hospitalizations from two observational studies, Sanabria et al. (61) and Milan et al. (60), could be pooled in a meta-analysis (figure 4). Milan et al. (60) defined disease-specific hospitalizations as infections (peritonitis and exit site), overhydration, and access dysfunction. Sanabria et al. (61) provided numbers for hospitalizations due to peritonitis and overhydration. The result from the meta-analysis was not statistically significant, but the two study results are consistent in implying that there were fewer disease-specific hospitalizations in the TM group than in the SC group. However, the certainty of evidence (GRADE) is very low, and the results should be considered with caution (table 8). For a more detailed GRADE assessment see appendix 5.

Figure 4: Meta-analysis showing effect of TM on disease specific hospitalizations

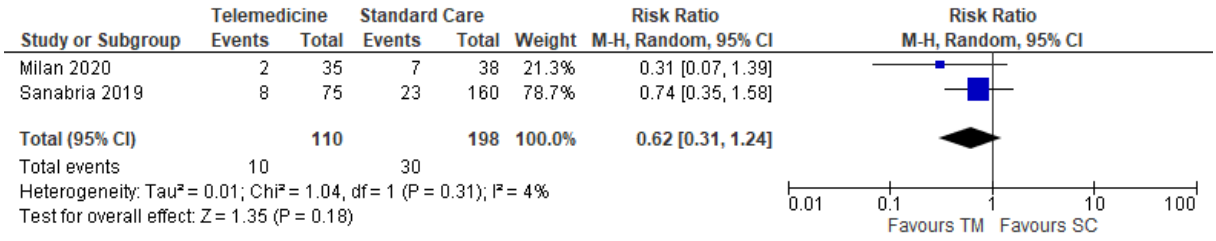


Table 8: SoF on effect of TM on hospitalizations

Telemedicine compared to Standard care only for patients with CKD on home dialysis

Patient or population: Patients with CKD on home dialysis (PD). **Setting**: PD centres (n=963). USA, Colombia, Spain China and Italy.
Intervention: Telemedicine. **Comparison**: Standard care

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
		Standard care	**Telemedicine**	**Difference**		
Hospitalization days (Hospitalization days) assessed with: Hospital records follow up: range 6 months to 12 months № of participants: 6,833(4 observational studies)	All four studies showed that there were fewer hospitalization days in the telemedicine group. The results for the two smallest studies did not reach statistical significance. The results for the two largest studies reached statistical significance (95%) IRR 0.68 (0.55-0.83) & 0.46 (0.23-0.92) after 12 months follow-up.				⨁◯◯◯ VERY LOW [ac]	It is uncertain the extent to which the intervention decreases hospitalization days
Hospitalizations (all-cause) assessed with: Hospital records follow up: range 3 months to 6 months № of participants: 208 (1 RCT & 1 observational study)	not pooled	not pooled	not pooled	not pooled	⨁◯◯◯ VERY LOW [a,bc]	It is uncertain the extent to which the intervention decreases hospitalizations (all cause, 3 mo)
Hospitalizations (all-cause) follow up: range 9 months to 12 months № of participants: 6,863 (1 RCT & 2 observational studies)	All three studies showed that there were fewer hospitalizations (all-cause) in the telemedicine group. One study did not reach statistical significance and had wide CI (95%) -RR.0.57 (0.17-1.88). The results for two largest studies reached statistical significance (95%) IRR 0.74 (0.66-0.83) & 0.61 (0.39-0.95) after 12 months FU				⨁◯◯◯ VERY LOW [ac]	It is uncertain the extent to which the intervention decreases hospitalizations (all cause, 9-12 mo)
Hospitalizations (disease-specific) assessed with: Hospital records follow up: range 6 months to 9 months № of participants: 308 (2 observational studies)	**RR 0.62** (0.31 to 1.24)	15.2%	**9.4%** (4.7 to 18.8)	**5.8% fewer** (10.5 fewer to 3.6 more)	⨁◯◯◯ VERY LOW [ac]	It is uncertain the extent to which the intervention decreases hospitalizations (disease-specific)

***The risk in the intervention group **(and its 95% confidence interval) is based on the assumed risk in the comparison group and the** relative effect **of the intervention (and its 95% CI). CI:** Confidence interval**; IRR:** Incidence rate ratio**; RR:** Risk ratio**; MD**: Mean difference**; Mo:** Months**; RCT**: Randomised controlled trial. **Explanations:** a. All studies have some risk of bias, b. One study favors the intervention and the other the control. c. Wide CI and uncertainty about the size of effect

3.3.2 Effect on infections not requiring hospitalization

Two RCTs, both from China, tested the effectiveness of TM FU on PD patients for the outcome infections. There was no information regarding if the infections were treated at home or in the hospital. The results could not be pooled due to different ways of presenting data (table 9). Furthermore, the FU time differed considerably. Li et al. (59) had a six-week intervention and reported results three months after baseline and Cao et al. (55) had a mean FU of 11.4 months. The results on this outcome were inconclusive, with results in favour of the control group as well as the intervention group. Li et al. (59) did not report any data, only that the results were not statistically significant. No statistically significant results were found to support either benefits or harms from TM FU on infections not requiring hospitalization. The GRADE assessment was rated as low (table 10). For a more detailed GRADE assessment see appendix 5.

Table 9: Effect of TM on infections not requiring hospitalization

Study	Intervention	Control	Results
Cao, 2018[a]	Peritonitis rate (one episode per number of patient-months) 60	Peritonitis rate (one episode per number of patient-months) 40	Favours the control
Cont.	Exit site infections 3	Exit site infections 7	P 0.19 FS RR 0.45 (0.12-1.68) P 0.23 AC
Li, 2014[b]	Catheter infection, exit site condition and peritonitis, no data	Catheter infection, exit site condition and peritonitis, no data	Not significant

Legend: AC=Author's calculations; FU=Follow-up; FS=From study; N=Number; RR=Relative risk. **N**: a) N=160; b) N=135

Table 10: SoF on effect of TM on infections not requiring hospitalization

Telemedicine compared to standard care for patients with CKD on home dialysis

Patient or population: patients with CKD on home dialysis (PD). **Setting**: PD centres (n=3) in China

Intervention: Telemedicine. **Comparison**: Standard care

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
		Standard care	**Telemedicine**	**Difference**		
Infections not requiring hospitalization (Infections) assessed with: % follow up: range 3 months to 12 months № of participants: 295 (2 RCTs)	One study did not report any data, only that it was not significant. The other study shows results both in favour of TM and SC. The intervention in one study lasted for six weeks and last point of measurement was at three months, the other had a mean FU of 11.4 months. Thus, there was a great difference in FU time. Both studies had extensive SC FU. The results cannot provide evidence that TM had an effect on infections not requiring hospitalization				⊕⊕◯◯ LOW [a,b]	TM FU may result in no difference in infections not requiring hospitalization

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **FU:** Follow-up; **SC**: Standard care; **TM**: Telemedicine; RR**:** Risk ratio; **MD:** Mean difference. **RCT**: Randomised controlled trial.

Explanations: a. Inconsistent results with some in favour of standard care and some telemedicine. b. Few events and uncertainty about the effect size

3.3.3 Effect on technical failure as the cause for transfer to a different dialysis modality

One RCT from China and five observational studies from the USA (n=2), Colombia (n=2), and Spain (n=1) reported on the effect of TM on technical failure as the cause for transfer to a different dialysis modality. All six studies were conducted within the last five years and used 'new' internet-dependent technology. Five studies used programs that transferred treatment data to a health provider. In the sixth study, Cao et al. (55) used an instant messaging software for FU and support of patients. The FU time across the six studies ranged from 6-12 months. Chaudhuri et al. (56) and Corzo et al. (57) reported results as rates and ratios. I contacted both authors for data to include in the meta-analysis but did not get a reply. In four of the studies,

the patients were on PD, and technical failure was defined as a change of modality to HD. Chaudhuri et al. (56) and Corzo et al. (57) specified that the HD treatment had to be for more than six weeks or 30 days, respectively. Cao et al. (55) and Milan et al. (60) did not specify any timeframe the patients were on HD before it was defined as a transfer. Sanabria et al. (61) presented technical failure as a cause of censure. I contacted the main author of the study for more information but did not get a reply. In the HHD study from Weinhandl & Collins (62), there was no information regarding the consequences of HHD attrition due to technical failure. I contacted one of the authors for additional information but did not get a reply. Neither Sanabria et al. (61) nor Weinhandl & Collins (62) specified that technical failure led to a change in modality, but it is likely as complete attrition from RRT would result in death for the patient. Thus, the results from both studies were included in the meta-analysis.

This was the outcome with the highest statistical power due to a high number of participants. Three studies were similar enough regarding SPICO to be pooled in a meta-analysis (figure 5). The results for the three studies not included in the meta-analysis are presented in table 11.

The result from the meta-analysis was statistically significant (RR=0.78, 95% CI 0.66, 0.92), and heterogeneity was not detected. Weinhandl & Collins (62) weighed 95.7% in the analysis due to a high number of participants. This was the only study, including the three that were not pooled, that reached statistical significance by itself. The results from all the six studies reporting this outcome were consistent in that there was less technical failure as cause of transfer to different dialysis modality in the TM group than in the SC group. The overall certainty of evidence (GRADE) was rated as very low and the result must be considered with caution (table 12). For more results on this outcome, including sub-group analyses from

Weinhandl & Collins (62) on novice patients see appendix 4. For a more detailed GRADE assessment see appendix 5.

Figure 5: Meta-analysis showing effect of TM on technical failure

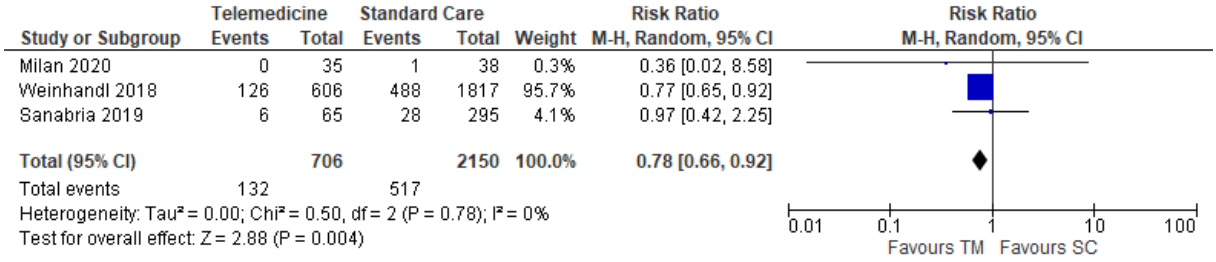


Table 11: Effect of TM on technical failure (studies not included in meta-analysis)

Study	Intervention	Control	Results
Cao 2018[a]	4 events	4 events	RR: 1.00 (0.26-3.86)
Chaudhuri 2020[b]	Un. PPY 0.10 10/100 PY	Un. PPY: 0.14 14/100 PY	Adj.HR: 0.79 (0.63-1.00) 4/100 PY fewer events in the intervention group
Corzo 2020[c*]	Un. IR: 0.08 (0.05-0.15)	Un. IR: 0.09 (0.07-0.12)	Un. IRR: 0.88 (0.41-1.74) P 0.65

Legend: Adj=Adjusted; HR=Hazard ratio; IR=Incidence rate; IRR=Incident rate ratio; PD=peritoneal dialysis; PY=Person year; PPY=Per person year; TM=Telemedicine; Un=Unadjusted. **N**: a) N=160; b) N=6343; N=558
*For results from the matched sample see appendix 4

Table 12: SoF on effect of TM on technical failure

Telemedicine compared to Standard care only for patients with CKD on home dialysis

Patient or population: patients with CKD on home dialysis. **Setting**: HHD and PD centres (n=1020). China, Italy, USA & Colombia
Intervention: Telemedicine. **Comparison**: Standard care

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
		Standard care	**Telemedicine**	**Difference**		
Technical failure as the cause for transfer to a different dialysis modality (Technical failure) assessed with: Hospital records follow up: range 6 months to 12 months № of participants: 9,917 (6 observational studies)	**RR 0.78** (0.66 to 0.93)	24.0%	**18.8%** (15.9 to 22.4)	**5.3% fewer** (8.2 fewer to 1.7 fewer)	⨁◯◯◯ VERY LOW [ab]	It is uncertain the extent to which the intervention decreases technical failure as the cause for transfer to a different dialysis modality

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio; **MD:** Mean difference. **Explanations:** a. All studies have some risk of bias. b. Wide CI and uncertainty about the size of effect

3.3.4 Effect on self-reported Quality of Life

Two RCTs and one observational study had data regarding the effect of TM on self-reported Quality of Life. All studies used the tool 'The short form of kidney disease quality of life' (KDQOL), which is an adaptation of the SF-36 tool, transformed to fit kidney disease patients and disease-specific challenges that often follow kidney disease (63). All answers were transformed into pre-coded numeric values with a range from 0-100, where 100 was the highest QOL (64).

Milan et al. (60) only used the kidney-specific KDQOL questions, and four additional PD questions. Data were collected after six months. The two similar RCTs from Li et al. (59) and Wong et al. (63) included the non-kidney-specific questions of the KDQOL as well as the

kidney specific ones. The intervention was six weeks with a last point of measurement three months after baseline, which is the data included in the analyses.

For detailed data on all KDQOL reported aspects see appendix 4. There were several questions/areas. None of the studies offered any overall total effects across the questions/areas. Thus, I chose the three questions/areas that I considered the most likely to be affected by TM. The results from the two RCTs were pooled in three meta-analyses. Because Milan et al. (60) reported median interquartile rage, this study could not be included in the meta-analyses and are presented in tables 13 and 14 (no data were available for the last question/area). As we can see from all meta-analyses, the results have wide CI, showing that there is uncertainty about the effect size. For dialysis staff encouragement (figure 6), the results favour TM with a statistically significant result (MD=4.61, CI 95% 0.83-8.40, P 0.02) and low heterogeneity. Table 13 shows that there was no difference between the two groups (P 0.17) in Milan et al. (60). For patient satisfaction (figure 7), the heterogeneity was high, and the effect of TM is inconclusive (MD=0.57, CI 95% -8.02-9.16), P 0.90). Table 14 shows that there was no difference between the groups (P 1.00). For energy/fatigue (figure 8) the results favour TM with no heterogeneity detected (MD=4.82, CI 95%-0.30-9.93, P 0.07). However, the wide CI indicates that energy/fatigue could be both better and worse in the TM group.

Neither the results for ‘patient satisfaction’, ‘energy/fatigue’ nor the other results in appendix 4 suggest that TM had an overall effect on QoL. However, ‘dialysis staff encouragement’ reached statistical significance and could imply that TM has effect when looking at some questions/areas and not the overall effect on QoL. The certainty of evidence (GRADE) was rated as low to very low (table 15). For a more detailed GRADE assessment see appendix 5.

Figure 6: Meta-analysis showing effect of TM on QoL (dialysis staff encouragement)

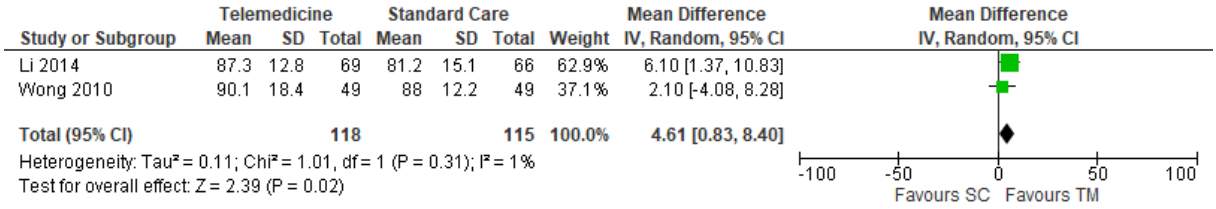


Table 13: Effect of TM on dialysis staff encouragement (study not included in meta-analysis QoL)

Study Scale	Intervention	Control	Result Follow-up
Milan 2020[a] Median (IQR)	100 (100-100)	100 (87.5-100)	6 mo P 0.17

Legend: IQR=Interquartile range; mo=Months; N=Number; TM=Telemedicine. **N**: a) N=73

Figure 7: Meta-analysis showing effect of TM on QoL (patient satisfaction)

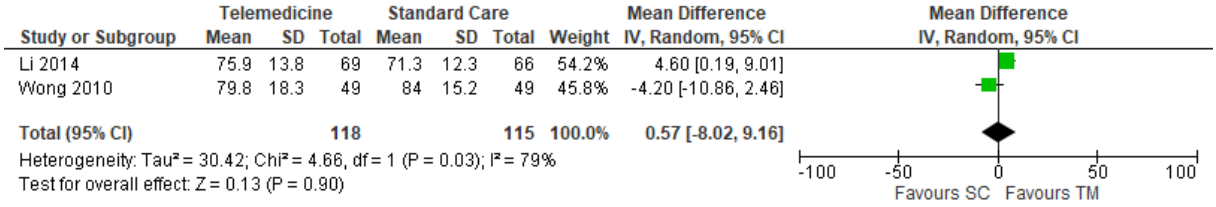


Table 14: Effect of TM on patient satisfaction (study not included in meta-analysis QoL)

Study Scale	Intervention	Control	Result Follow-up
Milan 2020[a] (Median IQR)	83.3 (66.7-100)	83.3 (66.7-100)	6 mo P 1.00

Legend: IQR=Interquartile range; mo=Months; N=Number; TM=Telemedicine. **N**: a) N=73

Figure 8: Meta-analysis showing effect of TM on QoL (energy/fatigue)

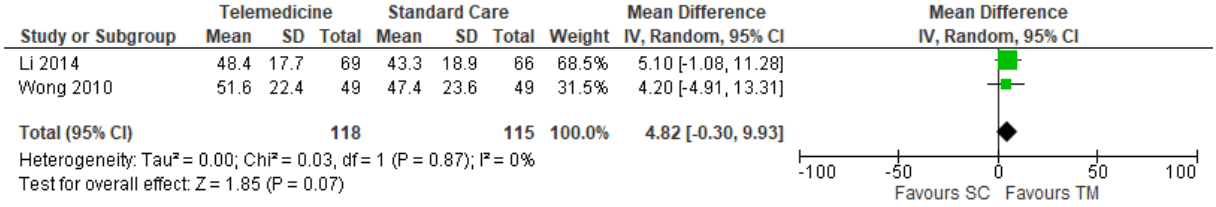


Table 15: SoF on effect of TM on QoL

Telemedicine compared to Standard care only for patients with CKD on home dialysis

Patient or population: patients with CKD on home dialysis (PD). **Setting**: PD centres (n=5) in China, Hong Kong and Italy.
Intervention: Telemedicine. **Comparison**: Standard care only

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
		Standard care	**Telemedicine**	**Difference**		
QoL- Dialysis staff encouragement (KDQOL) assessed with: Self-report KDQoL follow up: range 3 months to 6 months № of participants: 306 (2 RCTs & 1 cohort study)	-	The mean qoL-Dialysis staff encouragement was **84.02** KDQoL	-	MD **4.61** **KDQoL higher** (0.83 higher to 8.4 higher)	⨁◯◯◯ VERY LOW [ab]	It is uncertain the extent to which the intervention improves QoL dialysis staff encouragement
QoL- Patient satisfaction (QoL) assessed with: Self-report KDQoL follow up: range 3 months to 6 months № of participants: 306 (2 RCTs & 1 cohort study)	-	The mean qoL-Patient satisfaction was **76.57** KDQoL	-	MD **0.57** **KDQoL higher** (8.02 lower to 9.16 higher)	⨁◯◯◯ VERY LOW [a,b,c]	It is uncertain the extent to which the intervention affects QoL patient satisfaction
QoL-Energy/fatigue (QoL) assessed with: Self-report KDQoL follow up: median 3 months № of participants: 306 (2 RCTs)	-	The mean qoL-Energy/fatigue was **45.00** KDQoL	-	MD **4.82** **KDQoL higher** (0.3 lower to 9.93 higher)	⨁⨁◯◯ LOW [a,b]	TM FU may slightly increase QoL energy/fatigue

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio; **MD:** Mean difference, **QoL**: Quality of life (KDQoL-tool to asses QoL in people with kidney disease), **RCT**: Randomized controlled trial, **TM**: Telemedicine, **FU:** Follow-up. **Explanations:** a. All studies have some risk of bias, b. Wide CI and uncertainty about the effect size, c. High heterogeneity

3.3.5 Effect on time patients used for travel

No studies reported on this outcome. Thus, there is no evidence to suggest increase or decrease from TM FU on time patients used for travel.

3.3.6 Ongoing study

My systematic searches only yielded one protocol where the study would have been included if it had been completed (table 16).

Table 16: Description of ongoing study on effect of TM

Protocol	Aim of study
Ma T, Yang Z, Li S, Pei H, Zhao J, Li Y, et al. The Peritoneal Dialysis Telemedicine-assisted Platform Cohort (PDTAP) Study: Design and methods. Perit Dial Int. 2020:896860820962901.	Cohort study. Aims to include 7000 PD patients in China. Outcomes: Patient survival, technique survival, hospitalization, and the occurrence of infectious and non-infectious complications

4 Discussion

In this SR, I aimed to summarize empirical research assessing the effect of TM on improving outcomes for patients with dialysis dependent CKD on home dialysis, including HHD and PD.

4.1 Summary of main results

The results in this SR are based on data from nine unique studies including six observational and three RCTs. Overall, the findings suggest that it is uncertain the extent to which TM decreases technical failure as the cause for transfer to a different dialysis modality and hospitalizations. The overall effect of TM as a tool for improving overall QoL or decrease number of infections that did not require hospitalization is inconclusive. The effect of TM as a tool to reduce the time patients use for travel were assumed in several studies but without any data to support the very plausible claim. The GRADE assessments for all outcomes were rated as very low or low (appendix 5). Thus, while the overall results suggest positive effects of TM, firm conclusions about the effect size cannot be drawn. That is, in line with the GRADE standard definitions (54), there is limited certainty that the effect estimates found in this review are close to the true effect. The main findings on the effect for each outcome is summarized below.

4.1.1 Effect on hospitalizations

The outcome included six studies and three analyses: hospitalization days, all-cause hospitalizations, and disease-specific hospitalizations. All analyses showed favourable results of TM.

For hospitalization days and all-cause hospitalizations, the greatest effect was observed in Sanabria et al. (61), which could be interpreted to mean that new patients benefit more from TM than experienced patients. However, the results from this study for hospitalization days and all-cause hospitalizations were from matched samples, and it is plausible that the effect would have been smaller if the results for the whole sample had been reported, as they were in the other studies that reported on this outcome. For disease-specific hospitalizations, however, the data from Sanabria et al. (61) were from the whole unmatched sample, and Milan et al. (60) with more experienced patients showed a greater effect. However, the results are based on few events.

Milan et al. (60) observed a median difference of five fewer hospitalization days in the intervention group. It is interesting that the median number of hospitalization days was lower in the intervention group as this group had a higher Charlson Comorbidity Index score. This could imply that because the patients had close FU by TM, the physicians felt comfortable discharging these patients earlier than the patients without TM.

Even though Milan et al. (60) favoured the SC group for all-cause hospitalizations, it is likely that hospitalizations (especially disease-specific and hospitalization days) in both Milan et al. (60) and Sanabria et al. (61) were prevented in the TM group due to daily reviews of treatment data and interventions from the hospital staff. Novice patients in Sanabria et al. (61) and frailer patients in Milan et al. (60) would be expected to need closer FU than experienced patients with better health. Hence, that TM FU with this type of technology offers benefits for frail patients and/or inexperienced patients regarding hospitalizations makes sense, as issues such as overhydration could be easily managed with changes of PD prescription or medications before the patient would need to be hospitalized.

4.1.2 Effect on infections not requiring hospitalization

Two studies reported numbers of infections, but without any information on whether these infections were treated at home or led to hospitalization. The results were inconclusive with results favouring both the TM and the SC groups. The results could be influenced by the fact that both groups had extensive FU, and close FU could also affect the outcome. Hence, the TM group did not receive a closer FU than the SC group. Thus, no effect on infections would be expected as prevention of infections are likely to depend on the level of FU and not on the form of it.

4.1.3 Effect on technical failure as the cause for transfer to a different modality

This was the outcome with the most included studies (n=6). It was also the outcome with the highest number of participants and only 'new technology' including only publications between the years 2018-2020. The result of the meta-analysis reached statistical significance (95%). This was the only outcome which included HHD patients, and one could argue that comparing HHD and PD would be like comparing apples and oranges. However, when there are no other apples around the best option is to compare it to other fruits. Hence, to conduct a SR on the effect of TM on HHD patient FU only, would prove difficult due to limited research. Thus, this review included both forms as both are equally important treatment options for the same condition. Weinhandl & Collins (62) only provided data from a matched analysis. Thus, the results available from this study could be stronger than the results from the whole sample.

In four of the studies on this outcome prescriptions could be changed from the hospital without in-person consultations. The HHD could also do real life 'troubleshooting'. This

technology offers possibilities to resolve technical issues early on and thereby prevent technical failure from progressing to the stage where the patient would have to transfer to a different dialysis modality. Hence, it seems plausible that close TM patient FU with this kind of technology can be beneficial regarding this outcome.

4.1.4 Effect on self-reported Quality of Life

Three studies reported on QoL measured by the KDQOL-tool. The tool included multiple questions/areas and the effect of TM patient FU on QoL were inconsistent in all the three studies for most of them, with results in favour of both groups. Thus, overall effect in QoL were inconclusive. However, only a few of the questions/areas -- such as but not limited to 'dialysis staff encouragement', 'patient satisfaction' and 'energy/fatigue' -- could be expected to be influenced by TM. The results in these three areas/questions showed improvement with TM.

The range of FU was 3-6 months and there was inconsistency in what SC was provided between the studies. It is plausible that the results would show a greater effect of TM with a longer FU time and more consistency between studies regarding SC. Health related QoL and travel time are associated (19). Thus, through longer interventions with fewer in-person consultations, time consumption for patient travel would decrease. Hence, it makes sense that this would positively impact QoL. Furthermore, the meta-analysis for 'dialysis staff encouragement' reached statistical significance (95%). However, for the study not included in the analysis, only the interquartile range suggested that there could be any differences between the groups. This could imply that regular scheduled conversations through TM such as in the two RCTs are important factors regarding the patients sense of 'dialysis staff encouragement'. In the observational study the hospital staff only contacted the patients when

they discovered treatment issues while reviewing the Sharesource platform. Patients differ, thus, it is likely that some patients would not 'trouble' hospital staff regarding 'petty' concerns. However, if asked many might share and feel encouraged by the personal tailored attention from hospital staff.

4.2 Overall completeness and applicability of evidence

The included studies provide a fairly good representation of the typical home dialysis population. However, there could be substantial differences between patients on HHD and PD. Applying the SR findings to contexts other than the ones covered here should be done with caution. The context of the different studies differed and comparing high income-countries to middle-income countries could raise some concerns regarding the organization and quality of healthcare services. The definitions of standard care were divergent, and some studies did not include information regarding SC at all. The TM interventions were also quite different. Comparing the use of a regular phone to modern cloud technology should be done with caution.

4.2.1 Quality of the evidence

Nine studies met my inclusion criteria, most were observational, and all nine studies had some risk of bias. For one outcome, the systematic searches did not yield any eligible studies. Hence, no analysis could be conducted. It was possible to conduct meta-analyses with a combined effect of studies for three of the outcomes. For the last outcome and for two of the three analyses for hospitalization, the results were synthesized narratively. The overall certainty of evidence after the GRADE assessment was very low or low for all outcomes, which means that I have very low or low confidence that the effect estimates are close to the true effect.

4.3 Agreements and disagreements with other studies or reviews

To the best of my knowledge, this is the first SR to systematically assess the effectiveness of TM compared to SC for adult patients with dialysis dependent CKD on home dialysis only, including HHD and PD. The results of my SR suggest a positive effect of TM on hospital days, all-cause hospitalization, disease-specific hospitalization, QoL 'dialysis staff encouragement', QoL 'patient satisfaction', QoL 'energy/fatigue' and technical failure as cause of transfer to a different dialysis modality. Due to low to very low certainty of evidence (GRADE), this review agrees with previous SRs that the body of evidence within this field indicates positive effects, but is insufficient to draw firm conclusions. A review from 2021 (search completed in December 2018) looked at e-health interventions in PD patients only. The authors stated that previous SRs on the topic included a small number of studies, as I have also observed. The authors concluded that the results were inclusive and underscored the need for further research (41). A Cochrane review from 2019 (search completed in January 2019) about e-health interventions to change health behaviours in people with CKD (also included pre-dialysis patients and renal transplant recipients) also reached the same conclusion. As in my SR, both these reviews included FU by regular phone as part of e-health.(43).

4.4 Transferability

As stated, introductory TM FU is expanding its reach in Norway and the outcomes included in this SR are as important in a Norwegian setting as it is in the countries where the included studies were conducted. Furthermore, the Norwegian government want more patients to perform dialysis at home and acknowledge the need for technology to meet the healthcare

demands of the future. The included studies are conducted in countries that are likely to differ from Norway with regards to culture and financing of healthcare. However, the patients suffer from the same disease regardless of context and are treated with similar dialysis equipment. Thus, it is likely that the results could be transferred to a Norwegian setting. Within three studies in this SR, the interventions had limited availability and were likely to be allocated based on needs. Hence, Norwegian primary studies would be an asset to the global body of evidence within this field as Norway has a strong economy relative to our population (65) and limited availability of the intervention is unlikely to be an issue.

4.5 Ethics

Most studies had written consent and were in line with the Helsinki declaration, but not all the studies had such information. In five studies, the main author stated conflict of interest as being an employee or receiving financial support from the company providing the TM technology. This could bias the results as the company and possibly the researcher could face economic gain from results favouring their technology. Thus, harms to patients could be conveniently overlooked, and harmful or ineffective interventions could be adopted, leading to insufficient patient FU. However, no harms were observed in any of the included studies regardless of financial support. See appendix 3 for more details.

In two of the studies, the authors raise concern about TM allocation or state that TM was prioritised to the patients who were believed to benefit the most from it. In one study, this was the patients who lived far from the hospital or had problems with mobilization. This priority is in line with the ethics principle about justice and prioritization of limited resources. These prioritizations in a clinical setting are understandable but could lead to substantial bias of the results from a research perspective.

4.6 Strength and weaknesses of this review

This SR is conducted in line with the Cochrane Handbook for Systematic Reviews of Interventions, which is a strength. It is based on systematic searches planned by the author together with an experienced librarian. These searches were supplemented by hand searches of multiple reference lists of relevant studies. The critical appraisal and GRADE assessments were done in line with international guidelines.

The author is an experienced nurse with long and diverse involvement in the field of nephrology. Coupled with her passion and dedication to the work, this made her able to fully understand the subject matter. The supervisor is experienced in research methodology and her support was a strength for this SR.

The author was working on this SR alone, and it is likely that having a co-author would have increased the methodological quality of the SR. Especially regarding the selection of studies for inclusion, for the critical appraisal and while writing the discussion section of this SR, the discussions a co-author would have yielded would have been a strength to the SR.

In the included studies, SC often included unsystematic phone FU as well as in-person consultations. Phone FU is also a type of TM. It could have offered strength to this SR if the author had decided to include RPM only instead of TM as TM is a very wide term. The systematic search covered the time period 2000-2021, but no relevant studies were found before 2007 and 67% were published in the last five years. It is plausible that this was because the technology is more developed and accessible now than it was 10-20 years ago. However, by including RPM only that would have yielded fewer studies in total. Thus, there would be less data to work with in the analyses.

Only studies in Nordic and English languages were included due to the author's bilingual shortcomings. Hence, studies in other languages were not assessed for eligibility. There could be studies available in other languages than the pre-selected ones, which would have increased the number of primary studies included in this SR if included.

Whenever possible, meta-analyses were conducted, and this adds to the strength of this SR. However, data suitable for meta-analyses were not available for all the outcomes. The author contacted several authors searching for more 'raw' data, but did not receive a reply. To include data from Chaudhuri et al. (56), Sanabria et al. (61), Corzo et al. (57), and Weinhandl & Collins (62), which were not rates, ratios, or the results of matched samples would have increased the statistical power of the analyses and thereby the possibility of identifying effects.

4.7 Implications of research findings

4.7.1 Implications for practice

Overall, the very low to low quality of evidence presented in this review is insufficient to make strong recommendations regarding the use of TM in FU for patients on home dialysis. The evidence suggests a positive effect regarding all outcomes, except infections not requiring hospitalizations where no effect was observed. Thus, it seems wise to offer TM to more patients on home dialysis. However, further research is needed to support or dismiss these findings.

4.7.2 Implications for further research

This SR included patients on both PD and HHD, but only one of the studies that met my inclusion criteria included patients on HHD. Thus, while there is a considerable knowledge

gap concerning the effects of TM both for patients on PD and HHD, the research gap concerning the effect of TM patients on HHD is particularly great.

There is a need for additional research of high methodological quality (preferably RCTs) to determine the effect of TM on several patient-important outcomes, such as but not limited to the ones included in this review. Furthermore, research on the economic impact of TM is needed to assess potential health care cost savings. This research could be in the form of a SR. However, as for the effect of TM in general for this group of patients, more primary studies are in demand. Future studies would benefit from being conducted by researchers without the conflict of interests demonstrated in many of the studies in this SR.

No studies on the outcome 'time patients used for travel' were eligible for inclusion in this SR. As stated introductory, health-related QoL and time patients use for travel are intertwined (19). The value of dialysis free time and reduction of fatigue are recognized by patients as important outcomes (18, 26, 27), which could reflect positively on QoL. Time spent on travel reduces the time patient can spend on rest and more enjoyable aspects of life than dialysis. Hence, future research on the effect of TM FU of patients on home dialysis should include this patient-important outcome. It is reasonable to suspect substantial potential for time-saving for patients if FU is performed from afar.

My inclusion criteria stated that the patients were living at home and performed dialysis independently or with the assistance of a carer. Many patients live in nursing homes worldwide, which could also be defined as the patient's home. Nevertheless, I could not find any research regarding the use of TM to support nursing home staff in assisting patients with their dialysis treatment. To my knowledge, HHD in nursing homes is rare, if at all existing, but PD is common. It is likely that nursing home staff and nurses, in particular, could assist

the patients to a greater extent with the assistance of TM support from specialist nurses at dialysis centres. Hence, this should be investigated further through primary studies as these are frail patients with great need for FU. If TM could be a tool to prevent unnecessary travel, this is likely to offer benefits for these patients.

I would recommend differentiating between TM and RPM in future research, prioritizing RPM as this can offer a modern approach with more extensive treatment data available to healthcare professionals.

4.8 Author's conclusions

This systematic review summarizes and presents results suggesting that there are positive effects of TM FU, in comparison to SC, for patients with CKD who perform dialysis at home. There is very low quality evidence that TM FU for the outcomes hospitalizations and technical failure as the cause for transfer to a different dialysis modality are more effective than SC. Furthermore, there is low quality evidence that TM FU improves QoL by decreasing fatigue when compared to SC. There is low quality evidence that there is no effect on infections not requiring hospitalization. Lastly, there is very low quality evidence that TM FU improves QoL by improving the patients' perception of dialysis staff encouragement and by improving patient satisfaction. No harms of TM for any of the included outcomes were found. Thus, to offer TM FU for home dialysis patients as an alternative to SC appears to be safe and provide health benefits.

If further knowledge on the effect of TM FU for home dialysis patients supports the effectiveness suggested in this review, this intervention could be an important contributor to ensure high quality futuristic patient-centred FU with regards to the world's aging population and increasing demands for nephrology services.

5 References

1. Chen TK, Knicely DH, Grams ME. Chronic Kidney Disease Diagnosis and Management: A Review. JAMA. 2019;322(13):1294-304.
2. Tonelli M, Riella M. Chronic kidney disease and the aging population. Indian journal of nephrology. 2014;24(2):71-4.
3. Waldum-Grevbo B. Kronisk nyresykdom: Store medisinske leksikon; [updated 2020 12.11.; cited 2021 14.03]. Available from: https://sml.snl.no/kronisk_nyresykdom.
4. HelseNorge. Samvalg, Kronisk nyresykdom i endestadiet 2020 [updated 2020 01.05; cited 2021 14.04]. Available from: https://tjenester.helsenorge.no/samvalg/verktoy/kronisk-nyresvikt-i-endestadiet/mitt-valg.
5. Carrero JJ, Hecking M, Chesnaye NC, Jager KJ. Sex and gender disparities in the epidemiology and outcomes of chronic kidney disease. Nat Rev Nephrol. 2018;14(3):151-64.
6. NHI. Kronisk nyresykdom - symptomer og tegn: Norsk Helseinformatikk AS (NHI); [updated 2021 23.03; cited 2021 20.03]. Available from: https://nhi.no/sykdommer/nyrerurinveier/kronisk-nyresykdom/kronisk-nyresykdom-symptomer/.
7. Meld. St. 29 (2016–2017). Perspektivmeldingen 2017: Finansdepartementet; [cited 2021 12.05]. Available from: https://www.regjeringen.no/no/dokumenter/meld.-st.-29-20162017/id2546674/sec8.
8. Meld. St. 7 (2019–2020). Nasjonal helse- og sykehusplan 2020–2023: Helse- og omsorgsdepartementet; [cited 2021 15.05]. Available from: https://www.regjeringen.no/no/dokumenter/meld.-st.-7-20192020/id2678667/.
9. Annual Report: The Norwegian Renal Registry; 2019 [cited 2021 13.05]. Available from: http://www.nephro.no/nnr/A_RSRAPPORT_NNR_2019.pdf.
10. Liyanage T, Ninomiya T, Jha V, Neal B, Patrice HM, Okpechi I, et al. Worldwide access to treatment for end-stage kidney disease: a systematic review. The Lancet. 2015;385(9981):1975-82.
11. Sinnakirouchenan R, Holley JL. Peritoneal dialysis versus hemodialysis: risks, benefits, and access issues. Adv Chronic Kidney Dis. 2011;18(6):428-32.
12. Os I, Waldum-Grevbo B. Dialysebehandling: Store medisinske leksikon; [updated 2021 18.04; cited 2021 20.04]. Available from: https://sml.snl.no/dialysebehandling.
13. Marshall MR, Polkinghorne KR, Kerr PG, Agar JWM, Hawley CM, McDonald SP. Temporal Changes in Mortality Risk by Dialysis Modality in the Australian and New Zealand Dialysis Population. American Journal of Kidney Diseases. 2015;66(3):489-98.
14. Lee SW, Lee NR, Son SK, Kim J, Sul AR, Kim Y, et al. Comparative study of peritoneal dialysis versus hemodialysis on the clinical outcomes in Korea: a population-based approach. Scientific Reports. 2019;9(1):5905.
15. Helsedirektoratet. Nyresvikt - dialysepasienter som får hjemmedialyse: Helsedirektoratet; 2018 [updated 2021 21.05; cited 2021 23.05]. Available from: https://www.helsedirektoratet.no/statistikk/kvalitetsindikatorer/behandling-av-sykdom-og-overlevelse/andel-dialysepasienter-som-har-hjemmedialyse.
16. Wilkie M. Home dialysis-an international perspective. NDT plus. 2011;4(Suppl 3):iii4-iii6.
17. Helsedirektoratet. Handlingsplan for forebygging og behandling av kronisk nyresykdom (2011-2015) 2011 [cited 2021 04.03]. Available from: http://www.nephro.no/foreningsnytt/Handlingsplan_forebygging_behandling_kronisk_nyresykdom.pdf.

18. Urquhart-Secord R, Craig JC, Hemmelgarn B, Tam-Tham H, Manns B, Howell M, et al. Patient and Caregiver Priorities for Outcomes in Hemodialysis: An International Nominal Group Technique Study. American Journal of Kidney Diseases. 2016;68(3):444-54.
19. Moist LM, Bragg-Gresham JL, Pisoni RL, Saran R, Akiba T, Jacobson SH, et al. Travel Time to Dialysis as a Predictor of Health-Related Quality of Life, Adherence, and Mortality: The Dialysis Outcomes and Practice Patterns Study (DOPPS). American Journal of Kidney Diseases. 2008;51(4):641-50.
20. European kidney health alliance. Recommendations for Sustainable Kidney Care 2015 [cited 2021 04.04]. Available from: http://ekha.eu/wp-content/uploads/2016/01/EKHA-Recs-for-Sustainable-Kidney-Care-25.08.2015.pdf.
21. Beaudry A, Ferguson TW, Rigatto C, Tangri N, Dumanski S, Komenda P. Cost of Dialysis Therapy by Modality in Manitoba. Clinical Journal of the American Society of Nephrology. 2018;13(8):1197-203.
22. Pike E HV, Ringerike T, Wisløff T, Desser A, Harboe I, Klemp M. The Health Technology Assessment compare efficacy, safety and cost-effectiveness of the different dialysis modalities: Norwegian Knowledge Centre for the Health Services; 2013 [updated 2016 05.12; cited 2021 12.05]. Available from: https://www.fhi.no/en/publ/2013/health-technology-assessment-of-the-different-dialysis-modalities-in-norway/.
23. Edney LC, Haji Ali Afzali H, Cheng TC, Karnon J. Estimating the Reference Incremental Cost-Effectiveness Ratio for the Australian Health System. PharmacoEconomics. 2018;36(2):239-52.
24. Tong A, Sainsbury P, Carter SM, Hall B, Harris DC, Walker RG, et al. Patients' priorities for health research: focus group study of patients with chronic kidney disease. Nephrology Dialysis Transplantation. 2008;23(10):3206-14.
25. Rygh E, Arild E, Johnsen E, Rumpsfeld M. Choosing to live with home dialysis-patients' experiences and potential for telemedicine support: a qualitative study. BMC Nephrology. 2012;13(1):13-.
26. Evangelidis N, Tong A, Manns B, Hemmelgarn B, Wheeler DC, Tugwell P, et al. Developing a Set of Core Outcomes for Trials in Hemodialysis: An International Delphi Survey. American Journal of Kidney Diseases. 2017;70(4):464-75.
27. Manera KE, Johnson DW, Craig JC, Shen JI, Ruiz L, Wang AY-M, et al. Patient and Caregiver Priorities for Outcomes in Peritoneal Dialysis. Multinational Nominal Group Technique Study. 2019;14(1):74-83.
28. Braut GS. Telemedisin Store medisinske leksikon [updated 2020 15.06; cited 2021 13.03]. Available from: https://sml.snl.no/telemedisin.
29. DelVecchio A. Definition, remote patient monitoring (RPM): Tech target, Search health IT; [updated April 2019; cited 2021 04.03]. Available from: https://searchhealthit.techtarget.com/definition/remote-patient-monitoring-RPM.
30. Choi P, Walker R. Remote Patient Management: Balancing Patient Privacy, Data Security, and Clinical Needs 2019 [cited 2021 20.05]. Available from: https://www.karger.com/DOI/10.1159/000496312.
31. NOU 2021: 4. Norge mot 2025 — Om grunnlaget for verdiskaping, produksjon, sysselsetting og velferd etter pandemien. Chapter 9 Oslo: Finansdepartementet; 2021 [cited 2021 17.05]. Available from: https://www.regjeringen.no/no/dokumenter/nou-2021-4/id2841052/?ch=10#kap9-2.
32. Rajkomar A, Farrington K, Mayer A, Walker D, Blandford A. Patients' and carers' experiences of interacting with home haemodialysis technology: implications for quality and safety. BMC Nephrology. 2014;15(1):195-.

33. Viglino G, Neri L, Barbieri S, Tortone C. Videodialysis: a pilot experience of telecare for assisted peritoneal dialysis. J Nephrol. 2020;33(1):177-82.
34. Ursin L. Pasientautonomi: Store medisinske leksikon; [updated 2021 12.03; cited 2021 15.03]. Available from: https://sml.snl.no/pasientautonomi.
35. Helsedirektoratet. Digitale helsetjenester (e-helse/telemedisin). Kapittel 4.7 Oslo2020 [cited 2021 04.04]. Available from: https://www.helsedirektoratet.no/rapporter/utredning-av-tilbud-til-horselshemmede/drofting-og-vurdering-av-tiltak/digitale-helsetjenester-e-helse-telemedisin.
36. Folkehelseinstituttet. Metodehåndbok- Slik oppsummerer vi forskning 2018 [cited 2021 21.03]. Available from: https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2018/slik-oppsummerer-vi-forskning-2018v2-endret-2021.pdf.
37. Muller AE OS, Jacobsen Jardim PS, Johansen TB, and Berg RC. "Managing chronic illnesses with remote patient monitoring in primary health care: an overview of overviews.": Norwegian Institute of Public Health; 2020 [cited 2021 21.05]. Available from: https://munin.uit.no/bitstream/handle/10037/18802/article.pdf?sequence=3&isAllowed=y.
38. Widmer RJ, Collins NM, Collins CS, West CP, Lerman LO, Lerman A. Digital health interventions for the prevention of cardiovascular disease: a systematic review and meta-analysis. Mayo Clin Proc. 2015;90(4):469-80.
39. Barbosa MT, Sousa CS, Morais-Almeida M, Simões MJ, Mendes P. Telemedicine in COPD: An Overview by Topics. COPD: Journal of Chronic Obstructive Pulmonary Disease. 2020;17(5):601-17.
40. Hu Y, Wen X, Wang F, Yang D, Liu S, Li P, et al. Effect of telemedicine intervention on hypoglycaemia in diabetes patients: A systematic review and meta-analysis of randomised controlled trials. Journal of Telemedicine and Telecare. 2019;25(7):402-13.
41. Cartwright EJ, Z ZSG, Foo M, Chan CM, Htay H, Griva K. eHealth interventions to support patients in delivering and managing peritoneal dialysis at home: A systematic review. Peritoneal Dialysis International. 2021;41(1):32-41.
42. Jhaveri D, Larkins S, Sabesan S. Telestroke, tele-oncology and teledialysis: a systematic review to analyse the outcomes of active therapies delivered with telemedicine support. J Telemed Telecare. 2015;21(4):181-8.
43. Stevenson JK, Campbell ZC, Webster AC, Chow CK, Tong A, Craig JC, et al. eHealth interventions for people with chronic kidney disease. Cochrane Database of Systematic Reviews. 2019(8).
44. François K, Bargman JM. Evaluating the benefits of home-based peritoneal dialysis. Int J Nephrol Renovasc Dis. 2014;7:447-55.
45. Walker RC, Howard K, Morton RL. Home hemodialysis: a comprehensive review of patient-centered and economic considerations. Clinicoecon Outcomes Res. 2017;9:149-61.
46. Higgins JPT TJ, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.2 (updated February 2021): Cochrane; 2021 [cited 2021 13.05]. Available from: www.training.cochrane.org/handbook.
47. Tonelli M, Wiebe N, Guthrie B, James MT, Quan H, Fortin M, et al. Comorbidity as a driver of adverse outcomes in people with chronic kidney disease. Kidney International. 2015;88(4):859-66.
48. Suggested risk of bias criteria for EPOC reviews: Cochrane; 2017 [cited 2021 20.05]. Available from:

https://epoc.cochrane.org/sites/epoc.cochrane.org/files/public/uploads/Resources-for-authors2017/suggested_risk_of_bias_criteria_for_epoc_reviews.pdf.
49. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses: The Ottawa hospital research institute; [cited 2021 21.03]. Available from: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp.
50. Akobeng AK. Understanding systematic reviews and meta-analysis. Archives of Disease in Childhood. 2005;90(8):845.
51. Popay J, Roberts H, Sowden A, Petticrew M, Arai L, Rodgers M, et al. Guidance on the conduct of narrative synthesis in systematic reviews. A product from the ESRC methods programme Version. 2006;1:b92.
52. GRADE: The GRADE Working Group; 2004-2021 [cited 2021 21.03]. Available from: https://www.gradeworkinggroup.org/.
53. Meader N, King K, Llewellyn A, Norman G, Brown J, Rodgers M, et al. A checklist designed to aid consistency and reproducibility of GRADE assessments: development and pilot validation. Systematic Reviews. 2014;3(1):82.
54. GRADEpro software [cited 2021 16.07]. Available from: https://gradepro.org/.
55. Cao F, Li L, Lin M, Lin Q, Ruan Y, Hong F. Application of instant messaging software in the follow-up of patients using peritoneal dialysis, a randomised controlled trial. Journal of Clinical Nursing. 2018;27(15-16):3001-7.
56. Chaudhuri S, Han H, Muchiutti C, Ryter J, Reviriego-Mendoza M, Maddux D, et al. Remote Treatment Monitoring on Hospitalization and Technique Failure Rates in Peritoneal Dialysis Patients. Kidney360. 2020;1(3):191-202.
57. Corzo L, Wilkie M, Vesga JI, Lindholm B, Buitrago G, Rivera AS, et al. Technique failure in remote patient monitoring program in patients undergoing automated peritoneal dialysis: A retrospective cohort study. Perit Dial Int. 2020:896860820982223.
58. Gallar P, Vigil A, Rodriguez I, Ortega O, Gutierrez M, Hurtado J, et al. Two-year experience with telemedicine in the follow-up of patients in home peritoneal dialysis. Journal of Telemedicine & Telecare. 2007;13(6):288-92.
59. Li J, Wang H, Xie H, Mei G, Cai W, Ye J, et al. Effects of post-discharge nurse-led telephone supportive care for patients with chronic kidney disease undergoing peritoneal dialysis in China: A randomized controlled trial. Peritoneal Dialysis International. 2014;34(3):278-88.
60. Milan Manani S, Baretta M, Giuliani A, Virzi GM, Martino F, Crepaldi C, et al. Remote monitoring in peritoneal dialysis: benefits on clinical outcomes and on quality of life. Journal of Nephrology. 2020;33(6):1301-8.
61. Sanabria M, Buitrago G, Lindholm B, Vesga J, Nilsson LG, Yang D, et al. Remote Patient Monitoring Program in Automated Peritoneal Dialysis: Impact on Hospitalizations. Perit Dial Int. 2019;39(5):472-8.
62. Weinhandl ED, Collins AJ. Relative risk of home hemodialysis attrition in patients using a telehealth platform. Hemodial Int. 2018;22(3):318-27.
63. Wong FK, Chow SK, Chan TM. Evaluation of a nurse-led disease management programme for chronic kidney disease: a randomized controlled trial. International Journal of Nursing Studies. 2010;47(3):268-78.
64. Kidney Disease Quality of Life Instrument (KDQOL): The RAND Corporation; [cited 2021 14.05]. Available from: https://www.rand.org/health-care/surveys_tools/kdqol.html.

65. Roser M. Economic Growth Our World in Data2013 [cited 2021 16.07]. Available from: https://ourworldindata.org/economic-growth.

Appendices

Appendix 1: Search strategy in electronic databases

CINAHL

(EBSCO) 1992-2020. Filter: year 2000-2021. Date of completion 13.03-2021

#	Search	Results
1	MH Home dialysis	863
2	((hemodialysis OR haemodialysis OR dialysis) AND home)	1728
3	MH peritoneal dialysis +	3252
4	TI peritoneal dialysis OR haemodialysis OR hemodialysis	11201
5	AB peritoneal dialysis OR hemodialysis OR haemodialysis	12734
6	1 OR 2 OR 3 OR 4 OR 5	18619
7	MH Telehealth +	26305
8	TI telemedicine OR telecare OR telemonitor OR mhealth OR mobile health OR m-health OR mobile app OR mobile application OR remote monitoring OR home monitoring OR telehealth OR ehealth	13371
9	AB telemedicine OR telecare OR telemonitor* OR mhealth OR mobile health OR m-health OR mobile app OR mobile application OR remote monitoring OR home monitoring OR telehealth OR ehealth	16844
10	7 OR 8 OR 9	38476
11	6 AND 10	110

Legend: AB=Abstract; MH=Medical heading; TI=Title

Embase

Classic+Embase 1947 to 2021 February 17 OVID. Filter: year 2000-2021.

Date of completion 14.03-2021

#	Search	Results
1	Emtree Telehealth+	55991
2	(mhealth OR ehealth OR telemedicine OR teledialysis OR telecare OR telecheck* OR teleconsult* OR telefollow* OR telehealth* OR telehome* OR telemanag* OR telemonitor* OR telenursing* OR telepatient* OR telesupport*).ab. OR (mhealth OR ehealth OR telemedicine OR teledialysis OR telecare OR telecheck* OR teleconsult* OR telefollow* OR telehealth* OR telehome* OR telemanag* OR telemonitor* OR telenursing* OR telepatient* OR telesupport*).ti.	32637
3	Ti,Ab, "remote patient mon*"	446
4	1 OR 2 OR 3	58851 (63671)
5	Home dialysis OR peritoneal dialysis OR (hemodialysis AND home) OR (haemodialysis AND home) ab.,ti.	39532
6	Emtree Home dialysis +	3128
7	Emtree Peritoneal dialysis+	46302
8	CAPD or APD or HHD ti.	3557
9	5 OR 6 OR 7 OR 8	54590
10	4 AND 9	215

Legend: Ab=Abstract; APD=Ambulatory peritoneal dialysis; CAPD=Continuous ambulatory peritoneal dialysis; Emtree=Embase subject heading; HHD=Home hemodialysis; Ti=Title

Pubmed

Filter: year 2000-2021. Date of completion 14.03-2021

#	Search	Results
1	Telemedicine MeSH	29842
2	(mhealth[Title/Abstract] OR ehealth[Title/Abstract] OR telemedicine[Title/Abstract] OR teledialysis[Title/Abstract]) OR (telecare[Title/Abstract] OR telecheck*[Title/Abstract] OR teleconsult*[Title/Abstract] OR telefollow*[Title/Abstract] OR telehealth*[Title/Abstract] OR telehome*[Title/Abstract] OR telemanag*[Title/Abstract] OR telemonitor*[Title/Abstract] OR telenursing*[Title/Abstract] OR telepatient*[Title/Abstract] OR telesupport*[Title/Abstract])	31962
3	Phrase search "remote patient mon*"	361
4	1 or 2 or 3	45 710
5	Home dialysis OR peritoneal dialysis OR (hemodialysis AND home) OR (haemodialysis and home)	20871
6	MeSH. Hemodialysis, home	997
7	MeSH. Peritoneal dialysis	13123
8	CAPD[Title/Abstract] OR APD[Title/Abstract] OR HHD[Title/Abstract]	7249
9	5 OR 6 OR 7 OR 8	25406
10	4 AND 9	137

Legends: APD=Ambulatory peritoneal dialysis; CAPD=Continuous ambulatory peritoneal dialysis; HHD=Home hemodialysis; MeSH=Medical subject heading

Appendix 2: Excluded studies read in full text

Excluded studies read in full text (n=52)	Justifications for exclusion
Amici G, Cicero AL, Natale G, Romanini D, Presello F, Zuccolo M, et al. Measured advantages of remote patient monitoring in automated peritoneal dialysis. Nephrology Dialysis Transplantation. 2018;33 (Supplement 1):i202.	Conference abstract No control group
Amici G, D'Angela D, Lo Cicero A, Romanini D, Martino FK, Spandonaro F. Pilot health technology assessment study: organizational and economic impact of remote monitoring system for home automated peritoneal dialysis. Int Urol Nephrol. 2021.	No control group
Ariza JG, Berek S, Rivera A. Puk19 Cost Consequence Analysis of a Remote Monitoring Program for Automated Peritoneal Dyalisis in Us. Value in Health. 2019;22 (Supplement 3):S916.	Conference abstract Not empirical
Ariza JG, Bunch A, Sanabria M, Rivera A, Berek S, Vesga J. Cost Consequence Analysis of a Remote Monitoring Program to Improve Clinical Practice of Automated Peritoneal Dyalisis in Colombia. Value in Health Regional Issues. 2019;19 (Supplement):S82.	Conference abstract Not empirical
Berman SJ, Wada C, Minatodani D, Halliday T, Miyamoto R, Lindo J, et al. Home-based preventative care in high-risk dialysis patients: a pilot study. Telemed J E Health. 2011;17(4):283-7.	Not home dialysis patients
Bieber SD, Weiner DE. Telehealth and Home Dialysis: A New Option for Patients in the United States. Clin J Am Soc Nephrol. 2018;13(8):1288-90.	Laws and regulations for telehealth in the US.
Cafazzo JA, Seto E. The hospital at home: advances in remote patient monitoring. Biomedical Instrumentation & Technology. 2010:47-52.	Review
Cargill A, Watson AR. Telecare support for patients undergoing chronic peritoneal dialysis. Perit Dial Int. 2003;23(1):91-4.	Mostly children
Chand DH, Bednarz D. Daily remote peritoneal dialysis monitoring: An adjunct to enhance patient care. Peritoneal Dialysis International. 2008;28(5):533-7.	Case study (2 patients)
Collidge T, Honeyman B, Stewart S, Allan A, Robinson L, Brown R, et al. Teledialysis: new service technology. Journal of Renal Nursing. 2011;3(3):150-1.	Not home dialysis patients
Corzo L, Vesga J, Sanabria M, Rivera A. Clinical outcomes in remote patient monitoring in automated peritoneal dialysis : A colombian experience. Nephrology Dialysis Transplantation. 2020;35 (SUPPL 3):iii1475.	Conference abstract (About an included study)
Dey V, Jones A, Spalding E. Telehealth technology: A patient centred intervention in peritoneal dialysis. Nephrology Dialysis Transplantation. 2015;30:iii326	Conference abstract, same study as Dey, 2016 without a control group
Dey V, Jones A, Spalding EM. Telehealth: Acceptability, clinical interventions and quality of life in peritoneal dialysis. SAGE Open Med. 2016;4:2050312116670188.	No control group
El Shamy O, Sharma S, Winston J, Uribarri J. Peritoneal Dialysis During the Coronavirus Disease-2019 (COVID-19) Pandemic: Acute Inpatient and Maintenance Outpatient Experiences. Kidney Medicine. 2020;2(4):377-80.	Review
El Shamy O, Tran H, Sharma S, Ronco C, Narayanan M, Uribarri J, et al. Telenephrology with Remote Peritoneal Dialysis Monitoring during Coronavirus Disease 19. Karger AG; 2020. p. 480-2.	Letter about Covid-19 and the impact in kidney care/review
Ersoy FF, Sanli T, Bozkurt N, Bora F, Sari F, Cetinkaya R, et al. An improved CAPD submodality using a new assist device: CAAPD (continuous ambulatory/automated peritoneal dialysis). Nephrology Dialysis Transplantation. 2019;34 (Supplement 1): a530	Conference abstract, no control group

Firanek C, Main C, Rutherford P. Health care professionals' and patients' perceptions of an APD cycler development with remote monitoring: An opportunity to improve standard of care? Nephrology Dialysis Transplantation. 2015; 30:iii269.	Conference abstract, no control group
Gresse S, Ariza JG, Iizuka IJ, Zanetti I, Basso G. Cost Consequence Analysis of a Remote Patient Monitoring Program to Improve Clinical Practice of Automated Peritoneal Dyalisis in Brazil. Value in Health Regional Issues. 2019;19 (Supplement):S82-S3.	Estimations based on literature, simulated patients and statistics
Harnett P, Jones M, Almond M, Ballasubramaniam G, Kunnath V. A virtual clinic to improve long-term outcomes in chronic kidney disease. Clinical Medicine, Journal of the Royal College of Physicians of London. 2018;18(5):356-63.	Not home dialysis patients
Harrington DM, Myers L, Karen E, Bhise V, Nayak KS, Rosner MH. The use of a tablet computer platform to optimize the care of patients receiving peritoneal dialysis: A pilot study. Blood Purification. 2014;37(4):311-5.	No control group
Hjelm NM. Benefits and drawbacks of telemedicine. Journal of Telemedicine and Telecare. 2005;11(2):60-70.	Review
Huang R, Liu N, Nicdao MA, Mikaheal M, Baldacchino T, Albeos A, et al. Emotion sharing in remote patient monitoring of patients with chronic kidney disease. J Am Med Inform Assoc. 2020;27(2):185-93.	No control group and wrong outcome
Hueso M, De Haro L, Calabia J, Dal-Re R, Tebe C, Gibert K, et al. Leveraging Data Science for a Personalized Haemodialysis. Kidney Diseases. 2020;6(6):385-94.	Review
Iannuzzella F, Stefani A, Corradini M, Pasquali S. Evaluation of a telemonitoring system based on a mobile medical app in a cohort of peritoneal dialysis patients: A pilot study. Nephrology Dialysis Transplantation. 2016;31:i241.	Short English summary of an article I think is in Italian, there does not seem to be a control group
Ibrahim A, Chan CT. Managing kidney failure with home hemodialysis. Clinical Journal of the American Society of Nephrology. 2019;14(8):1268-73.	Practical guide for HHD
Kaldoudi E, Passadakis P, Panagoutsos S, Vargemezis V. Homecare telematics for peritoneal dialysis. Journal on Information Technology in Healthcare. 2007;5(6):372-8.	Review
Kiberd J, Khan U, Stockman C, Radhakrishnan A, Phillips M, Kiberd BA, et al. Effectiveness of a Web-Based eHealth Portal for Delivery of Care to Home Dialysis Patients: A Single-Arm Pilot Study. Can J Kidney Health Dis. 2018;5:2054358118794415.	No control group
Minatodani DE, Berman SJ. Home telehealth in high-risk dialysis patients: a 3-year study. Telemed J E Health. 2013;19(7):520-2.	Not home dialysis patients
Mitchell JG, Disney AP, Roberts M. Renal telemedicine to the home. J Telemed Telecare. 2000;6(1):59-62.	Case report
Milan Manani S, Crepaldi C, Giuliani A, Virzi GM, Garzotto F, Riello C, et al. Remote Monitoring of Automated Peritoneal Dialysis Improves Personalization of Dialytic Prescription and Patient's Independence. Blood Purification. 2018;46(2):111-7.	No control group
Milan Manani S, Rosner MH, Virzì GM, Giuliani A, Berti S, Crepaldi C, et al. Longitudinal Experience with Remote Monitoring for Automated Peritoneal Dialysis Patients. Nephron. 2019;142(1):1-9.	No control group
Mitra S, Cress C, Goovaerts T. Workforce development and models of care in home hemodialysis. Hemodialysis International. 2015;19(S1):S43-S51.	Review
Musso CG, Plazzotta F, Otero C, Aguilera J, Campos F, Diez GR, et al. Informatic nephrology: 17 years of one-center experience. International Urology and Nephrology. 2015;47(9):1587-8.	Letter
Nakamoto H, Hatta M, Tanaka A, Moriwaki K, Oohama K, Kagawa K, et al. Telemedicine system for home automated peritoneal dialysis. Adv Perit Dial. 2000;16:191-4.	No control group

Nakamoto H, Kawamoto A, Tanabe Y, Nakagawa Y, Nishida E, Akiba T, et al. Telemedicine system using a cellular telephone for continuous ambulatory peritoneal dialysis patients. Adv Perit Dial. 2003;19:124-9.	No control group
Nayak A, Karopadi A, Antony S, Sreepada S, Nayak KS. Use of a Peritoneal Dialysis Remote Monitoring System in India. Peritoneal dialysis international. 2012;32(2):200-4.	Comparing RPM in rural and RPM in urban patients
Nayak Karopadi A, Antony S, Subhramanyam SV, Nayak KS. Remote monitoring of peritoneal dialysis: Why? Where? How? Hong Kong Journal of Nephrology. 2013;15(1):6-13.	Comparing RPM in rural and RPM in urban patients
Nayak KS, Ronco C, Karopadi AN, Rosner MH. Telemedicine and Remote Monitoring: Supporting the Patient on Peritoneal Dialysis. Perit Dial Int. 2016;36(4):362-6.	No control groups, summary from three different studies
Patterson P. Telehealth for Home Dialysis Therapies. Nephrol Nurs J. 2017;44(6):545-8.	An interview with a doctor
Polanco E, Aquey M, Collado J, Campos E, Guzman J, Cuevas-Budhart MA, et al. A COVID-19 pandemic-specific, structured care process for Peritoneal Dialysis patients facilitated by Telemedicine: therapy continuity, prevention and complications management. Therapeutic apheresis and dialysis : official peer-reviewed journal of the International Society for Apheresis, the Japanese Society for Apheresis, the Japanese Society for Dialysis Therapy. 2021.	No control group
Psarros G, McElduff P. PUK3 Cost Consequence Analysis of Remote Monitoring with the Homechoice Claria with Sharesource Platform for Automated Peritoneal Dialysis Patients in the Australian Setting. Value in Health Regional Issues. 2020;22 (Supplement):S108.	Cost analysis based on hospitalization rate from included study
Rodriguez-Palomares JR, Sanchez-Heras M, Gaitan D, Nieto I, Zapata AP, De Arriba G. Remote monitoring of automated peritoneal dialysis. improving quality of treatment for patients. Nephrology Dialysis Transplantation. 2019;34 (Supplement 1):a239.	Conference abstract, no control group
Ronco C, Manani SM, Giuliani A, Tantillo I, Reis T, Brown EA. Remote patient management of peritoneal dialysis during COVID-19 pandemic. Perit Dial Int. 2020;40(4):363-7.	Review
Scarpioni R, Manini A, Chiappini P. Remote patient monitoring in peritoneal dialysis helps reduce risk of hospitalization during Covid-19 pandemic. J Nephrol. 2020;33(6):1123-4.	There are patients with RPM and without, but they are not compared
Sicotte C, Moqadem K, Vasilevsky M, Desrochers J, St-Gelais M. Use of telemedicine for haemodialysis in very remote areas: the Canadian First Nations. Journal of Telemedicine & Telecare. 2011;17(3):146-9.	No control group
Tangaro S, Fanizzi A, Amoroso N, Corciulo R, Garuccio E, Gesualdo L, et al. Computer aided detection system for prediction of the malaise during hemodialysis. Computational and Mathematical Methods in Medicine. 2016;2016 (no pagination).	No control group without TM
Theodoridis M, Kaldoudi E, Thodis E, Panagoutsos S, Kantartzi K, Passadakis P, et al. Peritoneal dialysis monitoring and management at the point of need. NDT Plus. 2010;3:iii170.	No control group
Uchiyama K, Washida N, Yube N, Kasai T, Shinozuka K, Morimoto K, et al. The impact of a remote monitoring system of healthcare resource consumption in patients on automated peritoneal dialysis (APD): A simulation study. Clinical Nephrology. 2018;90(5):334-40.	Simulated patients
Viglino G, Neri L, Barbieri S, Tortone C. Videodialysis: a pilot experience of telecare for assisted peritoneal dialysis. J Nephrol. 2020;33(1):177-82.	Not the outcome of interest
Weinhandl E, Kraus M. Treatment Adherence and Technique Failure Risk in Home Hemodialysis Patients. American Journal of Kidney Diseases. 2019;73 (5):745-6.	Conference abstract, same as included study
Wood E, McCarthy K, Roper M. Remote monitoring of peritoneal dialysis: evaluating the impact of the Claria Sharesource system. Journal of Kidney Care. 2019;4(1):16-24.	No control group

Yeter HH, Karacalik C, Eraslan E, Akcay OF, Derici U, Ronco C. Effect of remote patient management in peritoneal dialysis on haemodynamic and volume control. Nephrology. 2020;25(11):856-64.	No pre intervention assessment

Appendix 3: Characteristics of the included studies and risk of bias

Cao 2018

Publication	**Cao F, Li L, Lin M, Lin Q, Ruan Y, Hong F. Application of instant messaging software in the follow-up of patients using peritoneal dialysis, a randomised controlled trial. Journal of Clinical Nursing. 2018;27(15-16):3001-7.**
Methods	RCT, mean 11.4 months follow-up
Aim	*"to investigate the application value of Internet-based instant messaging software in the follow-up of patients using peritoneal dialysis"* (p. 3001)
Participants	Sample size: 160 Recruitment: Patients on CAPD between January 2009–April 2016, were included in the study by the convenience sampling method. Inclusion criteria: on PD due to CKD; older than 18 years of age Exclusion criteria: recent episodes of peritonitis and other infectious diseases, active malignant disease, hearing impairment, mental illness or cognitive impairment, unable to provide written informed consent or severe cardiovascular complications Gender: 58% male Age mean: 52 Setting: 1 PD centre in Fujian, China
Intervention	Intervention: Instant messaging software, named the "Kidney cleaning group". Technical support, nurse support, physician support and support from fellow patients was available through chat and video. The patients were also divided in smaller chat groups with one experienced PD patient with little complications in charge of the group. Educational resources were also available in the platform. The group seam to also have SC at the same level as the control group
Comparison	SC. Weekly in person FU and phone FU by a specialist nurse.
Outcome	Hospitalisation measured by count/numbers. Infection (peritonitis & exit-site) measured by rate & count/numbers
Ethics	The study was approved by the local institutional review board and complies with the Declaration of Helsinki. Informed consent was obtained from all study participants.
Notes	

RISK OF BIAS ASSESMENT, RCT: Cao, 2018

Bias	**Author's judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	A random number table was used to randomly assign the 160 participants to the QQ follow-up group and the traditional follow-up group, with 80 patients in each group
Allocation concealment (selection bias)	Unclear risk	No information provided
Blinding of participants and personnel (performance bias)	Unclear risk	Unlikely due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	The clinical data and parameters were collected by a research nurse every 3 months, no information regarding blinding.
Incomplete outcome data (attrition bias)	Unclear risk	Unclear information regarding drop-out, for one outcome the whole sample is reported without drop-out, but for another 10 and 15 patients were lost to FU
Selective reporting (reporting bias)	Unclear risk	No mentioning of pre-registered protocol, however there are no reason to suspect that all outcomes are not reported
Other bias	Low risk	Not detected

Chaudhuri 2020

Publication	**Chaudhuri S, Han H, Muchiutti C, Ryter J, Reviriego-Mendoza M, Maddux D, et al. Remote Treatment Monitoring on Hospitalization and Technique Failure Rates in Peritoneal Dialysis Patients. Kidney360. 2020;1(3):191-202.**
Methods	Retrospective Cohort study, 12 months follow-up
Aim	To assess if RPM utilization was associates with hospitalization and technique failure rates
Participants	Sample size: 6343 Recruitment: Data from PD patients (age 18 years or older) treated anytime during October 1, 2016–May 31, 2019. Data from all patients on PD that fit the inclusion criteria Inclusion criteria: registered online and created an RTM account on or before May 31, 2018. Treated continuously with PD for at least 30 days after registration and not hospitalized within 30 days after registration. Exclusion criteria: body mass index .65 kg/m2. Patients with missing data for any covariates used for the adjustment of the analysis Gender: Men 73% Age mean: 57 Setting: The dialysis organization (Fresenius Kidney Care, Waltham, MA) of a large integrated kidney disease healthcare company (Fresenius Medical Care, Bad Homburg, Germany). 931 clinics
Intervention	Intervention: "Patient hub" application. The patients can see their prescription, laboratory results and enter treatment data. The app transmits data to health care providers. The data is reviewed daily on business days. The patients also had SC.
Comparison	Non-users (registered but never entered data). SC was monthly in person review of the patient paper records.
Outcome	Hospital admission counts per patient year (PPY). Hospital days PPY. Sustained technique failure counts (PPY) defined as PD complications that required patients to receive .6 consecutive weeks of HD.
Ethics	"This analysis was performed under a protocol that was reviewed by New England Independent Review Board who determined it was an exempt assessment of existing patient data from a quality improvement process, which was anonymized and did not require informed consent per title 45 of the United States Code of Federal Regulations part 46.102 (1-9652-1; New England Independent Review Board, Needham Heights, MA).The analysis was conducted in adherence with the Declaration of Helsinki"(p 193).
Notes	*"Neither the RTM nor the electronic medical record captured data on interventions performed due to findings from RTM entries, so we are not able to assess if interventions are being performed in a more timely manner before monthly clinic visits"* (p 200). The authors are employed by Fresenius medical care and three of them also have ownership.

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE

COHORT STUDIES: Chaudhuri 2020 Authors judgement Good quality

Selection

1) Representativeness of the exposed cohort

a) truly representative of the average (describe) in the community *****

b) somewhat representative of the average US, PD patient (frequent users tended to more often be of a white race, non-Hispanic ethnicity, educated, and had a shorter dialysis vintage) in the community *****

c) selected group of users eg nurses, volunteers

d) no description of the derivation of the cohort

2) Selection of the non exposed cohort

a) drawn from the same community as the exposed cohort *****

b) drawn from a different source

c) no description of the derivation of the non exposed cohort

3) Ascertainment of exposure

a) secure record (eg surgical records) *****

b) structured interview *****

c) written self report

d) no description
4) Demonstration that outcome of interest was not present at start of study
a) yes *
b) no
Comparability
1) Comparability of cohorts on the basis of the design or analysis
a) study controls for age *
b) study controls for any additional factor race *
Outcome
1) Assessment of outcome
a) independent blind assessment *
b) record linkage *
c) self report
d) no description
2) Was follow-up long enough for outcomes to occur
a) yes (select an adequate follow up period for outcome of interest) 12 months *
b) no
3) Adequacy of follow up of cohorts
a) complete follow up - all subjects accounted for *
b) subjects lost to follow up unlikely to introduce bias - small number lost - > ____ % (select an adequate %) follow up, or description provided of those lost) *
c) follow up rate < ____% (select an adequate %) and no description of those lost
d) no statement

Corzo 2020

Publication	**Corzo L, Wilkie M, Vesga JI, Lindholm B, Buitrago G, Rivera AS, et al. Technique failure in remote patient monitoring program in patients undergoing automated peritoneal dialysis: A retrospective cohort study. Perit Dial Int. 2020:896860820982223.**
Methods	Retrospective Cohort Study, mean 8.3 months follow-up
Aim	To assess association between RPM use and APD technical failure
Participants	Sample size: 558 Recruitment: Prevalent APD patients (1 October 2016-30 June 2017 with follow up until 30 June 2018). TM was assigned to consecutive patients based on limited availability. Inclusion criteria: 18 years or older, diagnosis of kidney failure, treated with APD for more than 90 days Exclusion criteria: pregnancy, dialysis due to non-kidney indication such as congestive heart failure or liver cirrhosis Gender: 60% male Age mean: 54 Setting: five urban renal centres close to the capital of Colombia, chosen by convenience. The centres had at least 10 APD patients on TM and patients without
Intervention	Claria Sharesource from Baxter. Same program as Milan, 2020 and Sanabria, 2019. The software collects treatment data and transmits it to the health care providers, and the prescription can be changed “from afar”. The share source patients can add some data themselves such as blood pressure and weight. The PD nurses check the platform daily. The physicians review treatments with significant issues daily and a weekly check of treatments without serious problems.
Comparison	Monthly in person FU
Outcome	Technical failure defined as switch to HD for at least 30 days. Reported as a rate and ratio.
Ethics	Data obtained from Versia, Baxter, Spain electronic medical records. Individual consent from participants. Protocol approved by the clinical research committee of RTS, Colombia.
Notes	A propensity score was used to create a pseudo-population and the baseline covariates were well balanced. Report results from a matched sample Could be bias from scares telemedicine and local prioritizing

	Funding: Renal therapy services, Colombia

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE
COHORT STUDIES: Corzo 2020 Authors judgement Good quality

Selection

1) Representativeness of the exposed cohort
   a) truly representative of the average (describe) in the community *****
   b) somewhat representative of the average APD patient in the community *****
   c) selected group of users eg nurses, volunteers
   d) no description of the derivation of the cohort
2) Selection of the non exposed cohort
   a) drawn from the same community as the exposed cohort *****
   b) drawn from a different source
   c) no description of the derivation of the non exposed cohort
3) Ascertainment of exposure
   a) secure record (eg surgical records) *****
   b) structured interview *****
   c) written self report
   d) no description
4) Demonstration that outcome of interest was not present at start of study
   a) yes *****
   b) no

Comparability

1) Comparability of cohorts on the basis of the design or analysis
   a) study controls for age *****
   b) study controls for any additional factor gender *****

Outcome

1) Assessment of outcome
   a) independent blind assessment *****
   b) record linkage *****
   c) self report
   d) no description
2) Was follow-up long enough for outcomes to occur
   a) yes (select an adequate follow up period for outcome of interest) at least 1 year *****
   b) no
3) Adequacy of follow up of cohorts
   a) complete follow up - all subjects accounted for □
   b) subjects lost to follow up unlikely to introduce bias - A flowchart describes the dropout, it is good reasons and there is still an adequate number of patients left in both groups *****
   c) follow up rate < ____% (select an adequate %) and no description of those lost
   d) no statement

Gallar 2007

Publication	**Gallar P, Vigil A, Rodriguez I, Ortega O, Gutierrez M, Hurtado J, et al. Two-year experience with telemedicine in the follow-up of patients in home peritoneal dialysis. Journal of Telemedicine & Telecare. 2007;13(6):288-92.**
Methods	Controlled before and after study, mean 8 months follow-up
Aim	*"to evaluate the use of telemedicine in the long-term control of stable patients undergoing PD"*(p. 288)
Participants	Sample size: 57 Recruitment: September 2003 to August 2005, patients were randomly selected from current cases and invited to join the study group. The patients that declined to join the intervention group were placed in the control group. Inclusion criteria: Not stated, but the summary says"stable patients undergoing peritoneal dialysis at home".

	Exclusion criteria: Not stated Gender: 60% male Age mean: 47 Setting: Not stated, but likely to be in one clinic in Madrid, Spain
Intervention	Alternatively monthly FU in the hospital and by video conference. If more FU was needed it was done by TM. The video conference equipment was installed in the hospital and in the patient's home. During the TM consultation the patient's PD technique, exit site care and early signs and treatment of peritonitis was addressed with a PD nurse. The nurse would ask the patients questions about possible difficulties.
Comparison	Does not say anything about SC, but it is likely to be monthly in person as the TM group received alternatively monthly in person and TM FU. No information about the control group except from outcome hospitalization and that they had a slightly not significant higher Charlson's co-morbidity index (P 0,58).
Outcome	Hospitalization days measured as a rate
Ethics	Approved by ethics committee. Cases signed a written consent
Notes	Grant Support was received from Fondo de Investigacio´n Sanitaria (FIS) and Baxter Health Corporation

Risk of bias assessment, EPOC, Controlled before and after study

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation	High risk	The patients that refused to join the intervention group were placed in the control group
Allocation concealment	High risk	Not enough information, but unlikely
Baseline outcome measurements similar	Unclear risk	Limited information about the control group
Baseline characteristics similar	Unclear risk	Very limited information about the control group
Incomplete outcome data	Unclear risk	No information about 'drop outs'
Knowledge of the allocated interventions adequately prevented during the study	Unclear risk	Unlikely due to the nature of the intervention
Protection against contamination	Low risk	The control group did not receive the intervention
Selective outcome reporting	Unclear risk	No information about a pre-registered protocol
Other risks of bias	Unclear risk	Not clear if the financial support received could raise concern about bias

Li 2014

Publication	**Li J, Wang H, Xie H, Mei G, Cai W, Ye J, et al. Effects of post-discharge nurse-led telephone supportive care for patients with chronic kidney disease undergoing peritoneal dialysis in China: A randomized controlled trial. Peritoneal Dialysis International. 2014;34(3):278-88.**
Methods	RCT, 3 months follow-up
Aim	*"to test the effectiveness of postdischarge nurse-led telephone support on patients with peritoneal dialysis in mainland China"* (p. 278)
Participants	Sample size: 135 Recruitment: PD patients were sequentially recruited over 18 months in 2010 – 2012. Inclusion criteria: Mandarin-speaking, able to communicate and access a telephone after discharge and agreed to participate Exclusion criteria: on intermittent peritoneal dialysis or HD, with planned admissions for special treatment procedures, with Tenckhoff catheters in situ for less than three months (because the adaptation period required to adjust to the new treatment regimen may bias quality of life measurements). Patients with psychosis or dementia, patients who are dying or unable to communicate, and those who have been transferred to another unit during their stay in hospital. Gender: 59% male Age mean: 56 Setting: renal unit of two local regional hospitals in Guangdong province, China
Intervention	Intervention: Similar as Wong, 2010. Nurse led disease management program where phone calls were made every week for 6 weeks. Structured format of calls included follow up of issues raised at the last call. At baseline, a nurse conducted an initial assessment with the patient based on the omaha system (originally used in USA for community health nursing practice). The system was adopted for the CKD patients and used as framework. There are four dimensions to the Omaha system, environmental, psychological, psychosocial and health-relates behaviours. Patients also received SC.
Comparison	The control group received a conversation with the doctor about special points that needed attention when returning home, a telephone hotline service, a set of free self-help printed materials on maintaining healthy lifestyles and a reminder to attend their outpatient clinic appointment. It was not clear how often these outpatient clinic appointments were.
Outcome	Measured at baseline, after 6 weeks and after 12 weeks. Hospitalization measured in rates Infection (peritonitis, catheter infection, exit site condition) measured by observation QoL-Instrument KDQOL
Ethics	Written consent. Approved by the local research ethics committees, it was in accordance with the Helsinki declaration. Participants were reassured that their decision to participate or not participate in the study would not affect the care they normally received, the information would be kept confidential and anonymous, and they reserved the right to withdraw from the study at any time.
Notes	Short intervention

RISK OF BIAS ASSESMENT, RCT: LI, 2014		
Bias	**Authors' judgment**	**Support for judgment**
Random sequence generation (selection bias)	Low risk	The patients were assigned to the study or control group using fifty sets of computer-generated random numbers
Allocation concealment (selection bias)	Unclear risk	No information available
Blinding of participants and personnel (performance bias)	Unclear risk	Do not mention, but likely not to be blinded because of the nature of the intervention

Blinding of outcome assessment (detection bias)	Unclear risk	Hospital records, but also some self-reporting on some of the outcomes
Incomplete outcome data (attrition bias)	Unclear risk	Dropout (13.7% to 17.5%), reasons for dropout similar in both groups. Only patients with full data were included in the analysis
Selective reporting (reporting bias)	Unclear risk	No mentioning of pre-registered protocol. For some of the outcomes only significance of results was reported without data
Other bias	Low risk	Not detected

Milan 2020

Publication	**Milan Manani S, Baretta M, Giuliani A, Virzi GM, Martino F, Crepaldi C, et al. Remote monitoring in peritoneal dialysis: benefits on clinical outcomes and on quality of life. Journal of Nephrology. 2020;33(6):1301-8.**
Methods	Retrospective Cohort study, 6 months follow-up
Aim	To compare *"clinical outcomes and quality of life (QoL) in two group of patients undergoing APD, with and without exposure of RPM"*. (p. 1301)
Participants	Sample size: 73 Recruitment: All APD patients in the centre in the time period 01.03.2019 to 30.08.2019 Inclusion criteria: 18 years or older and treated for more than 3 months Exclusion criteria: Not stated Gender: 75% male Age median: 60 Setting: PD centre at San Bortolo Hospital, in Vicenza, Italy
Intervention	Claria™, connected to Sharesource platform, Baxter and home bridge Connectivity PD, Fresesenius. The software collects treatment data and transmits it to the health care providers, and the prescription can be changed "from afar". The share source patients can add some data themselves such as blood pressure and weight. The PD nurses check the platform daily. The physicians review treatments with significant issues daily and a weekly check of treatments without serious problems. It is not stated if the patients also received SC.
Comparison	In person FU every three months reviewing the treatment history on their card, or at the hospital if there was an unplanned visit, or FU by phone when needed
Outcome	Hospital days as median Hospitalization as number of hospitalizations Hospitalization by overhydration, infection or access dysfunction as number of disease specific hospitalizations Technical failure as cause for transfer to different dialysis modality Quality of life measured by KDQOL and four additional PD specific questions
Ethics	In accordance with the Helsinki Declaration. The protocol and consent form were approved by the Ethics Committee of San Bortolo Hospital. Written informed consent by all patients.
Notes	Biased by prioritizing the interventions to the patients that lived far from the hospital or that had mobility problems

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE
COHORT STUDIES: Milan, 2020 Authors judgement Fair quality

Selection

1) Representativeness of the exposed cohort
   a) truly representative of the average _____ (describe) in the community *****
   b) somewhat representative of the average _____ in the community *****
   c) selected group of users, they gave RM to the patients that lived far away or had difficulty in moving
   d) no description of the derivation of the cohort
2) Selection of the non exposed cohort
   a) drawn from the same community as the exposed cohort *****
   b) drawn from a different source
   c) no description of the derivation of the non exposed cohort
3) Ascertainment of exposure
   a) secure record (eg surgical records) *****
   b) structured interview *****
   c) written self report
   d) no description
4) Demonstration that outcome of interest was not present at start of study
   a) yes *****
   b) no

Comparability

1) Comparability of cohorts on the basis of the design or analysis
   a) study controls for (select the most important factor) *****
   b) study controls for any additional factor * (This criteria could be modified to indicate specific control for a second important factor.)

Outcome

1) Assessment of outcome
   a) independent blind assessment *****
   b) record linkage *****
   c) self report
   d) no description
2) Was follow-up long enough for outcomes to occur
   a) yes (6 months) *****
   b) no
3) Adequacy of follow up of cohorts
   a) complete follow up - all subjects accounted for *****
   b) subjects lost to follow up unlikely to introduce bias - 4 in each group, well explained *****
   c) follow up rate < ____% (select an adequate %) and no description of those lost
   d) no statement

Sanabria 2019

Publication	**Sanabria M, Buitrago G, Lindholm B, Vesga J, Nilsson LG, Yang D, et al. Remote Patient Monitoring Program in Automated Peritoneal Dialysis: Impact on Hospitalizations. Perit Dial Int. 2019;39(5):472-8.**
Methods	Retrospective cohort study, mean 9 months follow-up
Aim	*"to evaluate the association of RPM exposure with numbers of hospitalizations and hospital days"*. (p. 472)
Participants	Sample size: 360 Recruitment: "Patients were selected at all BRCS units located in cities where RPM was introduced" (p 473). Inclusion criteria: "1) both genders, age 18 years or older; 2) diagnosis of ESRD; 3) being an incident patient on home-based APD therapy (defined as undergoing the first 90 days of APD therapy); and 4) initiation of APD between 1 October 2016 and 30 June 2017"(p 473).

	Exclusion criteria: *"1) pregnancy; 2) life expectancy of less than 6 months; and 3) ESRD comorbidity index (ESRD-CI)* > 8"(p 473). Gender: 66% male Age mean: 57 Setting: 28 urban Baxter renal care centres, Colombia
Intervention	Claria sharesource from Baxter, the same as in Corzo, 2020 and Milan, 2020. The software collected treatment data and transmitted it to the health care providers, and the prescription could be changed "from afar". The share source patients could add some data themselves such as blood pressure and weight. The PD nurses checked the platform daily. The physicians reviewed treatments with significant issues daily and a weekly check of treatments without serious problems.
Comparison	Monthly in person
Outcome	Hospitalizations per patient-year Hospital days per patient-year
Ethics	The study was approved by an ethics research committee
Notes	Authors are employed and/or received financial support from Baxter The authors acknowledge that subjective considerations could bias the results as the patients where not randomized. RPM device was assigned to consecutive patients according to the (limited) availability. No specific clinical criterion was set for the allocation of a patient to the RPM program.

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE
COHORT STUDIES: Sanabria 2019 Authors judgement Good quality

Selection

1) Representativeness of the exposed cohort
   a) truly representative of the average APD patient in the community *****
   b) somewhat representative of the average urban incidence APD patients in Colombia *****
   c) selected group of users eg nurses, volunteers
   d) no description of the derivation of the cohort
2) Selection of the non exposed cohort
   a) drawn from the same community as the exposed cohort *****
   b) drawn from a different source
   c) no description of the derivation of the non exposed cohort
3) Ascertainment of exposure
   a) secure record (eg surgical records) *****
   b) structured interview *****
   c) written self report
   d) no description
4) Demonstration that outcome of interest was not present at start of study
   a) yes *****
   b) no

Comparability

1) Comparability of cohorts on the basis of the design or analysis
   a) study controls for age *****
   b) study controls for any additional factor mean comorbidity index *****

Outcome

1) Assessment of outcome
   a) independent blind assessment *****
   b) record linkage *****
   c) self report
   d) no description
2) Was follow-up long enough for outcomes to occur
   a) yes (select an adequate follow up period for outcome of interest) 1 year *****
   b) no
3) Adequacy of follow up of cohorts
   a) complete follow up - all subjects accounted for *****
   b) subjects lost to follow up unlikely to introduce bias – RPM 14% and SC 19% this is a lot, but it is well explained (censored due to technical failure or death) *****

c) follow up rate < ____% (select an adequate %) and no description of those lost d) no statement

Weinhandl 2018

Publication	**Weinhandl ED, Collins AJ. Relative risk of home hemodialysis attrition in patients using a telehealth platform. Hemodialysis International. 2018;22(3):318-27.**
Methods	Retrospective cohort study, mean 11 months follow-up
Aim	*"to assess whether use of Nx2me was associated with risk of HHD attrition"* (p. 318)
Participants	Sample size: 2424 Recruitment: Data collected by NxStage Medical. 606 Nx2me users were identified. 49.5% initiated use of Nx2me in <3 months after initiation of of HHD with NxStage equipment. 2000 cohorts of matched control patients were constructed. Inclusion criteria: Users of Nx2me with NxStage HHD Exclusion criteria: Not stated Gender: 63% male Age mean: 53 Setting: Multicentre, 55 clinics across the USA that offered NxStage home hemodialysis
Intervention	Intervention: HHD, Nx2me telehealth platform. The software collected treatment data and transmitted it to the health care providers. Real life "troubleshooting" was possible if the patients had problems during treatment.
Comparison	SC monthly in person review of paper file
Outcome	Technical failure measured and presented in many different tables as HR etc.
Ethics	No statement
Notes	The structure of the publication is confusing. Authors are NxStage employees

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE
COHORT STUDIES: Weinhandl 2018 Authors judgement Good quality

Selection

1) Representativeness of the exposed cohort
   a) truly representative of the average (describe) in the community *****
   b) somewhat representative of the average HHD patient doing dialysis with Nxstage equipment , slightly younger and more likely to be black in the community *****
   c) selected group of users eg nurses, volunteers
   d) no description of the derivation of the cohort
2) Selection of the non exposed cohort
   a) drawn from the same community as the exposed cohort *****
   b) drawn from a different source
   c) no description of the derivation of the non exposed cohort
3) Ascertainment of exposure
   a) secure record (eg surgical records) *****
   b) structured interview *****
   c) written self report
   d) no description
4) Demonstration that outcome of interest was not present at start of study
   a) yes *****
   b) no

Comparability

1) Comparability of cohorts on the basis of the design or analysis
   a) study controls for age (select the most important factor) *****
   b) study controls for any additional factor sex *****

1) Assessment of outcome
   a) independent blind assessment □
   b) record linkage *****
   c) self report
   d) no description

2) Was follow-up long enough for outcomes to occur
a) yes (select an adequate follow up period for outcome of interest) Mean follow up time is not stated, but there are many patients yielding many patients years all together*
b) no
3) Adequacy of follow up of cohorts
a) complete follow up - all subjects accounted for □
b) subjects lost to follow up unlikely to introduce bias - small number lost - > ____ % (select an adequate %) follow up, or description provided of those lost) □
c) follow up rate < ____% (select an adequate %) and no description of those lost
d) no statement

Wong 2010

Publication	**Wong FK, Chow SK, Chan TM. Evaluation of a nurse-led disease management programme for chronic kidney disease: a randomized controlled trial. International Journal of Nursing Studies. 2010;47(3):268-78.**
Methods	RCT, 3 months follow-up
Aim	To *"examine whether a disease management approach to managing the chronic kidney disease group would help enhance health outcomes"* (p. 269)
Participants	Sample size: 94 Recruitment: All patients who were on CAPD returning to the centres for clinical follow-up were invited to participate in the study. Inclusion criteria: Communicable, alert and oriented, could be contacted by telephone at home, lived in the hospital service area Exclusion criteria: On intermittent peritoneal dialysis or haemodialysis, Old-age home residents Gender: 53% male Age mean: 62 Setting: two renal centres of a hospital cluster in Hong Kong
Intervention	Nurse led disease management program where phone calls were made every week for 6 weeks. In addition, the doctor called after 4 weeks and after the 6 weeks was over to review health goals, offer advice and close the case. Structured format of calls included follow up of issues raised at the last call. At baseline, a nurse conducted an initial assessment with the patient based on the omaha system (originally used in USA for community health nursing practice). The system was adopted for the CKD patients and used as framework. There are four dimensions to the Omaha system, environmental, psychological, psychosocial and health-relates behaviours. Patients also received SC.
Comparison	SC. Instructions on medications and basic health advice. No information about the frequency of in person FU
Outcome	Measured QoL at baseline, after 7 weeks and after 13 weeks Instrument: KDQOL
Ethics	Written consent form. The patients were free to withdraw from the study at anytime, and they were reassured that the decision whether or not to participate in the study would not prevent them from receiving the care that they would normally receive.
Notes	Short intervention

RISK OF BIAS ASSESMENT, RCT: Wong, 2010		
Bias	**Authors' jugement**	**Support for judgment**
Random sequence generation (selection bias)	Low risk	120 sets of computer-generated random numbers were used, and patients who fitted the criteria were randomized to the study or control group.

Allocation concealment (selection bias)	Unclear risk	No information provided
Blinding of participants and personnel (performance bias)	Unclear risk	Unlikely due to the nature of the intervention
Blinding of outcome assessment (detection bias)	Low risk	"A trained research assistant (RA) helped collect the data by interviewing the patients using the structured questionnaires and retrieving clinical data from the charts. The RA was blind to group allocation and had no association the clinical service"
Incomplete outcome data (attrition bias)	Low risk	11 'drop outs' in each group, well explained
Selective reporting (reporting bias)	Low risk	No mentioned pre-registered study protocol. No reason to suspect selective reporting
Other bias	Low risk	Not detected

Appendix 4: More results from included studies

Hospitalizations Chaudhuri 2020

Hospitalization days

Study	Population	Intervention	Control	Results Follow-up
Chaudhuri 2020	CKD- PD	Hospitalization days PPY 3 mo un: 3.03	Hospitalization days PPY 3 mo un: 7.64	IRR: 3 mo adj: 0.62 (0.42-0.90)
Cont.	Cont.	Hospitalization days PPY 6 mo un: 3.48	Hospitalization days PPY 6 mo un: 6.72	Hospitalization days PPY 6 mo adj: 0.65 (0.51-0.85)
Cont.	Cont.	Hospitalization days PPY 9 mo un: 3.65	Hospitalization days PPY 9 mo un: 6.56	Hospitalization days PPY 9 mo adj: 0.66 (0.52-0.82)
Cont.	Cont.	Hospitalization days PPY 12 mo un: 3.67	Hospitalization days PPY 12 mo un: 6.13	Hospitalization days PPY 12 mo adj 0.68 (0.55-0.83)

Legends: CKD=Chronic kidney disease; Cont=Continued; IRR=Incidence rate ratio; mo=Months; PD=Peritoneal dialysis; PPY=Per person year; Un=Unadjusted

Hospitalizations all-cause

Study	Population	Intervention	Control	Results Follow-up
Chaudhuri 2020	CKD- PD	IR/Hospitalization rate: 3 mo un: 0.78	IR/Hospitalization rate: 3 mo un:1.10	IRR 3 mo adj: 0.78 (0.66-0.91)
Cont.	Cont.	IR 6 mo un: 0.73	IR 6 mo un: 1.04	IRR 6 mo adj: 0.76 (0.67-0.87)
Cont.	Cont.	IR 9 mo un: 0.71	IR 9 mo un: 1.00	IRR 9 mo adj: 0.77 (0.68-0.87)
Cont.	Cont.	IR 12 mo un: 0.65	IR 12 m un:0.95	IRR 12 mo adj: 0.74 (0.66-0.83)

Legends: Adj=Adjusted; CKD=Chronic kidney disease; Cont=Continued; IR=Incidence rate; IRR=Incidence rate ratio; mo=Months; PD=Peritoneal dialysis; PPY=Per person year; Un=Unadjusted

Technical failure as cause for transfer to different modality

Study	Population	Intervention	Control	Results Follow-up
Chaudhuri 2020	CKD- PD	PD technical failure rates PPY 3 mo un: 0.12	PD technical failure rates PPY 3 mo un: 0.18	AHR 3 mo: 0.75 (0.49-1.13) *
Cont.	Cont.	PD technical failure rates PPY 6 mo un: 0.11	PD technical failure rates PPY 6 mo un: 0.17	AHR 6 mo: 0.74 (0.55-1.02) *
Cont.	Cont.	PD technical failure rates PPY 9 mo un: 0.10	PD technical failure rates PPY 9 mo un: 0.15	AHR 9 mo: 0.74 (0.57-0.96) *
Cont.	Cont.	PD technical failure rates PPY 12 mo un: 0.10 10/100 PY	PD technical failure rates PPY 12 mo un: 0.14 14/100 PY	AHR 12 mo: 0.79 (0.63-1.0) * 4/100 PY fewer events in the intervention group
Cont.	Kaplan Meier plot, association between technical failure rates and time on PD	Mean days on PD	Mean days on PD	12 mo FU
		U 345	U 332	U 13 days less in the control group P 0.02
		M 345	M 334	M 11 days less in the control group P 0.00
Corzo, 2020	CKD.PD	IR:	IR	Mean 8 mo FU IRR:
		M 0.08 (0.05-0.15)	M 0.18 (0.12-0.26)	M 0.45 (0.22-0.91) P 0.03
		U 0.08 (0.05-0.15)	U 0.09 (0.07-0.12)	U 0.88 (0.41-1.74) P 0.65
Weninhandl, 2018	CKD-HHD Matched controls	Cumulative incidence of technical failure:	Cumulative incidence of technical failure:	Favour intervention at 6 mo, 1 year and 2 years
		6 mo: 10.8	6 mo: 18.4%	
		1 year: 21.6%	1 year: 27.1%	
		2 years: 31.6%	2 years: 36.3%	
Cont.	Cont.	Technical failure event rate: 23.3 /100 PY	Technical failure event rate: 30.7 /100 PY	Mean FU 0,89 years AHR: 0.71 (0.57-0.87) P 0.00 7.4/100 PY less events in the intervention group
Cont.	Cont.	Technical failure events 126 (56.5%)	Technical failure events 487.7(63.5%)	Mean FU 0,89 years RR 0.77 CI 0.65-0.92 P 0.00 AC
Cont.	Cont.	Technical failure due to vascular access or health issues	Technical failure due to vascular access or health issues	Mean FU 0,89 years AHR:

		39 (17.5%)	102.5 (13.3%)	1.16 (0.78-1.72) P 0.47
Cont.	Cont.	Technical failure due to burden or psychosocial issues 60 (26.9%)	Technical failure due to burden or psychosocial issues 210.1 (27.4%)	Mean FU 0,89 years AHR: 0.82 (0.61-1.11) P 0.20
Cont.	Cont.	Technical failure due to other or unknown reasons 27 (12.1%)	Technical failure due to other or unknown reasons 175.1 (22.8%)	AHR: 0.43 (0.28-0.66) P 0.00
Continued with subgroup <3 mo HHD duration at baseline	Cont.	Cumulative incidence of technical failure	Cumulative incidence of technical failure	Favour intervention at 6 mo, 1 year and 2 years
		6 mo: 13.9%	6 mo: 26.1%	
		1 year: 24.7%	1 year: 36.1%	
		2 years: 41.9%	2 years: 45.9%	
Cont.	Cont.	Technical failure event rate: 31.3 /100 PY	Technical failure event rate: 46.1 /100 PY	14.8/100 PY less events in the intervention group
Cont.	Cont.	Technical failure events 75 (66.4%)	Technical failure events 307 (74.3%)	AHR: 0.66 (0.50-0.86) P 0.00
Cont.	Cont.	Technical failure due to vascular access or health issues 18 (15.9%)	Technical failure due to vascular access or health issues 51.3 (12.4%)	AHR: 1.03 (0.56-1.87) P 0.93
Cont.	Cont.	Technical failure due to burden or psychosocial issues 39 (34.5%)	Technical failure due to burden or psychosocial issues 136.2 (32.9%)	AHR: 0.85 (0.58-1.25) P 0.41
Cont.	Cont.	Technical failure due to other or unknown reasons 18 (15.9%)	Technical failure due to other or unknown reasons 119.9 (29.0%)	AHR: 0.42 (0.25-0.71) P 0.00

Legends: AC=Authors' calculations; AHR=Adjusted Hazard ratio; CI=Confidence interval; CKD=Chronic kidney disease; Cont=Continued; FU=Follow-up; HHD=Home hemodialysis; IR=Incidence rate; IRR=Incidence rate ratio; M=Matched; mo=Months; PD=Peritoneal dialysis; PY=Person year; PPY=Per person year; RR=Relative risk; U=Unmatched; Un=Unadjusted * only survivors of 1 year follow up were included in the Cox analysis for AHR (Chaudhuri)

Self-reported QOL (KDQOL) 3 tables

All three studies 11 questions table 1/3

Study Scale	Intervention	Control	Results Follow-up
Burden of KD			
Li, 2014 (Mean SD)	20.1 (10.4)	21.6 (12.0)	6 w P 0.45 FC
	21.5 (11.7)	21.1 (12.2)	12 w P 0.86 FI
Milan, 2020 (Median, IQR)	43.8 (25.0-68.8)	50.0 (31.3-68.8)	6 mo P 0.33 FC
Wong, 2010 (Mean SD)	28.6 (21.2)	32.1 (22.5)	7 w P 0.42 FC
	29.3(19.0)	35.2 (23.9)	13 w P 0.18 FC
Quality of social interactions			
Li, 2014 (Mean SD)	75.8 (14.8)	73.5 (15.4)	6 w P 0.38 FI
	73.2 (15.1)	71.7 (14.1)	12 w P 0.56 FI
Milan, 2020 (Median IQR)	73.3 (63.3-85.8)	86.7 (68.3-91.7)	6 mo P 0.29 FC
Wong, 2010 (Mean SD)	80.3 (18.8)	77.6 (20.3)	7 w P 0.49 FI
	77.8 (20.4)	75.5 (21.3)	13 w P 0.56 FI
Cognitive function			
Li, 2014 (Mean SD)	75.3 (15.5)	73.2 (16.5)	6 w P 0.45 FI
	74.2 (15.7)	76.8 (16.5)	12 w P 0.35 FC
Milan, 2020 (Median IQR)	80.0 (66.7-95.0)	83.3 (70.0-98.3)	6 mo P 0.91 FC
Wong, 2010 (Mean SD)	74.8 (22.9)	80.4 (19.1)	7 w P 0.19 FC
	74.7 (21.7)	80.7 (20.1)	13 w P 0.16 FC
Symptoms			
Li, 2014 (Mean SD)	71.7 (14.4)	66.7 (15.4)	6 w P 0.06 FI
	72.8 (15.0)	68.6 (6.2)	12 w P 0.08 FI
Milan, 2020 (Median, IQR)	77.1 (60.8-85.4)	83.3 (72.9-91.7)	6 mo P 0.29 FC

Wong, 2010 (Mean, SD)	78.1 (15.2)	69.8 (16.8)	7 w **P 0.01 FI**
	79.4 (12.9)	72.7 (16.5)	13 w **P 0.03 FI**
Effects of KD			
Li, 2014 (Mean SD)	63.6 (15.5)	62.8 (14.6)	6 w P 0.77 FI
	63.2 (14.2)	62.1 (14.3)	12 w P 0.63 FI
Milan, 2020 (Median IQR)	67.2 (53.9-84.4)	73.4 (55.5-91.4)	6 mo P 0.71 FC
Wong, 2010 (Mean SD)	71.7 (18.7)	68.3 (20.2)	7 w P 0.40 FI
	72.0 (17.0)	70.9 (17.5)	13 w **P 0.03 FI**
Sexual function			
Li, 2014 (Mean SD)	82.3 (16.7)	78.7 (16.6)	6 w P 0.21 FI
	83.7 (16.4)	78.4 (15.5)	12 w **P 0.05 FI**
Milan, 2020 (Median IQR)	100 (100-100)	100 (96.9-100)	6 mo P 0.20
Wong, 2010 (Mean SD)	62.5 (30.6)	75.0 (0.0)	7 w P 0.63 FC
	64.6 (30.0)	75.0 (0.0)	13 w P 0.73 FC
Sleep			
Li, 2014 (Mean SD)	59.7 (20.9)	52.3 (17.2)	6 w **P 0.02 FI**
	61.1 (20.6)	54.3 (18.1)	12 w **P 0.04 FI**
Milan, 2020 (Median IQR)	65.0 (50,0-75.5)	75.0 (55.0-85.0)	6 mo P 0.59 FC
Wong, 2010 (Mean SD)	63.8 (19.0)	47.9 (25.9)	7 w **P 0.00 FI**
	64.3 (19.9)	48.1 (22.1)	12 w **P 0.00 FI**
Social support			
Li, 2014 (Mean SD)	77.6 (15.3)	75.2 (15.0)	6 w P 0.35 FI
	74.1 (14.7)	73.2 (15.1)	12 w P 0.73 FI
Milan, 2020 (Median IQR)	83.3 (66.7-100)	83.3 (66.7-100)	6 mo P 0.72
Wong, 2010 (Mean SD)	81.0 (21.1)	76.7 (23.1)	7 w P 0.34 FI
	83.8 (16.2)	79.6 (21.0)	13 w P 0.26 FI
Work status			
Li, 2014 (Mean SD)	19.2 (11.4)	17.1 (10.3)	6 w P 0.25 FI
	17.3 (11.6)	14.8 (9.9)	12 w P 0.19 FI
Milan, 2020 (Median IQR)	50.0 (37.5-100)	50 (0-100)	6 mo P 0.69
Wong, 2010 (Mean SD)	29.6 (28.7)	36.7 (28.5)	7 w P 0.22 FC
	31.6 (30.1)	41.8 (27.7)	13 w P 0.08 FC
Patient satisfaction			
Li, 2014 (Mean SD) T2	73.2 (13.0)	70.6 (13.5)	P 0.25 FI
T3	75.9 (13.8)	71.3 (12.3)	**P 0.04 FI**
Milan, 2020 (Median IQR)	83.3 (66.7-100)	83.3 (66.7-100)	P 1.00

Wong, 2010 (Mean SD) Q2	79.3 (16.8)	83.0 (18.8)	P 0.30 FC
Q3	79.8 (18.3)	84.0 (15.2)	P 0.23 FC
Dialysis staff encouragement			
Li, 2014 (Mean SD)	85.1 (12.5)	76.8 (15.4)	6 w **P 0,00 FI**
	87.3 (12.8)	81.2 (15.1)	12 w **P 0,01 FI**
Milan, 2020 (Median IQR)	100 (100-100)	100 (87.5-100)	6 mo P 0.17
Wong, 2010 (Mean SD)	90.8 (16.9)	81.9 (19.3)	7 w **P 0.02 FI**
	90.1 (18.4)	88.0 (12.2)	13 w P 0.52 FI

Legends: FI=Favour intervention; FC=Favour control; IQR=Interquartile range; mo=Months; SD=Standard deviation; w=Weeks. Statistically significant results in bold writing

Two studies 9 questions table 2/3

Study **Scale (Mean SD)**	**Intervention**	**Control**	**Results** **Follow-up**
Physical functioning			
Li 2014	55.2 (15.1)	52.6 (15.8)	6 w P 0.32 FI
	53.9 (12.9)	51.5 (12.5)	12 w P 0.28 FI
Wong 2010	60.2 (27.1)	59.4 (28.5)	7 w P 0.88 FI
	58.2 (27.5)	58.3 (27.7)	13 w P 0.99 FC
Role-physical			
Li 2014	22.1 (16.1)	23.3 (18.6)	6 w P 0.68 FC
	20.8 (16.9)	20.4 (15.1)	12 w P 0,91 FI
Wong 2010	28.8 (41.0)	36.9 (43.8)	7 w P 0.45 FC
	25.0 (39.8)	37.5 (45.6)	13 w P 0.19 FC
Pain			
Li 2014	63.0 (19.0)	55.6 (18.2)	6 w **P 0.02 FI**
	64.2 (18.2)	59.7 (18.9)	12 w P 0.16 FI
Wong 2010	73.1 (32.0)	67.2 (31.1)	7 w P 0.36 FI
	76.5 (27.7)	73.5 (28.3)	13 w P 0.60 FI
General health perception			
Li 2014	36.3 (14.8)	31.8 (15.1)	6 w P 0.09 FI
	38.2 (17.5)	35.7 (17.7)	12 w P 0.41FI
Wong 2010	39.1 (23.8)	34.0 (20.4)	7 w P 0.26 FI
	40.7 (24.2)	37.9 (24.5)	13 w P 0.56 FI
Emotional wellbeing			
Li 2014	68.5 (19.2)	65.7 (19.1)	6 w P 0.40 FI
	65.4 (17.2)	63.5 (18.6)	12 w P 0.52 FI
Wong 2010	69.6 (21.3)	65.2 (20.4)	7 w P 0.31 FI
	70.8 (21.4)	67.0 (22.3)	13 w P 0.40 FI
Role-emotional			
Li 2014	53.6 (15.1)	54.3 (15.1)	6 w P 0.77 FC
	56.3 (14.8)	56.6 (16.5)	12 w P 0.90 FC
Wong 2010	55.8 (46.8)	57.1 (46.1)	7 w P 0.89 FC
	57.1 (47.1)	57.1 (47.1)	13 w P 1.00
Social function			
Li 2014	44.7 (17.3)	45.4 (19.1)	6 w P 0.83 FC
	42.5 (19.3)	43.4 (18.8)	12 w P 0.80 FC
Wong 2010	58.9 (28.6)	63.0 (30.6)	7 w P 0.50 FC
	55.6 (27.4)	59.7 (28.0)	13 w P 0.47 FC
Energy/fatigue			

Li 2014	46.5 (17.9)	41.8 (17.3)	6 w P 0.13 FI
	48.4 (17.7)	43.3 (18.9)	12 w P 0.11 FI
Wong 2010	49,8 (22.2)	46,0 (20.0)	7 w P 0.38 FI
	51.6 (22.4)	47.4 (23.6)	13 w P 0.37 FI
Overall health			
Li 2014	48.1 (16.6)	45.3 (16.3)	6 w P 0.31 FI
	49.2 (19.4)	47.2 (19.2)	12 w P 0.53 FI
Wong 2010	56.9 (16.2)	48.1 (21.2)	7 w **P 0.02 FI**
	56.6 (16.5)	52.0 (19.1)	13 w P 0.21 FI

Legends: FI=Favour intervention; FC=Favour control; IQR=Interquartile range; SD=Standard deviation; w=Weeks. Statistically significant results in bold writing

Additional questions from Milan 2020 table 3/3

Scale Median (IQR)	**Intervention**	**Control**	**Results Follow-up**
-Do you think that home-therapy monitoring could interfere with your privacy? -Do you think that your dialysis sessions are monitored frequently enough? -Do you think that dialysis-related issues are solved timely? -Do you feel comfortable carrying out your home-based therapy? -Answers: Very, quite or not at all	100 (87.5–100.0)	87.5 (75.0–100.0)	6 mo **P 0.02 FI**

Legends: FI=Favour intervention; IQR=Interquartile range; mo=Months. Statistically significant results in bold writing

Appendix 5: GRADE assessment

The GRADE evidence tables were generated through GRADEproGDT software (54).

"GRADE Working Group grades of evidence

High certainty: *We are very confident that the true effect lies close to that of the estimate of the effect*

Moderate certainty: *We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different*

Low certainty: *Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect*

Very low certainty: *We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect"*(54).

GRADE evidence table on effect of TM on hospitalization days

Setting: PD centres (n=961). USA, Colombia, Spain and Italy. **Bibliography**: Chaudhuri et al. (2020), Gallar et al. (2007), Milan et al. (2020), Sanabria et al. (2019)

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Telemedicine	Standard care only	Relative (95% CI)	Absolute (95% CI)	
Hospitalization days (follow up: range 6 months to 12 months; assessed with: hospital records)											
4	observational studies	serious[a]	not serious	not serious	serious[b]	none	All four studies (6,833 participants) showed that there were fewer hospitalization days in the TM group. The results for the two smallest studies did not reach statistical significance. The results for two larger studies reached statistical significance (95%) IRR 0.68 (0.55-0.83) & 0.46 (0.23-0.92) after 12 months follow-up.				⨁◯◯◯ VERY LOW

CI: Confidence interval, **Explanations**: a. All studies have some risk of bias. b. Wide CI and uncertainty about the size of effect

GRADE evidence table on effect of TM on all-cause hospitalizations

Setting: PD centres (n=963). USA, Colombia, China(n=2) and Italy. **Bibliography**: Chaudhuri et al. (2020), Cao et al. (2018), Milan et al. (2020), Li et al. (2014) & Sanabria et al. (2019)

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	TM	SC	Relative (95% CI)	Absolute (95% CI)	
Hospitalizations (all-cause) (follow up: range 3 months to 6 months; assessed with: Hospital records)											
2	observational studies	serious a	serious b	not serious	serious c	none	17/104 (16.3%)	19/104 (18.3%)	not pooled	not pooled	⨁◯◯◯ VERY LOW
Hospitalizations (all-cause) (follow up: range 9 months to 12 months; assessed with: Hospital records)											
3	observational studies	serious a	not serious	not serious	serious c	none	All three studies (6,863 participants) showed that there was fewer hospitalization (all-cause) in the TM group. One study did not reach statistical significance and had vide CI (95%) -RR.0.57 (0.17-1.88). The results for two larger studies reached statistical significance (95%) IRR 0.74 (0.66-0.83) & 0,61 (0.39-0.95) after 12 months FU.				⨁◯◯◯ VERY LOW

CI: Confidence interval; **RR:** Risk ratio. **Explanations:** a. All studies have some risk of bias, b. One study favors the intervention and the other the control. c. Wide CI and uncertainty about the size of effect

GRADE evidence table on effect of TM on disease-specific hospitalizations

Setting: PD centres (n=29). Colombia and Italy. **Bibliography**: Milan et al. (2020) & Sanabria et al. (2019)

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	TM	SC	Relative (95% CI)	Absolute (95% CI)	
Hospitalizations disease-specific (follow up: range 6 months to 9 months; assessed with: hospital records)											
2	observational studies	serious a	not serious	not serious	serious b	none	10/110 (9.1%)	30/198 (15.2%)	**RR 0.62** (0.31 to 1.24)	**58 fewer per 1000** (from 105 fewer to 36 more)	⨁◯◯◯ VERY LOW

CI: Confidence interval. **FU:** Follow-up. **RR:** Relative risk. **SC:** Standard care. **TM:** Telemedicine.
Explanations: a. Both studies have some risk of bias, b. Wide CI and uncertainty about effect size.

GRADE evidence table on effect of TM on infections not requiring hospitalization

Setting: PD centres (n=3) in China **Bibliography**: Cao et al. (2018) and Li et al. (2014)

Certainty assessment							Impact	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
Infections not requiring hospitalization (follow up: range 3 months (intervention 1,5 months) to 11 months; assessed with: hospital records)								
2	randomised trials	not serious	serious a	not serious	serious b	none	One study did not report any data, only that it was not significant. The other study shows results both in favour of TM and SC. The intervention in one study lasted for six weeks and last point of measurement was at three months, the other had a mean FU of 11.4 months. Thus, there was a great difference in FU time. Both studies (295 participants) had extensive SC FU. The results cannot provide evidence that TM had an effect on infections not requiring hospitalization.	⨁⨁◯◯ LOW

CI: Confidence interval. **FU:** Follow-up. **SC:** Standard care. **TM:** Telemedicine. **Explanations:** a. Results in favor of both SC and TM, b. Few events and uncertainty about the effect size

GRADE evidence table on effect of TM on technical failure

Setting: HHD and PD centres (n=1020). China, Italy, USA (n=2), Colombia (n=2). **Bibliography**: Cao et al. (2018), Chaudhuri et al. (2020), Corzo et al. (2020), Milan et al. (2020), Sanabria et al. (2019), Weinhandl & Collins (2018)

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	TM	SC	Relative (95% CI)	Absolute (95% CI)	
Technical failure as cause for transfer to different dialysis modality (follow up: range 6 months to 12 months; assessed with: hospital records)											
6	5 observational studies & 1 RCT	serious a	not serious	not serious	serious b	none	136/786 (17.3%)	521/2230 (23.4%)	**RR 0.78** (0.66 to 0.93)	**51 fewer per 1000** (from 79 fewer to 16 fewer)	⊕◯◯◯ VERY LOW

CI: Confidence interval; **RR:** Risk ratio. **Explanations:** a. All studies have some risk of bias b. Wide CI and uncertainty about the size of effect

GRADE evidence table on effect of TM on QoL

Setting: PD centres (n=5) in China, Hong Kong and Italy. **Bibliography**: Li et al. (2014), Milan et al. (2020), Wong et al. (2010)

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	TM	SC	Relative (95% CI)	Absolute (95% CI)	
QoL- Dialysis staff encouragement (follow-up: range 3 months to 6 months; assessed with: self-report; Scale from: 0 to 100)											
3	2 RCTs & 1 cohort study	serious a	not serious	not serious	serious b	none	118	115	-	MD **4.61 KDQOL more in TM** (0.83 more to 8.4 more)	⊕◯◯◯ VERY LOW
QoL- Patient satisfaction (follow-up: range 3 months to 6 months; assessed with: Self-report)											
3	2 RCTs & 1 cohort study	serious a	serious c	not serious	serious b	none	118	115	-	MD **0.57 KDQOL more in TM** (8.02 less to 9.16 more)	⊕◯◯◯ VERY LOW
QoL- Energy/fatigue (follow-up: 3 months; assessed with: Self-report)											
2	RCTs	serious a	not serious	not serious	serious b	none	118	115	-	**MD 4.82 KDQOL more in TM** (0.30 less to 9.93 more)	⊕⊕◯◯ LOW

CI: Confidence interval; **MD:** Mean difference; **RCT**: Randomized controlled trial; **Explanations**: a. All studies have some risk of bias, b. Wide CI and uncertainty about the effect size, c. High heterogeneity