Introduction

The impact of chronic disease is an enormous worldwide challenge, particularly when chronic diseases consume 80% of all health care resources (Dennis et al., 2008; Hylton, 2008). It is estimated that in developed countries, approximately 80% of general practitioner (GP) visits, 66% of presentations to emergency departments and 60% of all hospital days are related to chronic diseases (Hylton, 2008). It is significant to note that 5–10% of people have multiple chronic conditions that account for 50–55% of the overall spending on health care (Hylton, 2008; Pare et al., 2007).

This review explores the uptake of telehealth applications for improving the health care outcomes of chronic kidney disease (CKD) patients. CKD is a chronic disease caused by a number of aetiologies resulting in the irreversible, gradual loss of kidney function. CKD is classified from stage one through to five dependent on the glomerular filtration rate (GFR). According to Pryam, Kansara, Banerji and Loney-Hutchinson (2011) approximately 7% of adults over 30 years of age will develop CKD, and the prevalence increases to 23–35% in those aged over 65 years.

The high incidence rates of CKD in older people is compounded by the ageing global population. It is predicted that by 2050, 21% will be over 60 years of age, whereas in 2000 only 10% was over 60 years of age (Pare et al., 2007). According to several authors, CKD is nearing a worldwide epidemic with an estimated cost to worldwide economies in the past decade of approximately US$1 trillion (Davenport et al., 2008; El Nahas & Bello, 2005; Mobley, 2009). In Australia, the direct cost of providing dialysis treatment is estimated at A$1 billion annually (Lauder, 2010).

Abstract

Background: Worldwide 80% of health care costs are being consumed by people with chronic disease. In Australia, chronic kidney disease (CKD) is estimated to cost $1 billion. With tighter fiscal control and a constantly expanding CKD population, multiple strategies are being investigated to provide more efficient models of care. Telehealth is one strategy which could provide significant efficiencies in relation to improved care, better disease management and reduced overall costs.

Aim: To examine the peer-reviewed primary research exploring the use of telehealth in the context of renal health care.

Method: The databases EBSCO (CINAHL, OVID and PRO REQUEST) and PubMed were searched for all research articles published in English from January 2000 to January 2012. Inclusion criteria were research findings and published in English. Exclusion criteria were discussion papers and literature reviews.

Results: Ten articles met the inclusion criteria involving 3032 patients and four health care providers. Of those studies, eight were quantitative studies, one used qualitative methods and one adopted mixed methods. All of the research originated in North America and Europe. Renal health has used four types of telehealth: teleconferences, teleconsultation, telemonitoring and teledialysis. Telehealth applications have been successful in the remote care of CKD patients, in terms of patient outcomes and satisfaction.

Conclusion: Telehealth applications based on information and communications technologies (ICT) are currently being successfully used throughout the world to treat and manage the care of CKD patients. Compared to other chronic disease specialities, the development of telehealth applications within the renal setting appears underutilised and under-researched.

Keywords

Telehealth, telemedicine, nephrology, chronic kidney disease, end-stage kidney disease.
Background

Telehealth is defined as health care at a distance and utilising telecommunications mediums to allow for the provision of care from remote locations (Bussay & Michael, 2008; Krumm & Ferrari, 2008; Wootton, 2001). The beginnings of telehealth date back to the Netherlands in the early 1900s when audible heart sounds were first transmitted to a different geographical location through the medium of telephone lines (Bashshur & Shannon, 2009). From that time, telehealth made sporadic advancements, mainly constrained by the available technology and the overall cost of developing reliable and suitable means of transmission for the desired modality of care being considered. In the late 1980s, the science of information and communications technologies (ICT) matured to such an extent that the suitability and reliability of the technology together with their relative cost-effectiveness had made telehealth feasible (Bashshur & Shannon, 2009). While initially intended to maximise health care access to people in rural and remote areas (Bashshur & Shannon, 2009; MacKinnon, 1997; Newton, 2003), telehealth in the past decade had expanded into practically all aspects of health care, regardless of the geographical proximity to the health care facility. The benefits are improving access to health care while providing efficiencies, reducing health care costs and aiding in the quality of health care (Bashshur & Shannon, 2009; Roine et al., 2001). Telehealth is estimated to be growing by approximately 10% per year (Zarocostas, 2010).

The World Health Organization (2010) contends that the terms telehealth and telemedicine are synonymous and are often used interchangeably. Roine et al. (2001) and Wootton (1996) also suggest that telehealth is not one technology but a vast array of applications that facilitate medical activities at a distance. For the remainder of this paper, the term telehealth will be used. Following is an overview of the common terms used in the literature.

Teleconsultation

Teleconsultation is an internet-based camera system that allows both the patient and health care professional (often a medical practitioner) to have face-to-face consultations while being located in differing geographical locations. Electronic systems of audible stethoscopes or ultrasound devices can be incorporated into the system and a health care professional may be present with the patient to provide clinical information that the distant health care professional can not otherwise acquire (Rumpsfeld et al., 2005; Thompson et al., 2009).

Teleconferences

Teleconferences use a system similar to teleconsultations; however, they are used for discussions between health care team members. Teleconferences tend to be for patient case conferences, administrative purposes (meetings), and for training and education (Newton, 2003).

Telemonitoring

Telemonitoring is a branch of telehealth argued to be beneficial in the remote monitoring of persons suffering chronic diseases (Zarocostas, 2010); it is the electronic transmission of vital signs to a health care facility at a distance from the individual. Telemonitoring systems transmit data through miniature sensors that use wireless technology to provide specific clinical information regarding a patient’s current health status. Data is electronically transferred to a health care professional located at a different geographical location. Based on the information supplied electronically, the health professional uses clinical skills and judgement to determine the problem and then provide treatment changes back to the remotely located patient. Further, the data is stored and can be reviewed at a later time by the health professional to determine if any interventions that were initiated were satisfactory (McLean et al., 2011; Ng et al., 2006).

Teledialysis

Teledialysis is the branch of telehealth associated with dialysis (either haemodialysis – HD– or peritoneal dialysis – PD); it may comprise elements of telemonitoring and telehealth that allows for the analysis of remote treatments using a modem-based communication link connected to the automated peritoneal dialysis (APD) cycler or HD machine (Edefonti et al., 2003).

Aim

This paper sought to examine the peer-reviewed primary research exploring the use of telehealth applications introduced to determine the health care outcomes of those suffering CKD.

Search strategy

The databases EBSCO (CINAHL, OVID and PRO REQUEST) and PubMed were searched for all research articles published in English from January 2000 to January 2012. Searches were undertaken using the Boolean/phrase search modes using the terms telemedicine, telehealth, teledialysis, telemonitoring and teleconsultation together with the phrases chronic kidney disease, end-stage kidney disease, dialysis, kidney transplant or nephrology. A total of 130 articles were retrieved at this stage. Each abstract was then reviewed using the inclusion criteria of presenting research findings and published in English. Exclusion criteria were discussion papers and literature reviews. Subsequently, 108 articles were excluded as they did not meet the inclusion criteria, and a further 14 articles were identified as duplicates. An examination of the reference lists used in the remaining eight articles yielded a further two articles being included. A total of ten articles were selected for this literature review.

Findings

Since 2000, 10 research studies related to telehealth and renal health care have been published. These studies involve 3032 patients and four health care providers. Of those studies, eight were quantitative studies (including one randomised clinical trial), one qualitative methods and one used a mixed methods study. All of the research originated in North America and Europe. The study by Rumpsfeld et al. (2005) involved a combination of teleconferencing, teleconsultation...
Table 1. Summary of included articles.

<table>
<thead>
<tr>
<th>AUTHOR/ YEAR</th>
<th>JOURNAL</th>
<th>COUNTRY</th>
<th>AIM</th>
<th>C</th>
<th>D</th>
<th>M</th>
<th>T</th>
<th>SAMPLE</th>
<th>FRAME WORK</th>
<th>FINDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berman et al. (2011)</td>
<td>Telemedicine &amp; Telehealth</td>
<td>USA</td>
<td>Determine if home-based preventative telehealth can improve health care outcomes, quality of life and cost-effectiveness.</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>44 pts</td>
<td>Quantitative pilot study</td>
<td>Remote telehealth technology can play a major role in improving health outcomes at reduced costs for pts suffering ESKD.</td>
</tr>
<tr>
<td>Bernstein et al. (2010)</td>
<td>Clinical Journal American Society of Nephrology</td>
<td>Canada</td>
<td>Compare a model of remotely controlled satellite dialysis unit without an on-site nephrologists to a full-care unit with on-site nephrologists, in terms of survivability.</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2663 pts</td>
<td>Quantitative retrospective cohort study</td>
<td>Haemodialysis pts located remotely from nephrologists can have similar health outcomes compared to in-centre costs for pts suffering ESKD.</td>
</tr>
<tr>
<td>Chua &amp; Warady (2011)</td>
<td>Pediatric Nephrology</td>
<td>USA</td>
<td>Assess the adherence of children on APD to the dialysis prescription.</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>51 pts</td>
<td>Quantitative chart study</td>
<td>45% of the sample exhibited some non-adherence to dialysis prescriptions. The use of teledialysis would aid in increasing the performance of children's dialysis.</td>
</tr>
<tr>
<td>Edefonti et al. (2003)</td>
<td>Pediatric Nephrology</td>
<td>Italy</td>
<td>Evaluate the usefulness of TelePD in quantifying problems associated in paediatric PD.</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>4 pts</td>
<td>Quantitative retrospective study</td>
<td>TelePD (teledialysis) was found useful in detecting and resolving clinical and technical aspects of APD.</td>
</tr>
<tr>
<td>Gallar et al. (2007)</td>
<td>Telemedicine &amp; Telehealth</td>
<td>Spain</td>
<td>Evaluate telehealth in the long-term control of patients on home PD.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>57 pts</td>
<td>Quantitative comparative longitudinal study</td>
<td>Teleconsultation appears clinically viable in the long-term follow-up of stable PD pts.</td>
</tr>
<tr>
<td>Kariyawasam (2005)</td>
<td>EDTNA/ERCA Journal of Renal Care</td>
<td>UK</td>
<td>Determine effectiveness of teledicine in assessing and advising remotely located HDx patients suffering hyperphosphataemia.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>14 pts</td>
<td>Quantitative retrospective study</td>
<td>Proved effective at remotely controlling serum phosphate levels, with a reduction in phosphate of 20% after 6 months, compared to 3-4 monthly clinic consults.</td>
</tr>
<tr>
<td>Rumpsfeld et al. (2005)</td>
<td>Telemedicine &amp; Telehealth</td>
<td>Norway</td>
<td>Assess telehealth's impact in the creation of a common workplace between a university and two satellite dialysis units.</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>8 pts</td>
<td>Quantitative pilot study</td>
<td>Telemedicine was found to be appropriate in connecting primary &amp; secondary dialysis units.</td>
</tr>
<tr>
<td>Sicotte et al. (2011)</td>
<td>Telemedicine &amp; Telehealth</td>
<td>Canada</td>
<td>Compare two models of telehealth and assess the impact of health care in satellite dialysis units.</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>19 pts</td>
<td>Quantitative longitudinal study</td>
<td>Two applications of Telehealth in satellite units were found to have no adverse impact on health conditions.</td>
</tr>
<tr>
<td>Thompson et al. (2005)</td>
<td>Telemedicine &amp; Telehealth</td>
<td>USA</td>
<td>Determine the impact of telehealth on long-term transplant follow-up care and if distance impacts on depression.</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>138 pts</td>
<td>Randomised clinical trial</td>
<td>Telehealth was found to be safe and effective in the follow-up care of post kidney (and other organs) transplant pts who may display depressive symptoms regardless of distance.</td>
</tr>
<tr>
<td>Whitten &amp; Buis (2008)</td>
<td>Journal of Telemedicine &amp; Telecare</td>
<td>USA</td>
<td>Assess perceptions of telehealth and HDx. Does telehealth affect outcomes and is it suitable for other purposes?</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>34 pts, 4 Fm</td>
<td>Mixed methods design study</td>
<td>Patients and providers reported mainly positive perceptions of the dialysis. Similarly, teledicine was found to meet the clinical benchmarks established for the region.</td>
</tr>
</tbody>
</table>

Abbreviations: C = Teleconference; D = Teledialysis; M = Telemonitoring; T = Teleconsultation; Pts = Patients; Fm = Facility Managers; Y = Yes; N = No
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and teledialysis. Table 1 summarises the included articles. What follows is a description of the findings grouped into teleconferences, teleconsultation, telemonitoring and teledialysis.

**Teleconferences**

Four out of the 10 articles included for this review involved teleconferences between tertiary in-centre dialysis units and satellite dialysis units during which nurses and allied health professionals discussed patients, their conditions, treatments and dialysis prescription with the nephrologists (Bernstein et al., 2010; Rumpsfeld et al., 2005; Sicotte et al., 2011). These articles all found that case study teleconferences held on a routine basis by multidisciplinary teams were viable in the management of HD patients in remote locations. There was diversity in the reporting clinical outcome criteria which are described below.

Bernstein et al. (2010) measured short-term (1 year) and longer term (2–5 years) clinical outcomes, concluding that HD patient survival outcomes in remote satellite units managed through the case teleconference system were no worse than HD patients in urban dialysis units with on-site nephrologists. Sicotte et al. (2011) measured physiological markers (systolic blood pressure (BP), diastolic BP, serum haemoglobin, serum albumin, glycosylated haemoglobin, Kt/v, serum phosphate, serum parathyroid hormone, serum glucose) and care utilisation (the number of HD sessions, number of medication changes, number of transfers to the tertiary hospital) as clinical outcome measures. Sicotte et al. (2011) concluded that the case teleconference model (this study compared teleconferencing and teleconsultation models simultaneously) resulted in no worse standard of care outcomes with fewer medication changes compared to the pre-intervention period. Rumpsfeld et al. (2005) incorporated elements of teleconferencing, teleconsultation and teledialysis and results were reported as a combination of all three interventions (see below).

While teleconferences were often used as an educational medium to support skills and training of staff at remote sites, only two studies (Rumpsfeld et al., 2005; Whitten & Buis, 2008) reported results of telehealth and education. Rumpsfeld et al. (2005) intended to use teleconferencing for education every two weeks of the eight months of the research period; however, education was only conducted twice during the study period. No reason was provided for the failure to regularly use the teleconference facility for education. Whitten and Buis (2008), however, used teleconferences as an adjunct to other telehealth applications by using it as a medium for staff and patient educational activities and for administrative meetings between the dialysis units within the region. Staff reported that teleconferencing was a suitable educational medium.

**Teleconsultation**

Seven of the 10 included articles that reported the impact of teleconsultation. Six studies (Bernman et al., 2010; Gallar et al., 2007; Kariyawasam, 2005; Sicotte et al., 2011; Thompson et al., 2009; Whitten & Buis, 2008) compared the clinical outcomes of patients who participated in teleconsultations and compared outcome measures to either control groups or pre-intervention measurements. These studies used different outcome measures including: hospitalisation rates, the number of hospital days per admission, emergency room visits, biochemistry and self-report patient surveys. Five studies found that patient clinical outcomes met or exceeded the expected outcomes. Whitten and Buis (2008), however, found two outcomes, serum albumin and mean corrected calcium, were lower than the benchmark values for the region. The seventh study by Rumpsfeld et al. (2005) reported nurse satisfaction with teleconsultations with nurses indicating that there was no inconvenience in teleconsultation compared to the previous face-to-face consultation method. This same study also identified five instances where hospitalisation was prevented because of teleconsultation. In this study, teleconsultations were only used when medical intervention was considered to be necessary.

It is also interesting patients could instigate teleconsultations with the nephrologist outside the routine scheduled teleconsultation (if they wished clarification about their treatment prescription, for example) but that no patient selected this option.

Whitten and Buis (2008) also considered the perceptions of the HD patient and health care facility managers in their study of teleconsultations. The study found that both the patients and health care facility managers had positive perceptions of the teleconsultation process and resultant health care. However, the patients and managers were divided in their perceptions of how teleconsultations should be employed. Most patients and managers reported that the care provided by teleconsultation was as effective as a clinic visit and its usage should be increased. However, other patients and managers perceived that a mix of clinic consultations and teleconsultations would be more beneficial. The study conducted by Gallar et al. (2007) was the only one that investigated teleconsultation for PD patients. In this study, one group of patients received teleconsultations and this was compared to another group who attended traditional hospital-based clinics. It was found that teleconsultations were significantly quicker than clinic consultations, and in all cases the nephrologist could assess the exit site, review medications and assess for the presence of oedema. In terms of hospitalisation rates, Gallar et al. (2007) reported that the group receiving teleconsultations had 61% fewer hospital days per patient per year than the control group.
Finally, Thompson et al. (2009) postulated that teleconsultation may provide advantages in better managing depression in post-transplant recipients. Depression rates in this cohort of patients was high, which caused higher mortality, morbidity rates and lower medication adherence. By comparing teleconsultations led by nurse practitioners with remotely located transplant patients to traditional clinic-based consultations, Thompson et al. (2009) found that there was no difference in the detection or treatment of clinical depression.

Teledialysis
Three of the 10 articles included in this review examined the use of teledialysis (Chua & Warady, 2010; Edefonti et al., 2003; Rumpsfeld et al., 2005). Although the aims of the studies were different (prescription adherence or dialysis parameters for individual treatments), teledialysis was successful as an alternative strategy for the management of the remotely located dialysis patients. Edefonti et al. (2003) and Chua and Warady (2010) used a teledialysis system to determine the adherence behaviours of paediatric patients receiving APD to their prescription. Edefonti et al. (2003) used data transmitted electronically from the cycler to a computer at the tertiary dialysis unit. A review of cycles, dwell times, inflow rates, ultrafiltration rates per cycle and alarms could identify levels of adherence to APD prescriptions. For one family the low level of adherence triggered further nursing assessment which identified psychosocial issues. Nurses were then able to seek solutions with the family, in an attempt to improve adherence and therefore the overall quality of life of the patient. Whereas Chua and Warady (2010) used data stored on the cycler data card to analyse adherence and demonstrate the value of teledialysis in this particular study group. The study identified that 45% of patients exhibited some level of non-adherence to their prescription (missed treatment sessions and dialysate fill volume); and that males rather than females were more likely to be non-adherent.

In relation to HD, Rumpsfeld et al. (2005) used teledialysis to assess health outcomes in satellite dialysis units. All dialysis machines in two satellite units were electronically connected via the internet to the tertiary dialysis facility. This allowed real-time data of individual treatments, such as dialysis parameters, to be accessed and analysed by medical staff at the tertiary facility. In conjunction with telehealth and teleconsultation, this overall system proved that health outcomes for remotely isolated patients were comparable to the patients who received dialysis in the tertiary centre.

Telemonitoring
Of the 10 articles reviewed, Berman et al. (2011) was the only study of telemonitoring in the renal setting. Berman et al. (2011) examined the effectiveness of internet and home video monitoring equipment, together with teleconsultation support, to facilitate daily communications between frail patients receiving home-based renal therapy and nurses located in a remote location. This study compared the frail group who received dialysis at home, to a control group of similar patients being treated at an in-centre dialysis unit. Emergency department presentations, number of hospital admissions, number of hospital days and hospital costs were measured. Berman et al. (2011) found that telemonitoring applications were successful in supporting frail HD patients at home, resulting in 68% fewer hospital presentations and 78% fewer hospital days. They also found a 64% reduction in costs when compared to in-centre treatments.

Resource evaluation in telehealth
Seven of the 10 articles examined the effectiveness of remotely performed dialysis (HD n=4, PD n=3). While effectiveness was measured using differing criteria, all seven articles reported that telehealth applications were successful. Of those articles that examined clinical outcomes (n=5), all telehealth applications were found to have no adverse clinical health outcomes (Bernstein et al., 2010; Chua & Warady, 2010; Edefonti et al., 2003; Galler et al., 2007; Rumpsfeld et al., 2005; Sicotte et al., 2010; Whitten & Buis, 2005). Three articles found that the telehealth applications were not cost-effective (Gallar et al., 2007; Kariyawasam, 2005; Rumpsfeld et al., 2005). Therefore, further research is required involving large samples over a longer duration to find evidence of whether there is a cost benefit in terms of reduced hospital admissions to offset the high start-up cost of the telecommunication equipment.

Lastly, two articles reported high levels of satisfaction from the perspective of the patient and healthcare provider (Rumpsfeld et al. 2005; Whitten & Buis, 2008). Rumpsfeld et al. (2005) found that patients generally appreciated being able to have face-to-face teleconsultations more frequently than prior to the telehealth intervention. Similarly, 84% of nurses were either satisfied or very satisfied with the use of telehealth. Logistical issues including the nephrologist not being available resulted in 10% of all teleconsultations being cancelled. Technical issues (such as the lack of audio or visual signals) were reported in between 27% and 31% of all teleconsultations. No study other than Rumpsfeld et al. (2005) considered the technical aspects of the telehealth interventions.

Discussion
This review has found 10 studies in renal units involving differing applications of telehealth. The research undertaken to date has predominately focused on remotely located HD satellite units and how telehealth has had a neutral or positive impact on the health outcomes of patients. These articles are
congruent with other research of telehealth, which has shown that there is improved access to health care for people living in rural or remote areas when telehealth is used (Bashshur & Shannon, 2009; MacKinnon, 1997; Newton, 2003; Taylor, Stone & Huijbregts, 2012).

It is interesting to consider the questionable cost-effectiveness of telehealth in renal units. This finding is consistent with previous research regarding the cost-effectiveness for telehealth in other health settings and that only some low-cost telehealth interventions have been proven to be cost-effective (Celler et al., 2003; McLean et al.; 2011; Whetton, 2005). Several reasons for the lack of cost-effectiveness have been suggested. Firstly, research has required high-cost start-up ICT but that the actual studies have been of a short duration. Secondly, research has been assessing customer satisfaction of telehealth applications and not considering the long-term health care outcomes. Finally, previous research has not examined all perspectives of telehealth applications particularly the indirect fiscal savings that can be made in relation to the patient, health care provider and society in general (Hjelm, 2005).

The lack of research articles on other telehealth developments within renal units is a concern, given the advanced applications currently being used in other highly prevalent chronic diseases such as heart failure, diabetes and hypertension. A systematic review by Pare, Moqadem, Pineau and St-Hillare (2010) found 62 studies of telemonitoring in four chronic diseases (diabetes, hypertension, asthma and heart failure). This review determined that home telemonitoring of diabetic patients resulted in better glycaemic control, with a reduction of HbA1c levels of between 5% and 10%. In chronic hypertensive patients, telemonitoring produced significant results in the reduction of systolic blood pressure of between 6.0 mmHg and 10.0 mmHg while diastolic blood pressure fell by between 2.0 mmHg and 4.2 mmHg. In CKD, tight control of hyperglycaemia and blood pressure is argued as being essential in preventing or delaying the progression of the disease to ESKD, and to improve outcomes (El Nahas & Bello, 2005; Mobley, 2009). The uptake of telehealth applications in other specialities is highlighted by Shea and Chamoff (2012) who report that there are currently 3.4 million persons over 65 years of age using telemonitoring applications throughout USA and Europe. The lack of research into the use of telemonitoring systems in the CKD population to monitor vital signs and to provide far more efficient control over blood pressure and hyperglycaemia is surprising given that these areas are known to delay disease progression, improve patient outcomes and lead to a reduction in health care costs. Furthermore, cardiology is also using telehealth systems in the treatment of heart failure patients and monitoring implantable electronic devices for heart rate and arrhythmia control. With heart failure patients, telemonitoring is used to monitor vital signs, weight and medication concordance, general wellbeing, indications of symptoms exacerbation and patient education (fluid restrictions and low salt diets). Telemonitoring of heart failure patients has significantly reduced hospitalisation rates and the risk of death. Implantable haemovolaemic measuring devices have also been used. These devices transmit data indicating impending or actual pulmonary oedema, and this has resulted in reduced hospitalisation rates of between 21% and 36% (Birati and Roth, 2011). Implantable cardioverter defibrillators (ICD) are now capable of being remotely integrated via wireless transmissions to allow a cardiologist to remotely assess the condition of the patient and device. This application has produced lower hospitalisation rates and reduced clinic appointments with no significant change in mortality rates (Birati & Roth, 2011; Hiremath et al., 2010; Ypenburg et al., 2010).

With the improvements in technology and the demonstrated ability of other chronic disease specialities to be innovative in using telehealth to improve assessment, monitoring, diagnosis and treatment, it can only be questioned at what stage renal units will further embrace telehealth. Currently, implantable biomedical microsensors exist that can provide biochemistry data such as serum potassium, pH, calcium, sodium, haemoglobin, sodium and oxygen saturation levels. The future for renal telehealth could involve advanced telemonitoring or even implanted devices to monitor pulmonary oedema, biochemistry data, or as a means to more effectively manage CKD, thereby preventing or significantly delaying progression to ESKD. (Li et al., 2007; Wyatt & Sullivan, 2005).

Limitations and suggestion for further research
This review considered 10 renal telehealth applications from 2000 to 2012. The scope of this literature review was limited by the dearth of published research. The lack of research in renal telehealth is significant when considering renal telehealth research prior to the 21st decade. Several authors (Agroyannis et al., 1999; Baxter International, 1999; Going, 1998; Kaldoudi & Vargemezis, 2010; Mitchell & Disnay, 1997; Moncrief, 1998) reported that the same four applications of telehealth (teleconferencing, teleconsultations, telemonitoring and teledialysis) were being investigated between 1990 and 1999. Due to the continuing growth of the CKD population and the promising telehealth applications that have been successfully integrated into the management of chronic disease patients in other specialities, it would seem essential that research needs to be conducted into the telehealth applications that can be incorporated into the care of CKD patients; for instance, how telehealth can slow the progression of CKD or how the remote telemonitoring of physiological markers can improve health care outcomes of the CKD patient.
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Conclusion
Telehealth applications based on ICT are currently being successfully used throughout the world to treat and manage the care of CKD patients. At present there is limited published research into telehealth within renal units. In addition, there appears to have been little development within the fields of renal medicine or nursing with innovative or new applications of telehealth that have been seen elsewhere in other chronic disease specialities. Other specialities use advanced telehealth applications to improve patient care, reduce hospitalisation rates, better control key physiological markers of chronic disease and gain efficiencies for patients, practitioners and health care costs. In the current climate of fiscal constraint on health care and the exploding population of CKD patients, it would seem timely that renal units worldwide investigate how telehealth may be better used.

Acknowledgement
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References


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