The Jack Brockhoff Foundation Churchill Fellowship to discover new ways to deliver pulmonary rehabilitation for Australians with chronic lung disease.

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Signed Anne Holland Dated 23rd August 2010
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Introduction

Chronic obstructive pulmonary disease (COPD) is a disabling lung condition which affects over one million Australians. Over the last 15 years I have had the privilege of delivering pulmonary rehabilitation to people with COPD, a highly effective treatment which markedly improves symptoms and health status. However, too few Australians with COPD have access to this proven treatment. Delivery of pulmonary rehabilitation using information and communications technologies, known as telerehabilitation, has the potential to deliver this treatment to many thousands of Australians who could benefit, regardless of their geographic location. The Jack Brockhoff Foundation Churchill Fellowship gave me the opportunity to visit centres that are pioneering this treatment model in Norway, Spain, Scotland and Canada.

I would like to thank the Winston Churchill Memorial Trust and the Jack Brockhoff Foundation for giving me the opportunity to undertake this fellowship. It is an incredible privilege to be a Churchill Fellow, to represent Australia and to learn from international experts in the field. I hope that this report will give something in return, by contributing to future directions in health care and health policy in Australia.

I am very grateful to all of the clinicians, researchers and policy makers who hosted my visits to Norway, Scotland, Spain and Canada. The generosity with which people gave of their time and expertise was overwhelming. Particular thanks must to go to those in Tromso and Barcelona who provided extra support and enormous flexibility during the eruption of the Eyjafjallajoekull volcano in Iceland, which created extra challenges for my Fellowship and for travellers all over the world.

Special thanks to my husband David and my children Ruby and Ella, who have supported my vision for telerehabilitation and my Fellowship at a busy and challenging time in our lives. It was wonderful to share part of my Fellowship trip with you.

I dedicate this report to the late Professor Rob Pierce, a passionate advocate of lung health for all Australians. Rob’s belief in this project, along with his insistence that all good ideas could become reality if you tried hard enough, continue to inspire me to pursue telerehabilitation for Australians with COPD.
Executive Summary

Anne E Holland
Associate Professor of Physiotherapy, Alfred Clinical School, La Trobe University
99 Commercial Rd Melbourne 3004; ph +61 3 94796744; a.holland@alfred.org.au

The Jack Brockhoff Foundation Churchill Fellowship to discover new ways to deliver pulmonary rehabilitation for Australians with chronic lung disease.

Pulmonary rehabilitation is a highly effective treatment for people with chronic obstructive pulmonary disease (COPD), however in Australia it is estimated that we deliver this treatment to less than 1% of those who could benefit each year. The aim of my fellowship was to investigate the use of telerehabilitation to deliver pulmonary rehabilitation using information and communications technologies. I visited the following centres which are pioneering the use of telerehabilitation in COPD:

Norwegian Centre for Telemedicine, Tromso, Norway – pilot project of home-based telerehabilitation, connecting multiple patients to a clinician in real time.
Perth and Kinross Community Health Partnership (CHP), Scotland – provides pulmonary rehabilitation to three remote health facilities using videoconferencing.
Distance Lab, Inverness, Scotland – a pilot program of home-based telerehabilitation with multipoint videoconferencing and remote monitoring
Hospital Clinic, Barcelona, Spain – the Nexes project uses a smartphone to deliver comprehensive disease management to people with COPD living in the community.
Centre for Lung Health, Edmonton, Canada – a large scale program linking the pulmonary rehabilitation program at Edmonton General Hospital with 10 rural sites.

The experience of these centres shows that telerehabilitation, delivered using a variety of technologies and settings, is safe and feasible. The challenge for Australian healthcare providers and policy makers is to trial and evaluate telerehabilitation models that are best suited to identified local needs. In order for telerehabilitation to be successfully adopted in Australia, the following features are required:

1. Improved access to videoconferencing in health care facilities throughout Australia, regardless of facility size or location
2. Ensuring hospital data networks have capacity for telehealth applications and that appropriate support is provided for clinician users
3. Inclusion of telehealth options in health policy
4. Consideration of remuneration models for telehealth providers including doctors, nurses and allied health
5. Formalising links between tertiary hospitals in metropolitan centres and health care providers in regional centres, to ensure that clinicians with appropriate expertise and capacity are available to support regional telehealth applications
6. Development of low cost centre-based models of telerehabilitation in regional areas, where appropriate health care facilities and staff are available
7. Investigation of home-based telerehabilitation models for both metropolitan and rural settings, to facilitate access to pulmonary rehabilitation for those who are too disabled to access centre-based care or who live in remote areas
8. Involvement of the multi-disciplinary health care team, including allied health and nursing, in development of telerehabilitation programs
9. Rigorous assessment of new telerehabilitation programs, to ensure that the benefits of pulmonary rehabilitation are being delivered to Australians with COPD.
### Programme

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Pulmonary rehabilitation in Australia – Limited access to a highly effective treatment

Chronic obstructive pulmonary disease (COPD) is a disabling condition characterised by shortness of breath on exertion, marked disability and frequent hospitalisation. It affects over 1.2 million Australians, with an estimated prevalence of 1 in 6 of those over 45 years (Australian Lung Foundation 2008). COPD is a leading cause of disease burden in Australia, with significant impact on individuals and the community. Health system costs are estimated at $800-900 million per annum, the majority of which is attributable to hospital use.

There is strong scientific evidence supporting the benefits of Pulmonary Rehabilitation programs for people with COPD. These programs typically involve eight weeks of twice-weekly supervised exercise training in an outpatient setting as well as education regarding COPD self-management. Pulmonary Rehabilitation is known to improve exercise capacity, reduce breathlessness and improve quality of life, regardless of disease severity. Importantly, Pulmonary Rehabilitation also reduces acute exacerbations or ‘flare-ups’ of COPD and reduces hospital admissions. Pulmonary Rehabilitation is considered an essential component of care for people with COPD in Australia (COPDX Guidelines, 2006).

Despite the compelling evidence for its benefits, less than 1% of Australians with COPD receive Pulmonary Rehabilitation each year (Australian Lung Foundation 2008). Reasons include:

- A lack of programs, particularly in regional and rural areas – for example, there is just one Pulmonary Rehabilitation program for the whole of the Northern Territory
- A shortage of qualified health professionals, especially allied health and nursing
- Poor patient access to existing programs, due to disabling symptoms, poor mobility and lack of transport to centres

It is clear that the current model of centre-based Pulmonary Rehabilitation is not addressing the needs of the majority of Australians with COPD and that unless new models are found, uptake of these effective programs will continue to be poor.
Telerehabilitation is an emerging concept that involves delivery of rehabilitation services using information and communications technologies. Health professionals can now communicate with and monitor patients regardless of their location, which opens new possibilities for patients whose access to rehabilitation services is limited by geography and disability. Traditional pulmonary rehabilitation programs involve relatively simple physiological monitoring which could be transmitted quickly and cheaply over the internet. The educational components of pulmonary rehabilitation are well defined and could be delivered either in real time via videoconferencing or offline using recorded materials. There is enormous potential to deliver cost-effective pulmonary rehabilitation services using simple telehealth technologies, however there are few published reports detailing the clinical outcomes of such a model.

To date telerehabilitation has not been used to deliver pulmonary rehabilitation to Australians with COPD and Australian health services have limited experience with such technologies. However, the pressing need to improve access to pulmonary rehabilitation impels us to consider new and innovative solutions. The aim of my fellowship was to visit four international centres that are pioneering the use of telerehabilitation to deliver pulmonary rehabilitation services.

References:


Telerehabilitation in Norway

**Overview**

The Norwegian Centre for Integrated Care and Telemedicine (NST) is a centre of research and expertise that gathers, produces and disseminates knowledge about telemedicine services, both in Norway and internationally. The NST is located in Tromso, in North Norway.

From 2007 to 2009 the NST participated in the Better Breathing project, a European Union funded project which aimed to provide a new model for continuous care of COPD patients utilising telehealth technologies. During the Better Breathing project the NST developed and tested a home-based pulmonary rehabilitation program using new telehealth technologies. This was a sophisticated but low cost model that utilised open source software, a simple patient interface and videoconferencing via the patient’s television screen. The work was performed in partnership with the Northern Research Institute (Norut). Norut is a national research institute located in northern Norway with research activities within technology, innovation and social science.

At the time of my visit the project had concluded and results were being evaluated. Telerehabilitation was not being used in usual clinical practice.

**Aim of the project:** to provide home-based pulmonary rehabilitation to people with COPD who are unable to travel to hospital-based pulmonary rehabilitation program, either due to illness or distance.

**Collaborating centres:**

Norwegian Centre for Telemedicine, Tromso – main contact Tatjana M. Burkow  
Norut – Northern Research Institute, Tromso – main contact Lars K. Vognild  
University Hospital of North Norway (UNN), Tromso – main contact Marijke Risberg, physiotherapist.

**Setting:** Tromso, the largest city in North Norway, is located 350km inside the Arctic Circle. The city is home to 60 000 people, however there are an additional 100 000 people living in Troms county, often in sparsely populated regions. Tromso and surrounding regions have a long winter season, from October to April, and it is
difficult for people with chronic diseases to access the community due to snow and ice for much of the year.

**COPD in North Norway:** It is estimated that there are 200,000 people with COPD in Norway, many of whom have not had a formal diagnosis. Troms county includes 10% of the Norwegian population and therefore it is estimated that 20,000 people with COPD live in the region served by UNN.

**Pulmonary Rehabilitation in North Norway:** Pulmonary rehabilitation in Norway is delivered either in outpatient or inpatient settings. Outpatient pulmonary rehabilitation is similar to that in Australia, with patients attending the program twice a week for eight weeks. In addition, there are inpatient programs of approximately four weeks’ duration.

In North Norway, 600 patients receive pulmonary rehabilitation per year; only 130 of these receive rehabilitation in the outpatient setting, the rest attending inpatient programs. It is estimated that 2000 patients in North Norway would benefit from pulmonary rehabilitation each year and thus there is enormous unmet demand using traditional program models.

**Participants**

People with COPD living in Troms county, up to three hours driving time away, were recruited for the project. Participants who had previously completed inpatient or outpatient rehabilitation programs were recruited, so that all were familiar with the rehabilitation process.

Two projects were conducted – the first included five oxygen-dependent participants. The second project included 10 participants with a range of disease severity (GOLD stage II – IV).

**Telerehabilitation Technology**

**Interface:** Patients used their own TV and a dedicated remote control as interface – this was low cost, familiar and non-intrusive. Clinicians used existing computer hardware at the hospital.

**Residential Patient Device:** The residential patient device is a dedicated low cost computer providing a secure and reliable channel between home and hospital (Figure 1). Information is also stored at home so that patient could see it, to provide feedback
and motivation. Free open source software is used, along with a web interface and broadband access.

![Image](image.png)

**Figure 1** Project leader Tatjana Burkow with the first version of the Residential Patient Device. The current version is one quarter of the size.

The device has a single button to turn it on and off. To log in, the patient needs to enter a pin number using the remote control.

The residential patient device can take other inputs. Patients with COPD entered SpO₂ and step count data manually, using TV remote control. The system also supports wireless data input from Bluetooth devices, but this was not used in the COPD trials.

**Video Conferencing:** Point to multipoint using open source software Ekiga. Videoconferencing was run from the central server and started automatically – patients did not have to start it themselves.

**Web camera:** A standard fixed Logitech webcam with a cap that patients could use for privacy. Patients needed to adjust the camera angle themselves. Lighting was challenging as the lighting in patients’ homes was often inadequate for videoconferencing, especially in winter – extra lighting was not provided but was considered.

**Sound:** Over-ear headphones and microphone. These were wired – no safety issues were experienced with having an extra lead in the home. There was a mute button on the microphone for patient privacy. Microphones were single patient use for infection control reasons.
Remote Pulmonary Rehabilitation Program

Each rehabilitation group consisted of five patients, reflecting the videoconferencing capacity of the system used.

There are four components to the program:

1. supervised, group-based exercise training
2. group-based education and peer support
3. a patient diary
4. individual followup sessions.

1. Exercise training

Exercise training is performed as a group to music, once or twice a week. Exercise training is done in real time - patients can see each other and the supervising physiotherapist.

Patients removed their headsets during exercise – the physiotherapist reported that the sound of many patients breathing heavily made it difficult to hear when someone spoke. However patients were able to communicate with the physiotherapist if needed by picking up the headset.

The physiotherapist reported that the short delay experienced with videoconferencing took a little time to get used to – it meant that there would be a delay in patient response to instructions / demonstration during the exercise sessions.

An exercise video for instruction and follow-along exercise was also supplied, to encourage exercise outside the supervised sessions. Patients could use the video as many times as they chose throughout the week.

2. Group-based education and social support

Meetings occurred weekly. These sessions were led by the same multi-disciplinary team that leads the usual outpatient pulmonary rehabilitation education sessions. Patients were able to have discussion with their peers and the health care professional. Educational videos were also supplied and stored on the Residential Patient Device. These were designed to be reviewed prior to the group education session.

To ensure privacy, the patients were asked to inform the group if others would be present in the room during the group sessions.
3. Patient health diary

The diary was intended to facilitate self management and provide information for clinical staff regarding health status and progress. The diary was completed using the remote control and TV screen. Patients were encouraged to complete the diary daily.

The diary included:

- SpO₂ and HR – patients had a Nonin pulse oximeter at home and were taught to take measurements, which were then manually inputted via the TV remote
- Step count – a pedometer was worn to encourage activity and self-motivation
- Disease-related questions – designed to assess any changes in disease state / detect exacerbations.

The diary data could be reviewed by the patient and were sent weekly to the clinical staff – patients initiated sending of information, to facilitate self management.

4. Individual followup

Patients received weekly individual followup via videoconference, 10 to 15 minutes each time. This personalised followup was performed by the pulmonary rehabilitation nurse or physiotherapist and was based on diary information.

**System Training for patients**

A face to face assessment was performed prior to the program, either at the hospital or at home. Patients had the equipment set up at home by a project officer and also had a user manual. All had a home visit from the rehabilitation nurse prior to commencement. In one of the rehabilitation groups, the physiotherapist had not met the patients prior to commencement of the telerehabilitation program; however this was not perceived as a problem during training for either patients or staff.

**System Training for clinical staff**

Clinical staff had one training session for videoconferencing prior to program commencement. Both nursing and physiotherapy staff told me that the system had impressed them with how easy it was to use.

The clinicians involved in the project were extremely experienced in pulmonary rehabilitation. There was some discussion about how much this influenced the project - would it have worked so well with less experienced clinicians, who may have more difficulty combining clinical reasoning and technical requirements of the system?
However, an additional physiotherapist who was brought in to cover the annual leave of the usual rehabilitation clinician was able to conduct the exercise sessions with a similar amount of training, suggesting that little specific training is required.

**Technical support**

Technical staff started the videoconferencing at the hospital each time. Patients agreed to be available 10 to 15 minutes prior to the session to get the videoconferencing started. A member of the project team was present during the sessions to assist as required.

**Data Security**

The system used a VPN to UNN hospital with an encrypted video link.

In Norway a Risk Analysis, detailing data security and confidentiality arrangements, has to be performed prior to commencement of this type of project. This was performed twice, once very early in the project so that treatment of risks could be incorporated into design of the equipment and project. Risks are identified by brainstorming with the project team. The consequences and likelihood of each risk is considered and rated (high, medium or low for both consequences and likelihood). A decision is made about which risks are unacceptable, and about treatment of individual risks within the project.

The risk assessment is submitted to the hospital (UNN) privacy commissioner, who reports to the Data Inspectorate. The privacy commissioner receives the risk assessment report 30 days prior to the project commencing, is able to approve the report or request changes, and forwards the report to the Norwegian Data Inspectorate. The ethics committee overseeing the project requires evidence of the privacy commissioner’s report.

**Challenges**

On a small number of occasions the videoconferencing was not available as planned. This was a result of external network problems and was resolved when the external issues were resolved.

**Evaluation and Outcomes**

The results of the project have not yet been published and therefore complete results are not yet available. However, the team reports that there was high patient acceptance.
and that patients appreciated the peer support offered by group-based training and education.

The program nurse reported that individual followup sessions gave participants a feeling of safety, particularly when they were unwell. Although staff thought that perhaps these individual meetings could have been done on the telephone, patients liked to see the clinician using videoconferencing. All patients had previously undertaken an outpatient pulmonary rehabilitation program and they reported that the telerehabilitation program experience was much the same as the centre-based program.

Clinical outcomes assessed were spirometry, dyspnoea, quality of life and costs. These results are not yet published.

**Summary of Findings**

The telerehabilitation system is a sophisticated and attractive solution that has the following features:

- Home-based – allows access to pulmonary rehabilitation for patients who are unable to travel to centre-based programs
- Replication of the group rehabilitation environment – this was highly valued by patients
- Low cost – use of free open source software and low cost components; patients’ own televisions used as the interface. This is likely to be important for health system investment
- Well developed data security processes
- Non-intrusive technology which takes up little room and is acceptable to patients in their homes
- Little training required for clinicians.

It should be acknowledged that the pilot projects included only a small number of participants and that few outcome data are yet available. This system does not currently support objective monitoring of exercise intensity, which may make a therapeutic exercise training intensity more difficult to achieve. The team will follow this up in new project, IS-ACTIVE and JOIN-IN, funded by the European Union.

The telerehabilitation system has not yet been integrated into usual clinical practice. Data from larger trials would be useful to establish whether clinical outcomes are as
positive as those achieved in centre-based pulmonary rehabilitation programs. Project staff also reported health system funding barriers that have impacted on uptake in the clinical environment.

**References**


**Website:**

http://myhealthservice.itek.norut.no/


**Video:**

http://www1.nrk.no/nett-tv/indeks/72710
Telerehabilitation in Scotland

Overview

COPD in Scotland: Primary care data suggest that the prevalence of COPD in Scotland is around 1.9% (Information Services, NHS National Services Scotland), which suggests a total of 98000 people are living with COPD. The British Lung Foundation has estimated that Greater Glasgow faces the greatest challenge from COPD of all Primary Care Organisations in the United Kingdom, where 19% of people are at risk of future hospital admission for COPD. People here are 52% more likely to be admitted to hospital with COPD than the average for the rest of the United Kingdom.

Pulmonary Rehabilitation in Scotland: Pulmonary rehabilitation in Scotland is delivered in a variety of settings including hospitals, community health facilities and fitness centres. The exercise component of the programs I visited was circuit-based, using minimal equipment and with less monitoring of exercise intensity than is common in many Australian pulmonary rehabilitation programs. The self-management education component was very similar to that seen in Australia.

In 2004 it was estimated that less than 1% of people with COPD in the United Kingdom were receiving pulmonary rehabilitation each year (Yohannes, Clinical Rehabilitation 2004). Although the investment in strategies to improve outcomes for people with long term conditions is likely to have increased the number of programs in Scotland, it is clear that improving program access remains a pressing issue for both clinicians and policymakers.

Telehealthcare in Scotland: In recognition of the growing burden of chronic diseases including COPD on the community and health system, the Scottish Government has made significant investments in telehealth and telecare. This includes policies to promote use of telehealthcare in clinical service delivery, significant investment in videoconferencing facilities in clinical settings and evaluation of new telehealthcare services. To aid this process the Scottish Centre for Telehealth (SCT) was established in 2006, to support and guide the development of telehealth for clinical, managerial and educational purposes across Scotland. The Centre provides support and advice to NHS Boards regarding implementation and evaluation of telehealthcare technologies.
My visit to Scotland provides a terrific opportunity to see and discuss a range of facilitators and models for telehealthcare and telerehabilitation:

- **Health policy** – Long Term Conditions Collaborative – Iona Philp, Regional Manager

- **Remote monitoring for COPD** – Lothian COPD Telehealth trial at Lothian Community Health Partnership (CHP); Ruth Burns, Long Term Conditions Project Manager; Claire Sparrius, Clinical Specialist Respiratory Physiotherapist; Angela Lindsay, Allied Health Professions Manager and Telehealth Champion

- **Pulmonary rehabilitation delivered to remote centres via videoconferencing** – Perth and Kinross Community Health Partnership; Jane Dernie, Head of Allied Health Professions; Lindsay Willis, Physiotherapist.

- **Home-based pulmonary rehabilitation using innovative technologies** – Perth and Kinross Community Health Partnership; Jane Dernie, Head of Allied Health Professions; Lindsay Willis, Physiotherapist.

**Health Policy for Long Term Conditions in Scotland**

*Long Term Conditions Collaborative - Iona Philp, Regional Manager*

The increasing number of people with long term conditions has been identified as a major challenge for healthcare services in Scotland, which is entirely consistent with our experience in Australia. The Scottish Government’s vision for improving the health and wellbeing of people living with long term conditions is set out in *Improving the Health and Wellbeing of People with Long Term Conditions in Scotland: A National Action Plan*.

The Action Plan sets out seven high impact changes and associated improvement actions. It is notable that the improvement action ‘Offer Telehealth and Telecare solutions’ is specified under the domains of Improving Care Pathways, Improving Complex Care, Improving Self Management Support and Improving Access to Services (see [http://www.scotland.gov.uk/Publications/Recent](http://www.scotland.gov.uk/Publications/Recent)).

This high level policy support for telehealth care has undoubtedly had an impact on clinical practice. There was ready availability of videoconferencing infrastructure in every health care facility I visited. There was evidence of uptake of telehealth innovations in clinical practice – for instance COPD patients at Lothian CHP were
participating in a randomised controlled trial of home monitoring of symptoms and physiological data. Although this is part of a research project, the remote monitoring approach has clearly become embedded in the clinical service and was perceived by clinicians and managers to increase staff productivity as well as delivering better outcomes for patients. Results of the trial are not yet available; however the protocol may be viewed here: http://www.thepcrj.org/journ/vol18/18_3_233_235.pdf

**Telerehabilitation in clinical practice - Perth and Kinross**

*Community Health Partnership*

*Perth and Kinross Community Health Partnership - Jane Demie, Head of Allied Health Professions; Lindsay Willis, Physiotherapist*

**Setting:** Perth and Kinross Community Health Partnership (CHP) services a population of approximately 140000 people, of whom 44000 reside in the administrative centre of Perth. Perth and Kinross is a largely rural area, covering 5000km². Patients with COPD from the outlying areas had difficulty in accessing the rehabilitation programme at Perth Royal Infirmary due to travel issues – the northernmost point of Perth and Kinross is 45 miles away. Smaller community hospitals are located throughout the CHP, all of which have videoconferencing facilities.

**Aim of the service:** to provide better access to pulmonary rehabilitation programs for people living in outlying areas.

**Participants**

Patients with moderate to severe COPD take part in the program at three remote sites, Pitlochry, Crief and Blairgowrie. The program is run concurrently with the face to face program at Perth Royal Infirmary.

**Telerehabilitation Technology**

A Tandberg 880 videoconferencing unit with 23” monitor on a trolley is used at Perth and at the community hospitals. Audio is enhanced by use of a tabletop microphone. This videoconferencing capability was already present at all sites and did not need to be purchased for the program. The equipment is also used by other clinical programs.

A physiotherapy assistant provides supervision and monitoring at the remote sites, so there is no requirement for remote monitoring of physiological signals.
Remote Pulmonary Rehabilitation Program

The pulmonary rehabilitation program follows the standard format of twice-weekly sessions for eight weeks. At the Perth site the program is delivered by a specialist respiratory physiotherapist, Lindsay Willis, with a physiotherapy assistant and a respiratory nurse. At the remote sites the program is facilitated and monitored by a physiotherapy assistant. These assistants were already present at the remote site and thus no new staff were required, although there were some costs associated with backfill for training and to cover previous duties. Specialist staff from the Perth Royal Infirmary travel to the remote sites to perform pre and post program assessments.

1. Exercise training

Exercise training follows a circuit-based format. As patients at both Perth and the community hospitals are located at different stations around the room for exercise training, they are not directly monitored using videoconferencing for the majority of the exercise time. However, the physiotherapy assistant can seek support and advice from the Perth site if needed whilst the patients are exercising.

2. Group-based education and social support

Self-management education is provided using the videoconferencing link. This allows patients at the remote sites to participate in the group and interact with peers and members of the multidisciplinary team in Perth.
Experiences of patients
All patients who participated in the pilot project, run between October and December 2008, reported high satisfaction with the program and stated that they would participate in a telemedicine link again.
(see http://www.sct.scot.nhs.uk/copdtayside.html)

Training for clinical staff
Physiotherapy assistants at the remote sites did not have previous pulmonary rehabilitation experience and were trained at the Perth Royal Infirmary prior to commencing the program. Clinical staff commented that trust between the health professionals at each end was essential in order for the program to succeed.

Technical support
No technical support staff were present during the program, however could be accessed via a telephone helpline if needed. In the pilot project the videolink was effective for 16 out of 16 sessions. Clinicians report that the picture quality is good, despite some minor colour variations that did not affect care delivery. There are occasional difficulties with sound quality despite use of a tabletop microphone. This can be challenging as some patients have hearing impairment.

The health professionals involved quickly became proficient in use of the Tandberg unit, however rapid access to IT support was felt to be essential if it should be required. The involvement of IT staff from the initial setup phase of the program was considered essential.

Data Security
Videoconferencing uses the existing hospital data network. Participants in the program are required to sign a consent form to be photographed and videotaped.

Challenges
Some adaptations had to be made to the Perth gym area to improve sound quality.

Evaluation and Clinical outcomes:
Standard clinical outcomes, including incremental shuttle walk test, Chronic Respiratory Questionnaire and Hospital Anxiety and Depression are measured before and after the program. The pilot project showed improvements in these outcomes that were comparable to previous programs. The telerehabilitation model was low cost in comparison to other options such as sending clinicians to remote sites or transporting
patients to Perth. See [http://www.sct.scot.nhs.uk/copdtayside.html](http://www.sct.scot.nhs.uk/copdtayside.html) for further details regarding evaluation of the project.

**Remote rehabilitation – Distance Lab, Inverness**

*Andrea Taylor, Angus Aitken, Richard Wilson (Distance Lab); David Godden (Centre for Rural Health); Judith Colligan (Raigmore Hospital).*

Distance Lab is a research organisation that seeks to address the problems and opportunities found in rural and remote areas using digital media technology, design and the arts. As well as conducting academic research, Distance Lab works with briefs from industry and governmental partners to provide advice, generate ideas and build prototypes that can overcome the challenges of distance. Distance Lab received seed funding from the Highlands and Islands Enterprise, which facilitates economic and community development in Scotland.

**Aim of the project:** to provide home-based pulmonary rehabilitation for those who could not otherwise attend a centre-based program, primarily due to distance.

**Funding:** Chest Heart and Stroke Scotland are currently funding two pilot studies. The first pilot study was nearing completion when I visited in April 2010.

**Setting:** The Scottish Highlands is one of the most sparsely populated areas of Europe. It accounts for roughly a fifth of Britain's total area, yet less than two percent of the population live there. This amounts to approximately 370,000 people scattered widely over an area twice the size of Belgium. As in Australia, there are difficulties with recruitment and retention of health professionals in rural and remote regions. Access to specialist services is limited and often requires patients to travel large distances over difficult terrain.

**The project:** Distance Lab are running a pilot study of home-based pulmonary rehabilitation for people with COPD, using videoconferencing and remote monitoring technology to deliver a home-based exercise program delivered remotely by a physiotherapist.

The pilot has been run from the Distance Lab just outside Inverness, although it is likely a second study later this year will be run from Raigmore Hospital, to enable easier participation of the multi-disciplinary team.
Participants
Participants with a range of disease severity were accepted. Those with hearing impairment or had limited vision were excluded.

Telerehabilitation Technology
The kit was set up in the home by Distance Lab staff. Apart from minor difficulties with positioning of cables and position of furniture, no significant obstacles were encountered.

Interface: Patients used their own TV as a monitor. The physiotherapist used two monitors – the first displayed the patients in their homes and the second displayed remote monitoring information.

The Kit: A purpose built computer with a wired broadband connection and a single on/off button. The kit is attached to the TV via VGA cable – to date all patients have had relatively new televisions which enabled simple connection of the kit and a good picture. It is likely that with older model televisions requiring a SCART connection, the picture quality would be worse.

The kit also received oxygen saturation and heart rate data via a Bluetooth connection from a Nonin pulse oximeter. Pulse oximetry was performed by patients after exercise, only when requested by the physiotherapist.

Video Conferencing: JANET was used for videoconferencing– this is part of the UK education and research network and therefore comes at relatively low cost. Other elements include a Logitech Pro 9000 web camera and a ClearOne Chat 150 standalone speakerphone placed between the patient and the television. Additional programming has provided a countdown timer on a second screen, to enable the physiotherapist to time the duration of exercise.
Rehabilitation Program

The pulmonary rehabilitation program is an eight week, twice a week program that is supervised by a physiotherapist. Patients attend the hospital for assessments at the beginning and end of the program. They also completed their first session at the hospital, to meet each other and learn the exercises that would be performed during the remotely supervised sessions.

1. Exercise training

The exercise program consists of

1. a chair-based warm up
2. eight exercises that are each performed for a designated time and the number of repetitions recorded. The exercises include light upper limb weights, sit to stand, marching on the spot, quadriceps through range and heel raises.
3. relaxation.

This circuit-based program appears to be relatively low intensity and is consistent with other programs I saw in Scotland.

2. Group-based education and social support

Self-management education was provided on a limited basis in the pilot study, by the physiotherapist and the respiratory nurse. There are plans to expand this in the second study to include all members of the multi-disciplinary team. Some members of the team have expressed the desire to use powerpoint slides – there are plans to integrate this into the system so that patients can view the slides on their television. The
researchers noted that the interaction between participants had been relatively limited during the program.

**System Training for patients**
No specific training was provided. Distance Lab staff showed patients how to switch the kit on and off at the time of installation in their homes. Instruction sheets were provided.

**System Training for clinical staff**
The physiotherapist was involved in the project during its development and therefore no specific training was required.

**Technical support**
As the pilot project was conducted from the Distance Lab, excellent technical support was available for the physiotherapist. New solutions may be required when the project moves into the hospital setting.

**Data Security**
The system used a unique identifier for each patient and patient information was not stored electronically.

**Challenges**
A significant challenge was provision of broadband to homes that did not already have it. As well as the time lag for installation, currently available broadband contracts ran for a minimum of 12 months, far longer than the 2 months required to participate in the program. Wireless 3G broadband was not considered feasible due to lack of coverage in most of the surrounding area.

Use of visual aids for self-management training and education was not as easy as expected. The respiratory nurse reported some difficulty with assessing and training bronchodilator technique due to screen resolution.

A short time delay for transfer of videoconferencing data made engaging participants in conversation more challenging. Both the physiotherapist and the participants learnt to deal with the time lag quickly and the physiotherapist made sure to direct questions to a particular person.
The safe positioning of cables in participant’s homes was difficult on occasions but could be overcome with sufficient set-up time.

**Evaluation and Outcomes**
Since my visit the pilot program has concluded (n=4) and an evaluation has been conducted. Patients reported that they had felt comfortable (n=2) or very comfortable (n=2) with taking part in rehabilitation via videolink before the program, and all were very comfortable after the program. All reported that they felt part of a group and felt safe whilst exercising. Clinically significant improvements in exercise tolerance were seen in all patients following the program, of a similar magnitude to those seen in traditional centre-based programs.

**Future directions**
The second pilot project will test a more sophisticated model of Remote Rehabilitation using a wearable monitor that can log repetitions of exercises. It will also integrate a keypad on which patients can record symptom scores, which would be a very useful development for monitoring and recording exercise intensity.

**Summary of Findings – Scotland**

*Integration of telehealthcare into clinical practice*
Unlike many other parts of the world, Scotland has been successful in integrating telehealthcare into clinical practice for many different patient populations, including COPD. Two drivers have had an enormous role in facilitating this:

1. Health policy that mandates investigation of telehealthcare solutions across the spectrum of patient conditions
2. Investment in videoconferencing infrastructure in a wide range of hospital and community health care facilities, which markedly decreases the cost and practical obstacles to uptake.

The two different telerehabilitation models I saw in Scotland are both well-developed solutions that have differing attributes:

*The Perth and Kinross CHP model* involves only videoconferencing. It has the advantage of being simple and relatively low cost, especially where videoconferencing facilities are pre-existing and shared with other programs. It is a model that could readily be applied now. However, this model is not a solution where
no adequately staffed remote centre exists and does not address the needs of patients who have difficulty leaving their homes at all. This model does not provide remote monitoring of exercise intensity or physiological signals, although this is not essential for the current model which has a health care professional at each end.

*The Distance Lab model* is an exciting development that allows home-based pulmonary rehabilitation with videoconferencing as well as direct monitoring of the exercise component of the program through physiological signals such as oxygen saturation. The advantages of this model are that it can bring pulmonary rehabilitation to the home whilst preserving the benefits of group-based training; the model is applicable for patients who have no local centre to attend; and physiology and (potentially) exercise intensity can be monitored, which is attractive for ensuring safety and efficacy. However, this model is still in development and not yet ready for widespread application to clinical practice. Data regarding the safety and efficacy of this approach is eagerly awaited.

**References**


COPD prevalence data for Scotland: [http://www.isdscotland.org/isd/4897.html](http://www.isdscotland.org/isd/4897.html)


Distance Lab: [http://www.distancelab.org/projects/remote-rehabilitation/](http://www.distancelab.org/projects/remote-rehabilitation/)
Telerehabilitation in Barcelona, Spain
The Nexes Project

Overview

Setting: Hospital Clinic in Barcelona, under the leadership of Professor Josep Roca, is an internationally recognised centre of excellence for COPD care and research. The pulmonary rehabilitation program has both research and clinical arms. Professor Roca and Dr Jordi Vilaro, physiotherapist for the pulmonary rehabilitation program, provided detailed information during my visit.

The NEXES project: Professor Roca is leader of the Information and Communications Technology (ICT) program on chronic patient management at the Hospital Clinic. He is currently leading a multidisciplinary team working on NEXES, a European Union project aiming to validate and promote adoption of innovative services for patients with chronic conditions, supported by ICT. The project plans the controlled deployment and evaluation of four types of services: Wellbeing and physical training; Care for fragile patients; Home hospitalisation and early discharge, and Diagnostic and treatment support. The NEXES project is being conducted in Spain, Greece and Norway.

The home pulmonary rehabilitation program, part of the Wellbeing and physical training service, forms only one part of an integrated care program for people with COPD and other chronic diseases. The NEXES program uses ICT as a platform for integrating comprehensive clinical care across hospital and community settings. This includes linking and filtering relevant healthcare information and providing patient-oriented ICT solutions to improve self-management and home-based care. The remote pulmonary rehabilitation program described below should be seen within this wider chronic disease management context.

COPD in Spain: The prevalence of COPD in individuals between 40 and 80 years of age in Spain has recently been estimated as 10.2% (Miravitlles et al 2009). Nearly 80% of those with COPD are undiagnosed and thus undertreated. It is estimated that COPD makes up 2% of the Spanish healthcare budget representing approximately 0.25% of the gross national product. Currently COPD is the fifth highest cause of death in Spain.
**Pulmonary Rehabilitation in Spain:** It is estimated that pulmonary rehabilitation is delivered to between 0.7 and 0.9% of the population of people living with COPD in Spain, similar to figures in Australia and the United Kingdom. In Spain this could be attributed to the small number of programs and a lack of public funding in some regions. Pulmonary rehabilitation in Barcelona is mostly delivered in public hospitals which have been funded to provide this service since 2008. However in other parts of Spain, pulmonary rehabilitation is delivered by small private companies with few public programs available.

Pulmonary rehabilitation is mostly delivered by physiotherapists. There are only 350 physiotherapists in Spain who specialise in respiratory care, for a population of 46 million people. Strategies that could deliver pulmonary rehabilitation to a larger number of people at low cost would be highly desirable.

**Aim of the project:** to provide home-based pulmonary rehabilitation as part of a cost-effective program of integrated long-term care for people with COPD.

**Participants**
People with COPD across the range of disease severity are included. The program at Hospital Clinic is also expanding to include people with other chronic diseases such as diabetes and heart failure.

**Telerehabilitation Technology**
The NEXES program uses a mobile phone carried by the patient that is integrated with an information management platform (Linkcare) and a web interface for clinicians. This ‘knowledge management system’ is designed to be flexible enough to collect and provide information across the continuum of care. The current program utilises a java application running on a Nokia smartphone, however the application should export to any phone. A mobile phone was chosen as it is a simple interface that is familiar to patients and has good connectivity. Patients can use the mobile phone to make personal calls in the usual fashion – it is acknowledged that patients will not carry two phones and thus the device must serve both personal and health-related functions.

In the telerehabilitation program the mobile phone is used for the following functions:
- send exercise reminders via text message
- set exercise intensity – walking cadence is specified using a metronome
• time the duration of exercise
• collect oxyhaemoglobin saturation and heart rate data using a Nonin pulse oximeter that transfers data to the phone via Bluetooth
• administer pre and post exercise questionnaires including Borg symptom scores and patient feedback regarding the exercise session.

Data transmitted from the mobile phone are reviewed off-line by clinicians who log in to a web application. The patient’s program can be adjusted and patients can interact with their clinicians to ask questions and receive feedback on their progress. The web application is also used by clinicians to view other demographic and clinical data relevant to the patient, which is extracted from the hospital system; to complete checklists that ensure all relevant information is collected for the program; admit and discharge patients from programs; and generate reports.

**Remote Pulmonary Rehabilitation Program**

Patients undergo a comprehensive three-day assessment prior to commencing the program. This includes maximal, constant load and functional exercise capacity tests; spirometry; body composition assessed by bioimpedance; and a range of questionnaires that measure quality of life, dyspnoea and performance on activities of daily living.

Patients then undergo a minimum of three weeks of exercise training, supervised at the Hospital Clinic three times per week. The program is similar to those undertaken in Australia and consists of high intensity aerobic training and resistance training. This phase is considered essential to monitor the patient’s response to the exercise prescription in terms of dyspnoea and physiological responses. All patients undertake at least one hour of group-based self-management education during their supervised program.

After three weeks, patients who are considered to be in good physical condition are instructed to continue their exercise program at home or at a community centre, with monitoring via the smartphone. Patients who are considered to be in poor physical condition undergo eight weeks of supervised rehabilitation before undertaking home rehabilitation. The program also sees patients with diseases other than COPD who attend only for risk factor modification (eg for cardiovascular risk modification) and these patients do not need to undertake the centre-based program.
Patients are reassessed at the end of the hospital phase (at three or eight weeks) and then every six months thereafter, using the same measures taken at program entry.

1. **Exercise training at home:** The exercise prescription primarily targets exercise time, rather than intensity. Patients are encouraged to aim for one hour of exercise each day. Dr Vilaro commented that the Spanish population is very active and most patients are walking for longer than this. Patients are instructed to exercise at an intensity where they feel some difficulty maintaining a conversation.

Patients can view their own exercise data and relevant information from their assessment via a website, the Personal Folder. This allows patients to monitor own progress over time. At the time of my visit this was not yet operational, but has since become active. This site will be very useful for direct feedback to patients.

2. **Education and social support:** The mobile phone is used to send automatic text messages to provide education and reminders. These messages can be sent in random order or in a planned fashion. Topics for the text messages include:
   - medication reminders
   - instructions on how to access the call centre
   - exercise reminders
   - non-smoking messages
   - self-management messages

The group environment and peer support of traditional pulmonary rehabilitation programs is not replicated using this model.

**System Training for patients**

The program uses a mobile phone which is a familiar interface for many (but not all) patients. Some older people may not be familiar with the interface and require more support initially. Patients receive one hour of training with the mobile phone prior to beginning the home-based program, as well as a manual with instructions for use.

**Technical support**

The main objective of the NEXES project is to evaluate the potential for generalising ICT services in the healthcare system and thus there is a great deal of emphasis on ensuring that the platform functions well in the real clinical environment. The project therefore involves close collaboration between clinical, academic and technical staff.
As the platform and project are still evolving there appears to be a high degree of involvement from the technical team. It is difficult to assess the need for technical support if the program were to be generalised to other less expert sites, but the sophistication of the system underlying the simple interface suggests it is likely that some degree of support would be required.

**Data Security**

Data collected by the mobile phones are automatically sent to the Nexes-Linkcare platform. The platform has two different firewalls. The first is between the mobile phone and the platform. It analyses and identifies any data coming from the exterior device by a special code. If a mobile is recognized, the data are stored and analysed by the internet-based platform. The second firewall is between the platform and the main hospital database. This high level of security enables secure data sharing with clinicians.

**Challenges**

This highly innovative chronic disease management program presents new challenges for the health system. At present it is not clear who would pay for the mobile phone and data charges. If the system can be shown to be cost-effective, it may be in the interests of the health system to support these costs. Due to the size of the potential market for this solution, telecommunications providers may also be interested.

**Evaluation and Outcomes**

At the time of my visit the home rehabilitation module was being piloted in 10 patients with chronic diseases. Dr Vilaro reported that patients felt comfortable with the mobile phone and were able to follow the instructions provided on the phone. They also reported that having the phone provided good motivation to continue exercising and that they felt safe because of the monitoring provided. More formal evaluation data are not yet available.

**Summary of Findings**

The NEXES project is a highly sophisticated platform for chronic disease management that aims to integrate many data sources, improve access to patient information across the continuum of care and provide long-term support to patients with chronic disease. Telerehabilitation is one aspect of this comprehensive program.
The mobile phone interface used for this program is attractive because it is familiar, unobtrusive and attractive to patients. The potential of this home rehabilitation program to improve long-term adherence to physical activity recommendations is considerable. Underpinning this strategy is recognition of the long-term nature of chronic conditions and the need to provide timely support and management throughout the disease course.

The telerehabilitation model utilised here requires closely supervised centre-based training initially and thus will not be applicable to rural and regional locations in Australia where no such facilities exist. It would be interesting to see whether the program could be equally effective without this intensive period of supervised training. Future evaluation will confirm whether the costs associated with the long-term nature of the NEXES program are offset by improvements in clinical outcomes and reductions in health care utilisation. At present the health care system in Australia has no mechanism for supporting the telecommunications costs of such a program. However, it is likely that in partnership with telecommunications providers an appropriate and mutually beneficial funding model could be developed. This is a fruitful area for further investigation.

References


The NEXES project: http://www.epractice.eu/en/cases/nexes
Telerehabilitation in Alberta, Canada

Overview

The Centre for Lung Health in Edmonton, Canada has a long-running and successful telerehabilitation program for people with chronic disease living in Alberta province. Dr. G. Fred MacDonald, Dr Michael Stickland and respiratory therapist Monica Pratley oversee the program. Alberta Health Services has made significant investments in telehealth – a comprehensive overview of these services was provided by Josephine Amelio, Provincial Telehealth Manager.

Aim of the program: to provide better access to pulmonary rehabilitation programs for people living in outlying areas of Alberta province.

Setting: Alberta is located in western Canada and has a population of 3.7 million people. Its capital city Edmonton is located near the centre of Alberta and is home to approximately one million people. Edmonton is the most northerly of Canada’s large cities and the location of Alberta’s most northerly tertiary health services. Three quarters of a million people live north of Edmonton, however there are no pulmonologists in this region. It is an 11 hour drive from Alberta’s most northern point to Edmonton.

COPD in Canada: The prevalence of COPD amongst Canadian adults aged over 35 years has been estimated at 4.4%, or over 700 000 people. However, in a more recent survey for the Canadian Lung Association more than 8% of respondents reported being diagnosed with COPD, suggesting that the true prevalence may be much higher. In 2004, COPD was the forth leading cause of death in Canada.

Pulmonary Rehabilitation in Canada: There are 98 pulmonary rehabilitation programs in Canada. It has been estimated that only 1.2% of Canadians with COPD are able to access a pulmonary rehabilitation program each year (Brooks et al 2007). The Canadian Thoracic Society recommendations for management of COPD (2007) state that ‘an urgent need exists to increase access to pulmonary rehabilitation programs across Canada’ (p20B).

TeleHealth in Alberta: There are more than 700 telehealth endpoints across Alberta, with videoconferencing available in every healthcare centre. Alberta Health has approximately 800 events of telehealth every month, ranging from acute care
(emergency department consultations, a critical care line which links to 11 regional centers, links from regional areas to neonatal intensive care) to ambulatory consultations with specialists and rehabilitation services. The program is supported by 90 telehealth staff across Alberta province, with on-site technical support available at most locations and a telephone help line for technical issues. The program started with grant and project funds from the provincial and federal governments, however the telehealth projects have now been rolled into program funding and almost every project has become sustainable. There is high level executive support for the telehealth program in Alberta Health.

Alberta has a large aboriginal population in its northern regions, often living in areas with no road systems or limited access due to extreme weather. Targeted federal and provincial funding is providing telehealth options for these isolated communities. Ms Amelio described how the telehealth needs in these communities sometimes differ from other communities in the region. It is likely that Australia could learn much from Alberta Health’s experience that would be relevant to effective delivery of telehealth in our aboriginal communities.

**Telepulmonary COPD Clinic, Centre for Lung Health, Edmonton General Continuing Care Centre**

The Breathe Easy program at the Centre for Lung Health is a large and well established pulmonary rehabilitation program that enrolls over 500 patients each year. The Telepulmonary COPD clinic was developed to improve access to pulmonary rehabilitation for rural patients who lived away from a major centre. The program currently runs at 10 rural sites in central and northern Alberta, with populations ranging from 1000 to 50 000 people. Each site has a clinician capable of delivering exercise training (usually a respiratory therapist) who is supported and trained by the expert team at the Centre for Lung Health. The Telehealth pulmonary rehabilitation program currently enrolls approximately 125 patients each year and is thus the largest remote rehabilitation program that I visited.

**Participants**

People with COPD across the range of disease severity are included. Patients are referred by their local physician to attend the Telehealth pulmonary rehabilitation program at their local hospital or health centre. The physician referral includes a
medical history, respiratory function tests and a chest X-ray. All referrals are managed centrally at the Edmonton site.

A unique feature of this program is that all participants are assessed by a pulmonologist via videoconferencing prior to commencing the program. This consultation ensures that medical management is optimised prior to beginning rehabilitation. It was clear from my visit that this assessment is highly valued by participants, many of whom had never previously been seen by a respiratory specialist.

**Telerehabilitation Technology**

A Tandberg portable videoconferencing system is used to link the Centre for Lung Health in Edmonton with up to 10 satellite sites at local hospitals or health centres. The ability to link with multiple sites at a time vastly increases program capacity. The high throughput of the Edmonton Telehealth pulmonary rehabilitation program, which greatly exceeds that of other programs I visited, can be attributed to this feature.

**Remote Pulmonary Rehabilitation Program**

The program follows the standard format of twice-weekly sessions for eight weeks. The sessions comprise two hours of exercise training and one hour of group-based education.

The number of participants at each remote site ranges from two to six, along with 8 to 12 participants at the Edmonton site. The ability to link with multiple remote sites simultaneously increases the viability (and presumably the cost-effectiveness) of the telehealth pulmonary rehabilitation program – even if participant numbers at individual sites are small, the number of sites involved means that overall throughput is high and regional patients do not have to wait until a complete group is viable at their site.

**1. Exercise training**

Exercise training at the remote site is supervised by an on-site clinician with the appropriate skill mix for rehabilitation, usually a respiratory therapist. Training consists of individually prescribed aerobic and resistive exercise, stretching and breathing retraining. This is very similar to the exercise component of pulmonary rehabilitation programs in Australia. The exercise component does not utilise the
videolink. However, support and guidance for the local clinicians is provided by the respiratory therapist at the Edmonton site as required.

2. Group-based education
Health professionals in Edmonton deliver group-based education sessions simultaneously to patients located in Edmonton and a number of regional sites. All participants at the remote sites can be seen by participants at the Edmonton site, facilitating their inclusion in the group. Education topics include pathophysiology of lung disease, role of exercise, airway clearance, respiratory medications, use of inhalers, nutrition, relaxation, stress management, travel and oxygen therapy.

The presenter is able to move the video camera remotely, which is helpful for switching between PowerPoint slides and physical demonstration of techniques such as dyspnoea control strategies. Questions are taken from each of the remote sites individually to facilitate their inclusion. Clinical staff are present at the remote sites to ensure the smooth functioning of the videolink and assist with questions. Participants at the remote sites appeared very comfortable and interacted easily with the presenter.

Technical support
The Telehealth pulmonary rehabilitation program has been running since 2006 and clinicians are therefore familiar and comfortable with the technical requirements of videoconferencing. Alberta Health’s telephone support services can be accessed if required.

Data Security and privacy
Videoconferencing uses Tandberg units on the hospital network. The use of internet-based videoconferencing technologies is not permitted in Alberta Health. Videoconferencing uses separate bandwidth to the remainder of the hospital network.

Challenges
Dr Stickland commented that it would be useful to bring clinical staff from the regional centres to Edmonton for training, with annual updates. At present there are no resources for this. Central administration of referrals and data for the telehealth pulmonary rehabilitation patients is undertaken to ensure appropriate coordination and quality control, however this is a significant administrative load for which there is currently no funding mechanism.
**Evaluation and Outcomes**

Standard pulmonary rehabilitation outcome measures are used at the Edmonton and remote sites - 6-minute walk test, St Georges Respiratory Questionnaire and SF-36. Comparison of outcomes between the telehealth pulmonary rehabilitation patients at remote sites and patients undertaking the standard pulmonary rehabilitation program in Edmonton has been undertaken. Both strategies resulted in clinically significant improvements in quality of life and exercise capacity, with no differences between the groups. The manuscript reporting these findings is currently under review – this will add significantly to our understanding of the role of tele-pulmonary rehabilitation once it reaches publication.

**Summary of Findings**

The Centre for Lung Health in Edmonton runs a large and successful telehealth pulmonary rehabilitation program that is firmly embedded in usual care. Of particular note are the following features:

- Linkage with multiple remote sites simultaneously, which results in significant economies of scale and facilitates increased program throughput
- Individual patient assessments by a pulmonologist via videoconferencing at the start of the program – this is highly valued by participants and an excellent extension of the telerehabilitation model
- Good support for telehealth across Alberta Health, both in policy and practice. Tandberg videoconferencing units are available in all health settings, which has significantly reduced the barriers to participation for remote sites

The Centre for Lung Health has developed a telerehabilitation model that fulfils its goals of increasing access to pulmonary rehabilitation programs for people who live away from major centres. This is a simple model which uses minimal equipment, although it is reliant on suitable staff and health care centres being available in regional settings. It is likely that this model could also be effective in many parts of Australia, although it would require significant additional investment in infrastructure.

**References**


Conclusions

The experiences of centres in Norway, Scotland, Spain and Canada clearly show that it is safe and feasible to deliver pulmonary rehabilitation using telehealth technologies, using a variety of program models. The following features of the telerehabilitation programs require careful consideration in Australia:

**Infrastructure for telerehabilitation**

Videoconferencing is a fundamental requirement for successful telerehabilitation. A high quality link between clinicians and their colleagues or patients at a remote site was a key feature of most of the programs I visited. Real-time interaction between individuals was highly valued by both clinicians and patients and seen as fundamental to the success of the telerehabilitation programs.

The two telerehabilitation programs that were most successfully embedded in clinical practice (The Centre for Lung Health in Edmonton Canada and Perth Royal Infirmary, Scotland) were located in health services where videoconferencing was readily available at all sites, including community health centres in small towns. The videoconferencing equipment was multi-use (ie also used by other clinical services) and thus the expense was spread over many clinical programs. Health service data networks had been designed to support such applications and support structures to facilitate clinicians’ use of videoconferencing were in place. The widespread availability of this simple technology removed significant financial practical barriers to telerehabilitation.

In Australia, videoconferencing is not yet widely available to clinicians in many health services, particularly in allied health and nursing. Significant investment in videoconferencing equipment will be required in order to extend telehealth to larger numbers of Australians who could benefit. The ability of health service data networks to support high quality videoconferencing and the availability of appropriate information technology support staff will also require further investigation.

**Telehealth and health policy**

High level policy support for telehealth has been an important driver of practice in both Scotland and Alberta, Canada. In Scotland, there is a clear mandate to offer telehealth solutions in policy regarding care for people with long term conditions.
Likewise in Alberta, high level executive support has been a key driver of telehealth solutions for remote patients and has resulted in successful transition from projects into programs. Similar drivers are required in Australia if telehealth is to become embedded in usual care.

Clinicians in centres where telehealth was not widely used by clinicians reported that there were funding barriers to the uptake of telerehabilitation in clinical practice. Reimbursement for patient care delivered by teleconferencing was frequently not available, particularly for allied health and nursing staff, and patient care provided via telerehabilitation was not included in annual funding agreements. Such barriers must be addressed in Australia if telerehabilitation and other telehealth interventions are to have wide uptake.

**Health service organisation**

Telerehabilitation programs in clinical practice are primarily being used to improve access to services for people with chronic lung conditions who live a long way from a major centre (Alberta, Perth and Kinross). These models consist of a tertiary hospital located in a metropolitan centre that has responsibility for provision of expert services to a large geographical area. Telerehabilitation provides an elegant and cost effective solution for these health services.

In Australia, the current structure of health services frequently does not facilitate links between major metropolitan hospitals and rural areas. Regional health services may not include any tertiary facilities and often have difficulty recruiting and retaining expert clinicians. There is little incentive for metropolitan centres to assist with regional service provision via telehealth for patients outside their service boundaries, either from a financial or a patient care perspective. Facilitating and formalising links between regional and metropolitan health services would increase the potential for expert clinicians to provide telehealth and telerehabilitation services in areas where they are most needed.

*Which telerehabilitation model works best? Home-based versus centre-based models*

**Centre-based telerehabilitation models**, such as those at Perth and Kinross and Edmonton, link a large centre (usually a tertiary hospital) to one or more smaller health care facilities via videoconferencing.
Advantages of centre-based telerehabilitation models are:

- Low costs, especially if videoconferencing equipment is already available at all locations
- Potential to ‘scale up’ the model quickly by connecting with multiple centres at once (e.g., Edmonton)
- Forges links between health professionals at the two sites, facilitating mentoring and ongoing professional education
- Videoconferencing is ideally suited to delivery of the education program to remote sites by the multi-disciplinary team at the central site

Disadvantages of centre-based models are:

- There must be a health professional at the remote site who is capable of supervising the exercise component of the program and monitoring participants for safety
- No direct supervision of the exercise component by the central clinician is possible, due to the constraints of videoconferencing with a large group.
- The model is not applicable to those people who cannot access a centre due to disability – this includes many people with chronic lung disease who live in metropolitan centres
- The model is not applicable to those who live in more remote areas where there may be no health care centre close by

Home-based telerehabilitation models link an expert clinician to multiple patients in their own homes. These models involve more sophisticated technology which includes videoconferencing and physiological monitoring.

Advantages of home-based models are:

- Suitability for participants who are severely disabled or housebound due to poor health
- Does not require a local health care centre
- Requires only one health professional at the central site, who can monitor multiple patients at a time
- Direct supervision of the exercise component by the expert clinician
Disadvantages of home-based models are:

- More expensive and complicated technology is required, although low cost options are being developed (eg at Norwegian Centre for Telemedicine)
- Smaller numbers of participants at any one time, depending on the capacity of the multipoint videoconferencing
- May not adequately replicate the group environment and peer supports that are a fundamental component of pulmonary rehabilitation programs.

In Australia I can see a role for both centre-based and home-based telerehabilitation programs. Centre-based models will work well in regional areas where small health care centres and hospitals can be linked inexpensively to larger centres via videoconferencing. Home-based models would be appropriate for the many people with chronic lung disease who cannot access a centre-based program due to disability, both in metropolitan and regional centres, and for those regional areas that do not have a health care centre nearby. Choice of model should be determined according to local needs.

**Delivering the essential components of pulmonary rehabilitation: considerations for telerehabilitation**

**Patient assessment**

A comprehensive patient assessment, performed prior to commencing pulmonary rehabilitation, is essential to optimise medical management, guide exercise prescription and inform goal setting. Physician assessment via videoconferencing is a highly valued component of the telerehabilitation program in Edmonton, as many patients who live out of the metropolitan area have not previously been assessed by a specialist respiratory physician. Although many assessment components (such as obtaining a clinical history and administering quality of life questionnaires) can be performed via videoconferencing, exercise testing is not possible without the direct supervision of a clinician. Assessment of exercise capacity is an essential component of pulmonary rehabilitation, without which accurate exercise prescription and assessment of program outcome are not possible. Consideration must be given to appropriate training of health care professionals at remote sites in administration of exercise tests, or provision made for expert clinicians to travel to the remote sites at the beginning and end of the program.
**Exercise training**

In order to achieve the full benefits of pulmonary rehabilitation, a sufficiently high intensity of exercise must be achieved during training. This is usually achieved by prescribing a target walking speed or power output (e.g., on an exercise bike), factors that are easy to monitor in a centre-based program. Monitoring exercise intensity is more challenging for home-based telerehabilitation programs. None of the home-based programs I visited were able to directly monitor exercise intensity, relying instead on symptom scores such as breathlessness and rate of perceived exertion. Although monitoring exercise intensity is desirable and technically feasible (e.g., power output from a cycle ergometer is a signal that could be easily relayed) this needs to be balanced against the larger equipment requirements and greater costs of such a model. More data regarding the outcomes of programs that do not monitor exercise intensity will assist in determining whether this feature is essential to maximise the benefits of telerehabilitation programs.

**Education**

Education regarding self-management of COPD is a core component of pulmonary rehabilitation and is generally provided by a multi-disciplinary team of health professionals. Telerehabilitation is ideally suited to delivery of such education as it enables patients at remote sites to access the expertise of the large multidisciplinary team located at a tertiary centre. The centre-based models I saw capitalised on this by providing group-based education to large numbers of participants simultaneously across multiple sites. Home-based programs were experimenting with different models, including educational DVDs that could be viewed offline and discussed with the clinician at the next session. At present there are no data to suggest which model of remote education is more effective. However, the involvement of the multidisciplinary team is a key component of pulmonary rehabilitation and involvement of clinicians from a range of disciplines should be sought in the development of new telerehabilitation programs.

**Integrating telerehabilitation into usual clinical care**

Only two of the telerehabilitation programs that I visited had been fully integrated into usual clinical care. The key features of these programs were:

- Ready access to videoconferencing in all health facilities, regardless of size
- Adequate technical support for clinicians
- Trust between clinicians at each site
• Health policy that promoted adoption of telehealth solutions.

Despite incredible advances in technology, adoption of telehealth into routine clinical practice has been poor around the world. Many successful projects have not been translated into ongoing programs. To ensure any investment in telerehabilitation is fruitful, consideration should be given to the sustainability of the program once the initial excitement has died down.

Telerehabilitation, like all of telehealth, is a process rather than a piece of technology (Wootton 1996). An appropriate and rigorous assessment of this process is required for decision makers to be adequately informed about its benefits. It has been suggested that an assessment framework for telemedicine services should encompass the following dimensions:

• Clinical effectiveness
• Economics (costs and benefits)
• Acceptance by patients and providers
• Equity of access
• Organisational impact (Masella and Zanaboni 2008)

New telerehabilitation projects should ensure that valid and reliable data relating to these assessment dimensions are collected.

**Disseminating the findings of my fellowship**

Improving access to pulmonary rehabilitation in Australia is an important challenge. I hope that the findings of this report will be of interest to patients, clinicians and policy makers. This report and its findings will be distributed to patient advocacy groups, health care professionals working in pulmonary rehabilitation and respiratory medicine, relevant state and federal government departments and private industry. In addition, the findings of this report will inform my current research which seeks to develop a model of home-based telerehabilitation for Australians with COPD and other chronic diseases.

**References**


Recommendations

Experiences of centres in Norway, Spain, Scotland and Canada show that it is safe and feasible to deliver pulmonary rehabilitation to people with COPD using telehealth technologies. Both centre-based and home-based telerehabilitation program models, using a variety of ICT technologies, have been tested around the world. The challenge that faces Australian healthcare providers and policy makers is to trial and evaluate telerehabilitation models that are best suited to identified local needs. In order for telerehabilitation to be successfully adopted in Australia, the following features are required:

1. Provision of multi-use, mobile videoconferencing equipment in all health care facilities, regardless of size or location
2. Ensuring that hospital data networks have sufficient capacity to support telehealth applications
3. On-site, timely technical support for clinicians seeking to use telehealth in clinical care
4. Inclusion of telehealth options in health policy, especially for the care of people with long-term chronic health conditions,
5. Consideration of remuneration models for telehealth providers including doctors, nurses and allied health
6. Formalising links between tertiary hospitals in metropolitan centres and health care providers in regional centres, to ensure that clinicians with appropriate expertise and capacity are available to support regional telehealth applications
7. Setting up low cost centre-based models of telerehabilitation in regional areas, where appropriate health care facilities and staff are available
8. Investigation of home-based telerehabilitation models for both metropolitan and regional centres, to facilitate access to pulmonary rehabilitation for those who are too disabled to access centre-based care or who live in remote areas
9. Involvement of the multi-disciplinary health care team, including allied health and nursing, in development of telerehabilitation programs
10. Rigorous assessment of new telerehabilitation programs, to ensure decision makers have valid and reliable data regarding the costs and benefits of telerehabilitation for Australians.