INTRA-DIALYTIC EXERCISE TRAINING: A PRAGMATIC APPROACH

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SUMMARY
This continuing education paper outlines the skills and knowledge required to plan, implement and evaluate a pragmatic approach to intra-dialytic exercise training.
Aim: The aim of this continuing education article is to enable the nephrology multi-disciplinary team (MDT) to plan, implement and evaluate the provision of intra-dialytic exercise training for patients receiving haemodialysis therapy.

LEARNING OUTCOMES: After reading this article the reader should be able to:
1. Appreciate the level of evidence base for the clinical effectiveness of renal exercise rehabilitation and locate credible sources of research and educational information
2. Understand and consider the need for appropriate evaluation and assessment outcomes as part of a renal rehabilitation plan
3. Understand the components of exercise programming and prescription as part of an integrated renal rehabilitation plan
4. Develop a sustainable longer term exercise and physical activity plan

KEY WORDS **Chronic Kidney Disease • Exercise • Haemodialysis • Physical activity • Rehabilitation**

BIODATA

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INTRODUCTION

The focus on increasing physical activity (PA) for those people at risk of developing cardiovascular disease (CVD) is at an all time high. Physical inactivity significantly increases the risk of premature morbidity and mortality in patients requiring haemodialysis (Kurella Tamura *et al*. 2009; Koufaki *et al*. 2013). There is an increased age profile of incident patients undergoing haemodialysis, with a median age of 65 years and an associated presence of the clinical syndrome of frailty (Johansen *et al*. 2007). This syndrome is characterised by persistent fatigue, weight loss, muscle weakness, severe functional limitations and low PA levels, many of which often deteriorate further with the initiation of haemodialysis (HD) (Kurella Tamura *et al*. 2009). This translates into impaired capacity to undertake activities of daily living (ADL), to live independently and to impaired quality of life (Kouidi 2004). Higher levels of physical function and habitual PA have been shown to be related to enhanced longevity, less morbidity and hospitalisation rates and enhanced quality of life, in patients receiving dialysis-based renal replacement therapy (O'Hare *et al*. 2003; Mapes *et al*. 2003; Sietsema *et al*. 2004).

Exercise rehabilitation has started gaining some attention as an appropriate and safe option to improve physical function and

quality of life, by aiming to alleviate muscle weakness/dysfunction and unfavourable cardiovascular outcomes. Physical inactivity is a modifiable risk factor and exercise interventions designed to increase PA and reduce sedentary behaviours in patients at risk of CVD may improve health-related outcomes and be cost-effective in the longer term (Johansen 2012; Koufaki *et al*. 2013). Haemodialysis therapy enforces regular sedentary behaviour three times a week, for up to four hours at a time. A main facilitator to intra-dialytic exercise would therefore be the reduced time and transport cost burden to patients, as exercise time can be incorporated during dialysis therapy. There is also the potential for an improvement in dialysis efficiency and enhanced solute removal since exercise opens vascular beds in a larger proportion of the body (Parsons & Toffelmire 2006; M.A. RRFaP 2005). Current understanding of UK-based practices indicates that provision of PA/exercise programmes for patients with Chronic kidney disease (CKD) appears to be extremely varied across the UK (and possibly across the whole of Europe) and is often only an option for patients in an area where research studies are being conducted. This paper intends to raise awareness among members of the renal MDT and present a pragmatic approach to intra-dialytic exercise.

THE RESEARCH LITERATURE

Currently there are four published systematic reviews and meta-analyses that have evaluated the overall effectiveness of exercise interventions on various health-related outcomes in patients from all stages of CKD and following transplantation (Heiwe 2011) and in patients on haemodialysis only (Cheema 2005; Segura-Orti 2010; Smart 2011). Koufaki *et al*. (2013) recently published a systematic review and synthesis of the research evidence in an attempt to summarise and translate research evidence into meaningful conclusions for clinical practice. The reader is directed to these published reviews for an in-depth analysis of the research literature. In brief, the following research evidence-based conclusions can be drawn regarding the safety and effectiveness of intra-dialytic exercise (Learning outcome 1). Most importantly and despite the high-risk status of patients on haemodialysis, no fatal or serious exercise-related adverse events have been reported. Structured and supervised moderate-intensity intra-dialytic cycling, which continues for at least three months but ideally six months, induces large and clinically meaningful improvement in peak cardiovascular fitness (VO_2 peak) that exceeds the 1 MET criterion of 3.5 ml/min/kg. Self-reported physical function also significantly improves, which may allow patients to engage in more daily PA, if they think they are able to. There is less systematic and consistent evidence on the effectiveness of increased exercise/PA on reducing CVD and other metabolic risk factors. The limitations of the reported clinical trials are many and include small sample sizes, great variability in reported outcomes and insufficient or incompletely reported application of exercise dose. These limitations need to be addressed in larger and longer-term clinical trials, in order to reach credible conclusions.

EXAMPLES OF EXERCISE REHABILITATION ACTIVITIES

Groups dedicated to the promotion of research and service provision of exercise rehabilitation in CKD exist in the UK and mainland Europe—the British Renal Society Rehabilitation Network (BRS-RN) and the European Association of Rehabilitation in Chronic Kidney Disease (EURORECKD), and also in Canada—the Canadian Renal Rehabilitation Network (CRRN). Some UK units already have dedicated physiotherapists, technical instructors or 'nurse champions'. Cycling on dialysis (intra-dialytic exercise) is the most widely used form of exercise for patients on haemodialysis in the UK. Recent UK developments in the therapeutic management of patients with CKD within the National Health Service have also resulted into the development and pilot implementation of outpatient-based renal rehabilitation programmes. Only a couple of renal units offer this type of routine, service-delivered renal rehabilitation programme (Greenwood *et al*. 2012).

PHYSICAL FUNCTION ASSESSMENT FOR PEOPLE WITH CKD

In the light of the strong associations between physical function limitations, muscle weakness, PA levels and adverse health outcomes (Eidemak *et al*. 1997; Mapes *et al*. 2003), physical function outcomes should be measured routinely as part of initial and on-going patient assessment. This section should enable the reader to understand and consider the need for appropriate evaluation and assessment outcomes as part of a renal rehabilitation plan (Learning outcome 2). The choice of assessment tools will largely be determined by the individual patient's overall health status and willingness to collaborate, and staff expertise and equipment availability. It is also important to note that for some patients, physical function/functional capacity assessment and especially determination of peak physiological capacity may be contraindicated such as in cases of uncontrolled co-existing medical conditions/infections, unstable on dialysis treatment with large fluctuations in blood pressure and inter-dialytic weight. Furthermore, the choice of type and specific protocol for physical

Methods	Measurement outcomes	End-points	Comments
Integrated exercise capacity			
Incremental shuttle walk	• Distance and speed	• No increases in BP with increasing workload	• Most patients terminate test because of muscle fatigue, breathlessness and/or lack of confidence
	Usual monitoring tools • Blood pressure/HR • Angina scales • Rate of perceived exertion (RPE) scales	• BP > 220/110 mmHg • Symptoms such as dizziness, angina, lack of responsiveness to oral and/or visual signs • Patient's request • Equipment failure	• Familiarisation session should be provided • See absolute contraindications to exercise testing • Reproducibility information available
Neuromuscular capacity			
Absolute dynamic muscle strength	1,3 5 maximum repetitions (RM)	• Patient's request	• Familiarisation sessions may be required
Relative dynamic muscle strength	Max number of repetitions performed at % of RM	• Inability to continue due to adverse symptom development	• Whole-body and muscle group-specific warm-up sessions are required
Hand-grip strength	Kg m s^{-1} or max kg achieved		• Muscle function-related measures are strong independent predictors of disease progress and survival • Reproducibility information available on some indices • Ease of comparability with a wide range of other chronic conditions
Functional capacity			
Walking tests	*Walking distanc*e (in metres) Incremental shuttle walk, six-minute walk) *walking speed* (in m s^{-1}) Shuttle walk test, 10-m walk, timed up and go	• Patient's request • Inability to continue due to adverse symptom development	• They objectively measure patients' capability to perform tasks that relate to activities of daily living • Reproducibility info available for some tests (STS, walking test, stair climb) • Familiarisation sessions may be required • Assessor and patient friendly • Quick and inexpensive • Minimum interference and inconvenience for patient • Ease of comparability with a wide range of other chronic conditions
Sit-to-stand tests	STS-5, STS-10 (in s) or STS-60 (total number in 60s)		
Stair climb-descent	Climbing and descent speed, 2-minute stair climbing test		
Squat test	Time (s) to perform 10 squats		
Balance			
Flexibility tests	Sit and reach		

Table 1: Summary of reported functional capacity tools that can be used with patients on dialysis for routine physical function assessment.

function assessment should be based upon the primary purpose of the assessment (diagnostic, exercise training prescription, risk stratification, etc.) and should also take into consideration the specific characteristics of the tests available (e.g. validity, reproducibility, responsiveness and availability of normative data). Summary information, extracted from the research literature, about the different types of physical function tests used with patients in CKD stage 5 is provided in Table 1. For more

detailed description of protocols and validity information interested readers are referred to the review by Koufaki and Kouidi (2010).

In addition to objective assessment of physical function performance, assessment of habitual PA levels is of paramount importance, but unfortunately this health outcome is less well reported in patients on haemodialysis. Ideally, comprehensive assessment of PA should include all its dimensions (frequency, duration, intensity) and domains (occupational, leisure time, domestic, transport). Subjective methods of assessment include PA questionnaires such as the seven-day physical activity recall questionnaire or the International PA questionnaire, among others. Objective methods to assess PA include accelerometers that ideally measure acceleration in three different planes. Examples of such acceleremetres include ActiGraph, RT3 and many more. A more interested reader is directed to a guide to the assessment of PA produced by the American Heart Association (Strath *et al*. 2013).

In addition to physical function tests, validated patient-reported outcome measures should be obtained to establish the improvement in physical function (HR-QOL). The Dukes Activity Status Index (DASI) is a self-administered questionnaire that contains 12 components related to physical activity, which the patient scores their perceived level of ability against (Hlatky *et al*. 1989).

In summary, physical function/PA assessment outcomes can be used to:

- Establish degree of functional impairment and identify the optimum timing for interventions
- Evaluate the presence and severity of symptoms and adverse clinical outcomes such as muscle wasting, angina thresholds, etc.
- Determine safe and effective exercise rehabilitation training zones
- Evaluate response to therapeutic interventions

Time out activity

What physical function and physical activity tests do you think will be practical to do in your own unit? Will this give you enough information to evaluate the impact of the programme on patient care in your unit?

INTRA-DIALYTIC CYCLING—A PRAGMATIC APPROACH

A pragmatic approach to prescription and delivery of intra-dialytic exercise training has been utilised for many years in some renal units in the UK and is described in the following sections to facilitate an understanding of the components of exercise programming and prescription as part of an integrated renal rehabilitation plan (Learning outcome 3).

PATIENT SUITABILITY FOR STARTING AN EXERCISE PROGRAMME

The following exclusion criteria should be considered before any patient is accepted for an intra-dialytic exercise programme:

- myocardial infarction within three months
- **unstable** angina
- acute infection
- acute orthopaedic condition
- uncontrolled hypertension (>180/100)
- uncontrolled arrhythmia
- other conditions raising concern over safety of exercise should be discussed with the patient's consultant

On-the-day exclusion might also include:

- symptomatic hypotension
- low blood glucose
- cannulation/fistula problems
- excessive fluid overload (>4 kg)

STAFFING

Ideally, a specialist nephrologist would encourage cycling on dialysis when a patient first starts on dialysis with the intention of introducing exercise as a necessary aspect of patient treatment, rather than an optional adjunct. They are optimally placed to provide the medical assessment of suitability for the exercise programme and on-going medical support. This then means that a qualified member of staff, whether that is a physiotherapist, nurse or dietician, would be able to lead patient management in this programme. The aim is that the intra-dialytic cycling becomes a standard component of a haemodialysis session for suitable patients. All exercise sessions must be performed in a setting where supervision is provided by appropriately qualified staff and resuscitation facilities are readily available.

There have been many programmes in the UK that have trialled different staffing approaches in the management of an intra-

dialytic cycling programme. Some programmes have been delivered successfully with the nurse-led or dietitian-led approach, but the consensus, and outcome of a number of small pilot studies (unpublished data), show that a physiotherapist/exercise professional-led approach with a physiotherapy assistant/technical instructor may be the most effective approach. Ideally, there should be a 'Link Nurse' for each unit to promote the service and liaise with either the nephrologist or physiotherapists should any concerns arise.

Time out activity

Which member of staff is best placed to manage an intra-dialytic cycling programme in your unit? Is it possible to make links with your local physiotherapy team?

EQUIPMENT

There are several designs of exercise cycles used in UK dialysis units; free-standing models, exercise cycles that attach to the dialysis chair/couch, and models that can be positioned for use on a hospital bed. Examples of this equipment can be found on the British Renal Society's Physical Activity network website: www.britishrenal.org/Physical-Activity. The option chosen may be dependent upon the type of dialysis couch in operation in the dialysis unit, or whether patients are dialysed on hospital beds.

Time out activity

Does your unit have dialysis couches or beds? Look at the website and see which type of cycle will suit your unit.

PRAGMATIC EXERCISE PRESCRIPTION

Patients should wear appropriate footwear and adopt a well-supported upper body and lower back body stature that does not overstress the shoulder and lower back muscles (depending on the mode and cycle ergometer) during leg cycling. The first five minutes of cycling should be a progressive warm-up (starting slow and increasing intensity) and the final five minutes should incorporate a gradual reduction of resistance to same levels of warm-up. Primarily reduce the intensity to 30–50% of the conditioning workload for three minutes, ad then to 20–0% for another three minutes. The duration and intensity of exercise prescription should be increased according to patient tolerance, using the following steps as a guideline.

1. The initial prescription should be based on the exercise assessment. If using an intra-dialytic cycle, then this can be used for the assessment. The exercise intensity should aim to be 50–60% of what a patient could achieve at baseline assessments. If possible the patient should aim for 15–20 minutes during the first intra-dialytic exercise session with a rest in between. Frail patients should aim to do 10-minute cycling, either as 5×2 minutes or 2×5 minute sessions (short rests in between).
2. The first target is to gradually increase duration of exercise. When patients can achieve two, 20-minute continuous cycling bouts at an intensity corresponding to 50–60% of baseline tolerance level as assessed (this is normally achieved within eight weeks for most patients), you can start increasing the intensity of exercise to 70–80% of baseline levels. When patients reach the desired moderate intensity level, aim to increase duration again to 30–40 minutes of continuous cycling (this is normally achieved within 24 weeks for most patients).

The Rate of Perceived Exertion (RPE) scale (Eston 1997), or a similar outcome, can be used to monitor the patients' perceived physical effort to replace intensity level and ensure that the patient is exercising at a tolerable level. If using the RPE scale, the patient should be asked to rate himself or herself during the training time of the program, optimally aiming for their RPE between 13 and 15, 'somewhat hard' to 'hard'. For each exercise session, the resistance, distance, time and RPE from that session should be recorded, as well as any reasons for stopping or not partaking in the exercise training.

This information can be used for progression and safety monitoring, to share achievements with patients, and to assess compliance with the programme. Haemodynamic measurements (BP/HR) should be recorded before, and at five and 10 minutes after the cessation of exercise to ensure that patients have returned close to pre-exercise levels but also to prevent any potential exercise-related hypotensive episodes. It is also advisable that patients with diabetes are asked to measure their blood glucose before and after the end of exercise with the aim prevent any exercise-related hypoglycaemic episodes.

GOAL SETTING

It is important to ascertain a patient's motivation to increasing their exercise levels and likeliness to adhere to the program (Rollnick & Miller 2008). To do this, behavioural change techniques such as motivational interviewing can help to resolve ambivalence for starting the program, and encourage a patient to continue. Goal setting is another important aspect

of any exercise program, and can be an effective way of improving motivation, as well as likelihood of achievement. The goals must be Specific, Measureable, Achievable, Realistic and Timed (SMART), for example, to be able to walk up one flight of 12 stairs, with no rests, within three months. Ideally goals should be set at baseline, and re-assessed at consistent time-points, whether that be three- or six-monthly by an exercise professional. Practical resources for goal setting can be found at www.cardiosmart.org.

MANUAL HANDLING POLICY

The available equipment varies in weight and manoeuvrability, and consideration should be applied when asking staff to manual handle them. All staff should adhere to a specific intra-dialytic exercise manual handling policy to avoid injury. Some considerations for a manual handling policy may include: before-use safety checks, how the bike is stored, positioning of the dialysis couch for exercise and the position of the person handling the equipment if lifting or moving the bike in position.

COMPETENCE

Training, provided by a physiotherapist to all staff involved in the intra-dialytic cycling programme, is important. Staff should be deemed competent to:

- Assess the patient's ability to exercise, including validated outcome measures.
- Be able to identify when a patient is not suitable to exercise.
- Design an appropriate exercise programme, based on the exercise assessment.
- Progress the patient's exercise intensity to an individual level using RPE, or an alternative scale.
- Use the equipment safely, adhering to manual handling policies.

Time out activity

Having thought about which cycle would be most suitable, make notes on what would need to be considered when designing a manual handling policy. Can you think of some bullet-point information for a 'cheat sheet'?

'CHEAT SHEETS'

The success of an intra-dialytic cycling programme is dependent upon staff feeling confident in what they are doing. A one-page 'cheat sheet', giving basic information that can be referred to at each individual exercise session, can be attached to a wall or trolley. This could include:

- Contraindications
- Exercise prescription advice
- Basic equipment instructions

POTENTIAL BARRIERS, AND SOLUTIONS, TO THE PROVISION OF INTRA-DIALYTIC EXERCISE PROGRAMMES

In order to successfully implement an intra-dialytic cycling programme, and develop a sustainable longer term exercise and physical activity plan (Learning outcome 4), it is crucial to also appreciate the global barriers to implementation, and then consider localised barriers that may need to be problem-solved within individual haemodialysis units. Pre-existing exercise beliefs of patients and haemodialysis unit staff members can be a strong demotivating factor for exercise. Staff members caring for patients receiving haemodialysis therapy may consider patients as 'too old' (Kurella Tamura *et al*. 2009) and 'too unwell' or 'uninterested' (Delgado & Johansen, 2012) in undertaking exercise during dialysis.

When surveying 100 patients receiving haemodialysis therapy Delgado and Johansen (2012) found the main patient barriers to exercise as fatigue on haemodialysis days (67%) and non-haemodialysis days (40%), shortness of breath (48%) and lack of motivation (42%). Often these identified patient barriers can be problem-solved through considering a holistic patient-centred approach, utilising motivational interviewing techniques to set patient-specific, meaningful and achievable goals to assist with compliance with the initiation of exercise, and the maintenance of longer-term exercise behaviour. Some other possible non-patient-related reasons for the lack of provision of intra-dialytic exercise may include: lack of physiotherapy expertise, lack of knowledge and/or incentive among nephrologists, lack of facilities, a lack of financial incentives, funding for staff time and equipment, a poor understanding of the benefits of exercise therapy and a fear of complications.

There are a number of potential strategies that could be utilised at a local level to tackle some of the potential barriers to implementation of an intra-dialytic exercise programme. Involving members of the renal multi-disciplinary team, such as renal specific physiotherapists or exercise physiologists, who

are well equipped to provide specific and individualised exercise prescription, whilst appreciating confounding co-morbidities, can facilitate a change in the 'exercise culture' of a renal unit. The local kidney patient associations (KPAs) in some areas of the UK have been hugely instrumental in initial funding for equipment and staffing, and promotion of renal exercise services. Visiting a renal unit with an active intra-dialytic exercise programme may alleviate initial fears about implementing a programme. There are also resources available such as the British Renal Society's Physical Activity network website: www.britishrenal.org/Physical-Activity, and the TIME programme (http://www.britishrenal.org/TIME.aspx), which has information about promotional posters, exercise diaries and the round Britain cycle ride.

Time out activity

What would the potential barriers to exercise during dialysis be in your unit?
Consider a brief survey among patients and staff and explore actions to overcome these unit specific barriers

THE WAY FORWARD—TRANSLATIONAL REHABILITATION

The evidence for the benefits of physical activity for patients with CKD is accumulating and encouragement to exercise and lead a physically active life style is included in national CKD management guidelines (guidelines KDcp 2000). The challenge is, quite clearly, how to translate the research findings outlined above into routine clinical practice. Strong evidence for the beneficial effects of exercise in non-research settings comes from the Dialysis Outcomes and Practice Patterns Study (DOPPS), published in 2010 (Tentori *et al*. 2010). A cross-section of 20920 DOPPS participants in 12 countries from 1996 to 2004 was reviewed. Regular exercise was associated with higher health-related quality of life, better physical functioning, fewer limitations in physical functioning, better sleep quality, less intrusiveness of body pain or anorexia, a more positive affect and fewer depressive symptoms. The offering of exercise in a unit was associated with 38% higher odds of patients exercising. Finally, overall mortality risk was lower in those units with more exercisers.

The following are suggestions for ways that might be adopted to facilitate the incorporation of exercise therapy into routine care.

- Education, support, advocacy

  This should be offered to nephrologists in post, and in training and to nurses

- Exercise promotion and provision should be offered as part of routine care in all renal units
- Standards of care relating to exercise rehabilitation, endorsed by national and professional bodies, should be developed, with an agreed timescale for their implementation. The participation of representative patients' groups (National Kidney Federation in the UK) should be part of these activities
- The documentation of functional capacity initially and serially after the start of dialysis should exist in all national registries. In addition, every unit undertaking exercise promotion and delivery should document its effects and associations as part of routine care.
- Funding of well-designed, multicentre research continues to be crucial to provide a better evidence base. Future larger research trials should aim to specifically address the relationship between changes in physiological function and whether these translate into changes in functional outcome benefits and increased survival.

Areas in which no clear conclusions can be drawn from the current research literature that need to be addressed are: the effects of exercise on vascular function and incidence of cardiovascular events, dialysis efficiency, nutritional supplementation, blood pressure and systemic inflammation.

SUMMARY

Thus, although the research evidence base needs enriching, the association between exercise and better outcomes in the dialysis population is sufficiently strong to state the following. It is now time, as has been stated by a number of authors of previous reviews, for nephrologists and their MDT colleagues, for their professional bodies and for government health departments to recognise the importance of this area of renal care. Exercise rehabilitation for CKD patients should be implemented in renal units in as timely and comprehensive way as possible.

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CONFLICT OF INTEREST

No conflict of interest has been declared by the author(s).

AUTHOR CONTRIBUTIONS

SG and PK: Principal Project Leaders. SG, PK, PN, RC, EOC, T.M, VP: conceived study, participated in design and coordination, read and approved the final manuscript. SG, PK, PN, VP, RC, EOC, T.M, IM: helped to draft manuscript, read and approved the final manuscript.

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