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Remote physiotherapy monitoring using the novel D+R Therapy iPhone application

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ABSTRACT

Background: Patient compliance to physiotherapy after surgical intervention is key to optimal functional outcome. This has been recognised by published literature over a number of decades. Improving and monitoring patient compliance remains a challenge. This paper explores the use of a website linked iPhone application that may be used to address this issue.
Purpose: The purpose of this case study was to assess if the D+R Therapy application was of benefit to a patient and to assess the advantages and disadvantages of such a system.
Method: One patient who underwent knee cartilage resurfacing surgery was followed up in the post-operative period.
Results/conclusion: The D+R Therapy platform may provide a timely and cost effective method of managing patients undergoing musculoskeletal physiotherapy. Costs may be reduced by exploiting the hardware patients already own, and identifying non-compliant patients who may be of interest to both healthcare providers and insurers.
Level of evidence: Level IV.

1. Introduction

Patients who undergo orthopaedic surgery often require post-operative physiotherapy. These physical exercises aim to encourage movement and improve functional outcome. Early introduction, increasing complexity and regular supervision are regarded to provide superior results.[12] Patients are monitored regularly by their physiotherapist in clinic and their exercises amended accordingly.

Compliance with treatment is an important factor that influences final functional outcome.[1] Compliant patients have better outcomes than non-compliant patients.[13] Poor adherence has been recognised across many healthcare disciplines including physiotherapy.[2,3] One study found that 14% of physiotherapy patients did not return for follow-up appointments,[4] whilst another suggested non-adherence with treatment as high as 70%.[5] Poor adherence has implications on treatment cost and effectiveness.[6] One may anticipate that a greater level of monitoring would lead to better functional outcomes via the Hawthorne effect alone.[7]

D+R Therapy is a platform that allows patients to be remotely monitored. It consists of a downloadable iPhone application and linked website. Exercises are prescribed by the physiotherapist via the website and appear on the iPhone screen when the application is initiated. A text description and video clip are also included to remind patients of the exercises they are required to perform.

Patients undertake their musculoskeletal physiotherapy exercises whilst wearing their own smartphone on the appropriate limb (e.g., the upper arm for shoulder exercises). Movement is detected by the iPhone and data recorded and sent to the website where it can be accessed by their clinician. Data is displayed as a simple dashboard and graphically if required. A clinician is able to identify those patients who are non-compliant, who would then require encouragement, as well as those who are progresing rapidly and whose exercises should be altered accordingly (as in the case of professional athletes).

We therefore undertook this case study on a volunteer who had undergone knee surgery to trial this remote platform.

2. Case study

A 45-year-old woman presented with right knee pain, locking and giving way. She underwent an MRI scan that revealed cartilage defects at 2 sites, the distal femur (3 cm × 2 cm) and proximal tibia

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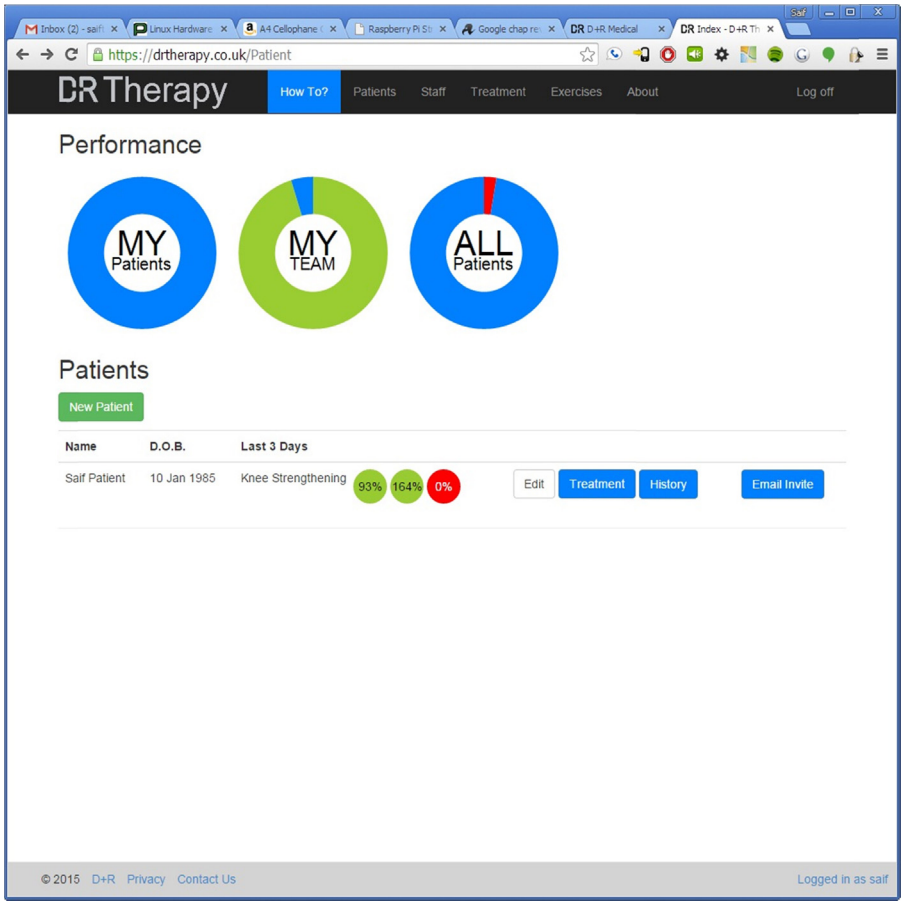

Fig. 1. The website dashboard.

(2 cm × 2 cm). A stem cell based cartilage repair procedure was recommended.

Under a general anaesthetic bone marrow was harvested from the right iliac crest and centrifuged to isolate pleuripotent stem cells. These were prepared and mixed with a hyaluronic gel and thrombin.

A right knee arthroscopy was performed and the femoral and tibial surfaces debrided and prepared for implantation. The joint was dried and infused with carbon dioxide, stem cells introduced and joint range of movement (ROM) noted to check the stability of the graft. The joint was closed in a standard manner.

In the immediate post-operative period, physiotherapy exercises were prescribed and she was reviewed on a weekly basis by a musculoskeletal physiotherapist. As an adjunct exercises were also prescribed on the D+R Therapy website (www.drtherapy.co.uk) which appeared on the patient's own iPhone5 via the predownloaded application (D+R Therapy). The patient was asked to attach her smartphone to her lower limb over the medial aspect of the lower tibia. The smartphone was held in place by an iPhone armband. The application was initiated and used to record limb movement for each exercise (Figs. 1–3).

3. Discussion

Patients who undergo orthopaedic surgery often require post-operative physiotherapy, and on occasion pre-operative physiotherapy. Currently, therapists are only able to monitor their patient's progress, and amend their exercises by reviewing them at regular intervals in clinic.

The issue of poor compliance has been recognised for several decades[8] but little has been done to address this common problem. This case study explored the use of a novel iPhone/Web platform that allows patients to be remotely monitored, ensuring they are performing their exercises correctly and altering their prescribed exercises where necessary.

The data recorded was accurate with regards to both time of use and repetitions performed as normal algorithms have been generated and allow comparisons to be made with those of the patients. The range of movement are recorded and presented in all three planes, as is acceleration, which in combination is likely to provide a better functional indicator of progress and outcome. The data was surprisingly clean with very little "noise". As a result this system does allow the progress made by a patient to be recorded and remotely monitored.

A distinct advantage of this platform is the use of the patient's own hardware, i.e. the iPhone. Smartphones contain the hardware necessary to detect movement, a feature exploited by the gaming industry. Patients seldom leave their smartphones and this device is always with them.

The software written for the platform displays a text description of the exercise to be performed as well as a video clip demonstrating the movement. This guide alone is likely to improve compliance as currently patients may explain their lack of progress due to losing the instruction leaflet describing the recommended exercises given to them by their clinician.

As with any health platform, security is essential and this system was written using Microsoft's Azure platform and is HIPPA compliant. All data is encrypted at rest and in transit and not stored on the device (reducing the memory burden of the smartphone).

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