Original article

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.

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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.^{1,2} 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.^{1,3} 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 progressing 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 pluripotent 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 pre-downloaded 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 decades⁸ 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 HIPAA compliant. All data is encrypted at rest and in transit and not stored on the device (reducing the memory burden of the smartphone).

Fig. 2. Exercises performed (frequency and repetitions).

Fig. 3. Individual movement recordings can be reviewed and downloaded.

The cost implications are significant^{9–11} with 5 areas where D+R Therapy can show benefits:

1. Patients get clearer information on their progress through gamified feedback from the application and hence better outcome.
2. The physiotherapist can remotely follow their patient's progress and amend exercises via the web (patients can be notified through an integrated push notification and those who are poorly compliant can be encouraged, those excelling can rapidly progress through their programme as is the case with athletes).
3. The number of hospital visits may be reduced as patients are remotely monitored. This would benefit working patients who would not have to take additional days off work. Physiotherapy departments would also benefit: a two-session reduction in a District General Hospital for shoulder decompression physiotherapy alone would reduce cost by approximately £80,000 (for a unit serving a population of 400,000).
4. Orthopaedic surgeons would be provided with accurate data of patient's performance in the pre-operative and post-operative period. This would allow them to counsel patients appropriately. Poor outcomes may be predicted in poorly compliant patients and hence reduce complaints and legal action against surgeons.
5. Private Medical Insurance companies would benefit from the data, identifying poorly compliant patients that may impact on patient premium.

From a patient's perspective our subject clearly understood the benefit of the platform. She was able to view the video clips for those exercises and motivated to undertake them. Her confidence in the programme was raised as she was aware that her clinician was remotely monitoring her progress. She was positively motivated to perform her rehabilitation exercises as she was able to see the performance charts generated. This also provided an opportunity for her to discuss her progress with her physiotherapist. In addition, she felt she would have been unlikely to perform the exercises fully without the support of the platform. However, she felt it difficult to start the app having attached it to the ankle due to pain and swelling and needed some help with regards to this.

4. Conclusion

These initial findings suggest that a remote method of assessing progress through a physiotherapy programme is now a practical possibility. Additional research is required to formally compare the rate of progress and functional outcomes of this novel platform.

D+R Therapy may provide a timely and cost effective method of treating patients by exploiting the hardware patient's already own, and identifying non-compliant patients which may be of interest to both healthcare providers and insurers.

Disclaimer

This study was not sponsored by any company. Any mention of commercial products, processes, or services cannot be construed as an endorsement or recommendation.

Conflicts of interest

The authors have none to declare.

References

1. Hayden JA, van Tulder MW, Tomlinson G. Systematic review: strategies for using exercise therapy to improve outcomes in chronic low back pain. *Ann Intern Med.* 2005;142(9):776–785.
2. Friedrich M, Gittler G, Halberstadt Y, Cermak T, Heiller I. Combined exercise and motivation program: effect on the compliance and level of disability of patients with chronic low back pain: a randomized controlled trial. *Arch Phys Med Rehabil.* 1998;79(5):475–487.
3. Campbell R, Evans M, Tucker M, Quilty B, Dieppe P, Donovan J. Why don't patients do their exercises? Understanding non-compliance with physiotherapy in patients with osteoarthritis of the knee. *J Epidemiol Community Health.* 2001;55(2):132–138.
4. Vasey L. DNAs and DNCTs – why do patients fail to begin or complete a course of physiotherapy treatment? *Physiotherapy.* 1990;76:757–765.
5. Sluijs EM, Kok GJ, van der Zee J. Correlates of exercise compliance in physical therapy. *Phys Ther.* 1993;73(11):771–782. [discussion 783–86].
6. Jack K, McLean SM, Moffett JK, Gardiner E. Barriers to treatment adherence in physiotherapy outpatient clinics: a systematic review. *Man Ther.* 2010;15(June (3)):220–228.
7. McCambridge J, Witton J, Elbourne DR. Systematic review of the Hawthorne effect: new concepts are needed to study research participation effects. *J Clin Epidemiol.* 2014;67(March (3)):267–277. <http://dx.doi.org/10.1016/j.jclinepi.2013.08.015>. PMID: PMC 2473969.
8. Jack K, McLean SM, Gardiner E. Barriers to treatment adherence in physiotherapy outpatient clinics: a systematic review. *Man Ther.* 2010;15(June (2–3)):220–228. <http://dx.doi.org/10.1016/j.math.2009.12.004>.
9. Daruwalla ZJ, Keng Lin W, Thambiah J. The application of telemedicine in orthopedic surgery in Singapore: a pilot study on a secure, mobile telehealth application and messaging platform. *JMIR Mhealth Uhealth.* 2014;2(June (2)):e28.
10. Dustin K, Baker BS, Charles T, Fryberger BS, Brent A, Ponce MD. The emergence of augmented reality in orthopaedic surgery and education. *Orthop J Harv Med Sch.* 2015.
11. Garden RM. Outpatient orthopedics and the impact of telemedicine upon costs and patient care. *J Correct Health Care.* 2015.
12. Ferrari S, Vanti C, O'Reilly C. Clinical presentation and physiotherapy treatment of 4 patients with low back pain and isthmic spondylolisthesis. *J Chiropr Med.* 2012;11(June (2)):94–103. <http://dx.doi.org/10.1016/j.jcm.2011.11.001>.
13. Vermeire E, Hearnshaw H, Van Royen P, Denekens J. Patient adherence to treatment: three decades of research. A comprehensive review. *J Clin Pharm Ther.* 2001;26(5):331–342.