

---

## **An acute knee injury: tracking a two-year recovery online**

---

**Clare F. Taylor\***

c/o Secretary to Mr. D. Williams,  
Department of Trauma and Orthopaedics,  
Royal Cornwall Hospital (RCH),  
Truro, Cornwall, TR1 3LJ, UK  
Fax: 01872 253449  
Email: cft199@doctors.org.uk  
\*Corresponding author

**Daniel H. Williams**

Department of Trauma and Orthopaedics,  
Royal Cornwall Hospital (RCH),  
Truro, Cornwall TR1 3LJ, UK  
Email: dan.williams@rcht.cornwall.nhs.uk

**Abstract:** Current government policy aims to deliver high quality healthcare by recording accurate data at the point of giving care, storing it efficiently and displaying it in a format, which is easily interpreted by healthcare professionals and patients. Few published reports describe the benefits of collecting and reporting such data from the point of view of the patient. We report the case of a 62-year-old lorry driver who used a web-based system to track patient reported outcome measures (PROMs) following an acute knee injury to full recovery over a 24-month period. The system reports clinical outcome scores in real-time to the patient and their medical team, clearly illustrating and enhancing recovery from injury. This case reveals how local software meets the needs of the individual patient linking and integrating such local systems must be the future focus of eHealth within the NHS to release the benefits presented by the information revolution.

**Keywords:** acute knee injury; information revolution; PROMs; patient reported outcome measures; electronic patient reported outcome measures; electronic healthcare; tracking recovery following injury; national PROMs program; electronic data collection; national program for information technology; Oxford knee score.

**Reference** to this paper should be made as follows: Taylor, C.F. and Williams, D.H. (2015) 'An acute knee injury: tracking a two-year recovery online', *Int. J. Electronic Healthcare*, Vol. 8, No. 1, pp.1–8.

**Biographical notes:** Clare F. Taylor is a Trauma and Orthopaedic Registrar on the Southwest Peninsula rotation in the UK, with an interest in soft tissue knees and sports injuries. She graduated from Southampton University Medical School in 2004 and completed her basic surgical training in the peninsula deanery including six months at the Royal Perth Hospital in Western Australia.

She took up the position of Registrar on the Southwest rotation in 2011 and has developed an interest in knee surgery and sports injuries. On completion of training she would like to undertake subspecialty fellowships in Trauma and soft tissue knee.

Daniel H. Williams is a Consultant Trauma and Orthopaedic Surgeon at the Royal Cornwall Hospital, UK, with an interest in primary/revision hip & knee arthroplasty. He published his Master's degree thesis on impingement in hip resurfacing arthroplasty and following subspecialty fellowships in Seattle, Oxford and the University of British Columbia, has developed an interest in measuring clinical outcomes. He strongly believes that Orthopaedics worldwide must better measure Patient Reported treatment specific Outcomes (PROMs). His part of a group that's designed and built the myClinicalOutcomes.co.uk website, a web-based system that enables live and remote analysis of cohort and individual patient data.

---

## **1 Introduction**

The Department of Health (DH) published 'Liberating the NHS: An Information Revolution' in 2010 stating that the delivery of high quality healthcare depends on recording accurate data at the point of giving care, storing the information in an efficient way and displaying it in a format which is easily interpreted by both healthcare professionals and patients. This enables healthcare services to deliver care in a safer and more efficient way, and encourages shared decision-making (Jones et al., 2010).

Patient reported outcome measures (PROMs) comprise validated condition-specific or generic question sets that measure patient symptoms. PROMs have been used in research – as outcomes in clinical trials and economic evaluations – for many years (Appleby et al., 2004; Fung and Hays, 2008; Greenhalgh, 2008; Marshall et al., 2006; Rose and Bezjak, 2009; Snyder and Aaronson, 2009) and have recently migrated into everyday clinical practice (Appleby and Devlin, 2005; Black, 2013; Fung and Hays, 2008; Rothwell et al., 2010; Snyder and Aaronson, 2009).

The National PROMs Program (Department of Health, 2008) started to collect data in 2009 about four procedures (including hip and knee replacement) and has already revealed powerful insights when linked to other datasets (Baker et al., 2012a, 2012b). The challenge now is to enable real-time clinical use of such data across a wider range of clinical conditions and problem areas. This case report demonstrates how the collection of PROM scores, using a web-based system illustrated and enhanced the recovery from an acute knee injury.

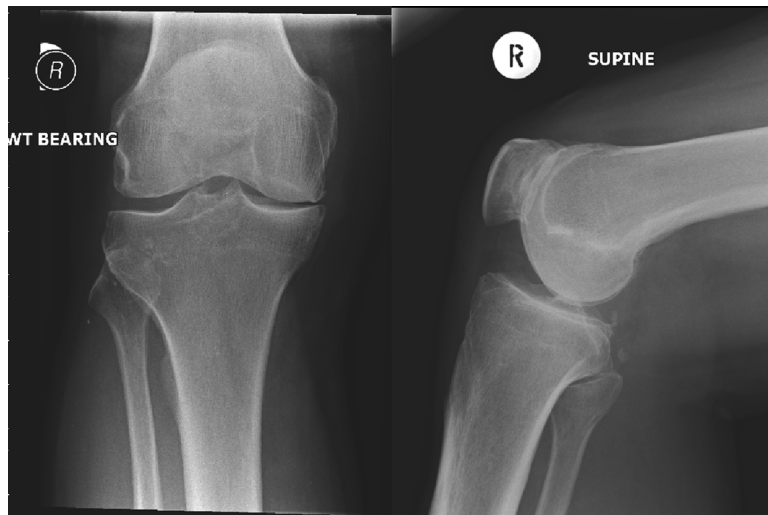
## **2 Case report**

A 62-year-old lorry driver was referred for an orthopaedic opinion with symptoms of ongoing right knee pain following a fall from his tanker onto hard ice five months prior to presentation. He was fit and well with no previous problems or complaints affecting that knee or leg. Examination of the right knee revealed flexion from 0 to 120 degrees with mild tenderness over the medial femoral condyle, stable ligaments, a normal McMurray's test and no distal neurovascular deficit.

The X-ray films showed mild medial joint space narrowing without any obvious bony abnormality (Figure 1). A T2-weighted magnetic resonance imaging (MRI) scan revealed evidence of an undisplaced and incomplete subchondral fracture of the medial femoral condyle with associated bone bruising (Figure 2).

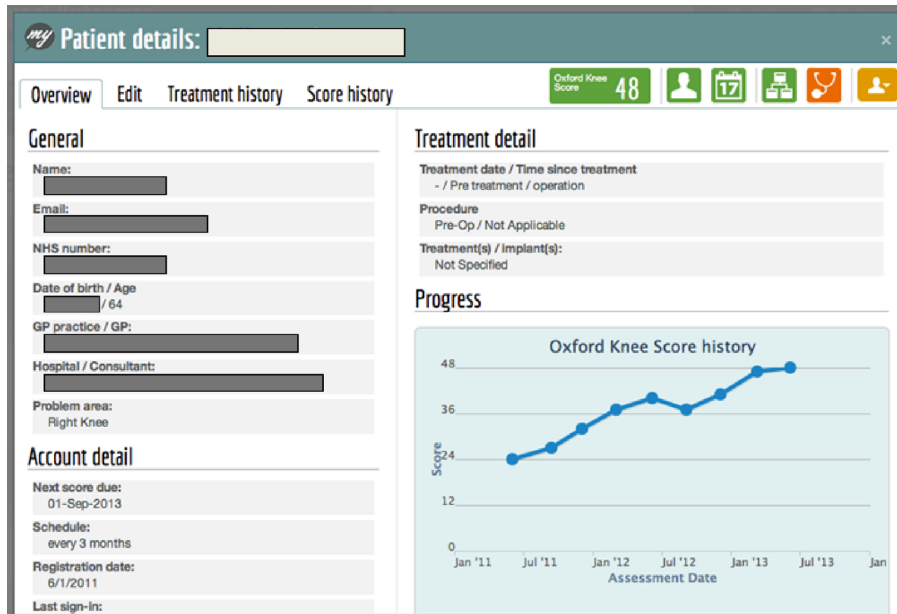
The patient was referred for physiotherapy to improve quadriceps strength and was encouraged to begin low impact cycling. At the same time the patient was asked to register on the web-based system in use at our institution for collecting clinical outcome scores. The patient registered demographic details, completed a condition specific and general well being PROM and consented to share their real-time clinical outcome data with their medical team. The system then enabled symptom scores to be monitored remote from the clinic setting enabling the patient's progress to be tracked between face-to-face appointments (Figure 3).

**Figure 1** Anteroposterior and lateral X-ray films of the right knee



**Figure 2** Coronal and sagittal T2 weighted MRI images of the right knee



**Figure 3** The surgeon's view of this patient's recovery curve on myClinicalOutcomes.co.uk (see online version for colours)

Source: Williams (2012)

The initial Oxford knee score (OKS) was 24/48 (worst to best 0–48) (Dawson et al., 1998) (Table 1). The patient was reviewed in clinic five months later and was proceeding well with a small improvement in the OKS, slowly building up the quantity of quadriceps strengthening exercises and low impact cycling. At 12 months the patient was cycling on a static bike on a daily basis and apart from occasional twinges of pain over the inside of the knee reported complete resolution of his symptoms; the OKS was 40/48. At final review at 16 months (21 months following the initial injury) the patient was cycling regularly and reported further improvements in his symptoms. The OKS at this time was 37/48 with a howRU score of 10/12 (Benson et al., 2010).

**Table 1** Oxford knee score (OKS) (Dawson et al., 1998) and howRU (Benson et al., 2010) recorded over a 24-month period from the initial consultation

	OKS/48	%	howRU/12	%
0	24	50	–	–
3	27	56	–	–
6	32	67	11	92
9	37	77	10	83
12	40	83	11	92
15	37	77	10	83
18	41	85	12	100
21	47	98	12	100
24	48	100	12	100

The patient was encouraged to monitor his clinical outcome scores beyond this final review and at 24 months the OKS was 48/48 and the howRU score 12/12. These clinical outcome scores indicated a good recovery and were reassuring to both the patient and the medical team (Figure 3).

### **3 Discussion**

‘Electronic health’ was first defined in 1999 and describes information technology and communication as applied to healthcare (Kadda, 2010; Efstathiou, 2008). The Internet has for some time been used for remote monitoring and industrial process control and virtual laboratories (Al-Rousan et al., 2006). Remote monitoring concepts have migrated into the healthcare sector allowing patients to be monitored away from the clinic setting, while still maintaining a patient centred approach. Remote patient monitoring can be defined as a service that enables physicians to access up-to-date patient status through the use of advanced telecommunication technology (Metaxiotis et al., 2004; Demiris, 2004).

In 2004 the Department of Health launched the NHS National Program for Information Technology (NPIIT) (Hendy et al., 2005), an initiative designed to create a central secure electronic patient record. The aim was to connect general practitioners (GPs) to hospitals while providing patients with access to their online clinical record. The cost of the program ran to some £12 billion and this top-down, one size fits all approach comprehensively failed to meet the local needs of the some 300 NHS trusts and 30,000 GPs. Significant delays, technical difficulties and rising costs led the Health secretary and NHS chief executive to discontinue the program late in 2011. The focus has since turned to the procurement and development of local software solutions with NHS care providers agreeing local IT contracts that address the needs of their local patients and medical teams (Campbell, 2011).

While many articles describe and discuss the benefits of collecting and using electronic data in clinical practice (Appleby and Devlin, 2005; Black, 2013; Fung and Hays, 2008; Rothwell et al., 2010; Snyder and Aaronson, 2009), there are few practical examples describing the advantages of using such data from the patient’s point of view. The case described here reveals how one such system, developed to meet local needs, enabled a patient with a knee injury to track his recovery over a two-year period using clinical outcome scores and to reach an OKS of 48/48 and a howRU score of 12/12. Scoring systems even with a low ceiling effect cannot infer complete recovery but can indicate at least a good recovery when viewed in the context of earlier scores (Jenny and Diesinger, 2012)

The system here also met the needs of the medical team who were able to track the patient’s score away from the clinic in the context of other patients with similar conditions. Aggregated comparison results are available at an individual patient, treatment cohort or specific demographic level. This allows patients with a low or deteriorating outcome score to be brought back for a face-to-face review at an appropriate time point while well patients, such as the patient described here, can be followed at home. To do this, a remote patient monitoring system must allow real-time data transfer, allow multiple doctors to remotely monitor their patients at the same time, allow one doctor to monitor multiple patients at the same time and/or allow a group of doctors to monitor one patient (Al-Rousan et al., 2006). Such a system offers the potential of increased efficiency, personalised attention, enhanced quality and equality of

management to all patients, while taking into account financial pressures placed on patients attending repeated hospital appointments (Kadda, 2010).

This single patient case study points towards what a future well designed study might look like. The assessment of recovery in this study beyond 21 months post-injury was based only on the OKS and howRU scores. The howRU is a short generic measure of health related quality of life that measures how the patient is feeling physically and mentally, and how much they can do in terms of function and independence. It was designed with electronic data collection in mind and has been validated against the Short form-12 (SF-12) (Ware et al., 1996) score at the aggregate level (Benson et al., 2010).

The OKS is a 12 question PROM specifically designed and developed to assess function and pain after total knee replacement (TKR). While the OKS is reliable and validated only when used in patients undergoing TKR surgery (Dawson et al., 1998); the Oxford scores (both hip and knee) have now been used widely for evaluating other interventions (Clarke et al., 2005; Reilly et al., 2005; Weale et al., 2001) including trauma (Mishra et al., 2004). Trauma scoring systems are available for use in the initial assessment of major trauma patients, to aid with resuscitation and ongoing acute management, and specific trauma outcome scores, mainly record survival, length of hospital stay, complications, and general health status (Revell et al., 2003). Further work using existing PROMs is therefore required or new measures require development to assess pain and functional recovery from episodes of trauma. Making use of web-based collection could speed up this work.

This case reveals how one web-based system, developed to meet local needs, enabled a patient with a knee injury to track his recovery over a two-year period. Linking such successful local systems to established national programs is now required to meet the vision described in the DH's 2010 paper 'Liberating the NHS: An Information Revolution' (Jones et al., 2010). Linked cost-effective systems would enable patients and their medical teams to access powerful national data, allowing cohort comparison and empowered decision making. Electronic healthcare as originally described by Eysenbach (Efstathiou, 2008).

## References

- Al-Rousan, M., Al-Ali, A.R. and Eberlein, A. (2006) 'Remote patient monitoring and information system', *International Journal of Electronic Healthcare*, Vol. 2, No. 3, pp.231–249.
- Appleby, J. and Devlin, D. (2005) *Measuring NHS Success: Can Patients views on Health Outcomes Help to Manage Performance?*, The King's Fund, London.
- Appleby, J., Devlin, N., Maynard, A., Scott, H. and Vallance-Owen, A. (2004) *Measuring Success in the NHS*, Dr Foster, Kings Fund and City University, London.
- Baker, P.N., Deehan, D.J., Lees, D., Jameson, S., Avery, P.J., Gregg, P.J. and Reed, M.R. (2012a) 'The effect of surgical factors on early patient-reported outcome measures (PROMS) following total knee replacement', *Journal of Bone and Joint Surgery – British Volume*, Vol. 94-B, No. 8, pp.1058–1066.
- Baker, P.N., Petheram, T., Jameson, S.S., Avery, P.J., Reed, M.R., Gregg, P.J. and Deehan, D.J. (2012b) 'Comparison of patient-reported outcome measures following total and unicondylar knee replacement', *Journal of Bone and Joint Surgery – British Volume*, Vol. 94-B, No. 7, pp.919–927.
- Benson, T., Sizmur, S., Whatling, J., Arikan, S., McDonald, D. and Ingram, D. (2010) 'Evaluation of a new short generic measure of health status: howRu', *Informatics in Primary Care*, Vol. 18, No. 2, pp.89–101.

- Black, N. (2013) 'Patient reported outcome measures could help transform healthcare', *British Medical Journal*, Vol. 346, jan28 1, pp.f167-f167.
- Campbell, D. (2011) 'NHS told to abandon delayed IT project', *theguardian.com* [online]. Available at: <http://www.theguardian.com/society/2011/sep/22/nhs-it-project-abandoned> (Accessed 20 August, 2013).
- Clarke, S., Lock, V., Duddy, J., Sharif, M., Newman, J.H. and Kirwan, J.R. (2005) 'Intra-articular hyaluronan G-F 20 (Synvisc) in the management of patellofemoral osteoarthritis of the knee (POAK)', *Knee*, Vol. 12, pp.57–62.
- Dawson, J., Fitzpatrick, R., Murray, D. and Carr, A. (1998) 'Questionnaire on the perceptions of patients about total knee replacement', *Journal of Bone and Joint Surgery – British Volume*, Vol. 80, No. 1, pp.63–69.
- Demiris, G. (2004) 'Electronics home healthcare: concepts and challenges', *International Journal of Electronic Healthcare*, Vol. 1, No. 1, pp.4–16.
- Department of Health (2008) *Guidance on the Routine Collection of Patient Reported Outcome Measures (PROMs)*, Department of Health (11007), London.
- Efstathiou, E. (2008) *Implementation of a System of Oxygen Saturation in the Blood and of Cardiac Frequency for a Remote Home Based Health Care Observation*, MSc Thesis, National Technical University of Athens, School of Electrical and Computer Engineering, Department of Systems of Communications and Materials' Technologies.
- Fung, C.H. and Hays, R.D. (2008) 'Prospects and challenges in using patient-reported outcomes in clinical practice', *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, Vol. 17, No. 10, pp.1297–1302.
- Greenhalgh, J. (2008) 'The applications of PROs in clinical practice: what are they, do they work, and why?', *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, Vol. 18, No. 1, pp.115–123.
- Hendy, J., Reeves, B.C., Fulop, N., Hutchings, A. and Masseria, C. (2005) 'Challenges to implementing the national programme for information technology (NPfIT): a qualitative study', *British Medical Journal*, Vol. 331, No. 7512, pp.331–336.
- Jenny, J.Y. and Diesinger, Y. (2012) 'The Oxford Knee score: compared performance before and after knee replacement', *Orthopaedics and Traumatology, Surgery and Research: OTSR*, Vol. 98, No. 4, pp.409–412.
- Jones, P., Mason, K. and Eccles, S. and Department of Health (2010) *Liberating the NHS: An Information Revolution*, London The Stationary Office (7881).
- Kadda, A. (2010) 'Social utility of personalised e-health services: the study of home-based healthcare', *International Journal of Electronic Healthcare*, Vol. 5, No. 4, pp.403–413.
- Marshall, S., Haywood, K. and Fitzpatrick, R. (2006) 'Impact of patient-reported outcome measures on routine practice: a structured review', *Journal of Evaluation in Clinical Practice*, Vol. 12, No. 5, pp.559–568.
- Metaxiotis, K., Ptochos, D. and Psarras, J. (2004) 'E-health in the new millennium: a research and practice agenda', *International Journal of Electronic Healthcare*, Vol. 1, No. 2, pp.165–175.
- Mishra, V., Thomas, G. and Sibly, T.F. (2004) 'Results of displacement subcapital fractures treated by primary total hip replacement', *Injury*, Vol. 35, pp.157–160.
- Reilly, K.A., Beard, D.J., Barker, K.L., Dodd, C.A., Price, A.J. and Murray, D.W. (2005) 'Efficacy of an accelerated recovery protocol for Oxford unicompartmental knee arthroplasty: a randomised controlled trial', *Knee*, Vol. 12, pp.351–357.
- Revell, M.P., Pynsent, P.B., Abdudu, A. and Fairbank, J.C.T. (2003) 'Trauma scores and trauma outcome measures', *Trauma*, Vol. 5, pp.61–70.
- Rose, M. and Bezjak, A. (2009) 'Logistics of collecting patient-reported outcomes (PROs) in clinical practice: an overview and practical examples', *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, Vol. 18, No. 1, pp.125–136.

- Rothwell, A.G., Hooper, G.J., Hobbs, A. and Frampton, C.M. (2010) 'An analysis of the Oxford hip and knee scores and their relationship to early joint revision in the New Zealand Joint Registry', *Journal of Bone and Joint Surgery – British Volume*, Vol. 92-B, No. 3, pp.413–418.
- Snyder, C.F. and Aaronson, N.K. (2009) 'Use of patient-reported outcomes in clinical practice', *Lancet*, Vol. 374, No. 9687, pp.369–370.
- Ware, J.E., Kosinski, M. and Keller, S.D. (1996) 'A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity', *Medical Care*, Vol. 34, pp.220–233.
- Weale, A.E., Lee, A.S. and MacEachern, A.G. (2001) 'High tibial osteotomy using a dynamic axial external fixator', *Clinical Orthopaedics and Related Research*, Vol. 382, pp.154–167.
- Williams, D. (2012) 'The myClinicalOutcomes website: providing real-time, patient-level PROMs data', *Bulletin of The Royal College of Surgeons of England*, Vol. 94, No. 1, pp.20–21.