



A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and advice services for patients with musculoskeletal problems: economic evaluation

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Complete List of Authors:	Hollinghurst, Sandra; University of Bristol, Community Based Medicine Coast, Joanna; University of Birmingham, Department of Health Economics Busby, John; University of Bristol, Bishop, Annette; Keele University, Foster, Nadine; Keele University, Primary Care Musculoskeletal Research Centre Franchini, Angelo; Imperial College, London, Grove, Sean; Bristol Community Health, Hall, Jeanette; Bristol Community Health, Hopper, Cherida; University of Bristol, Kaur, Surinder; University of Bristol, Montgomery, Alan; University of Nottingham, Salisbury, Chris; University of Bristol, Academic Unit of Primary Health Care
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3 **A pragmatic randomised controlled trial of 'PhysioDirect' telephone**
4 **assessment and advice services for patients with musculoskeletal problems:**
5 **economic evaluation**
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9 Sandra Hollinghurst, Joanna Coast, John Busby, Annette Bishop, Nadine E Foster, Angelo Franchini,
10 Sean Grove, Jeanette Hall, Cherida Hopper, Surinder Kaur, Alan A Montgomery, Chris Salisbury
11

12 Sandra Hollinghurst, PhD. Senior Lecturer in Health Economics¹

13 Joanna Coast, PhD. Professor of Health Economics²

14 John Busby, MSc. Research Assistant in Health Economics¹

15 Annette Bishop, PhD. Research Physiotherapist³

16 Nadine E Foster, D.Phil. NIHR Professor of Musculoskeletal Health in Primary Care³

17 Angelo Franchini, MSc. Research Associate⁴

18 Sean Grove, MSc. Clinical Lead Physiotherapy⁵

19 Jeanette Hall, Grad Dip Phys. Operational lead for Outpatient Physiotherapy⁵

20 Cherida Hopper, PhD. Trial Manager¹

21 Surinder Kaur, BSc. Research Associate¹

22 Alan A Montgomery, PhD. Professor of Medical Statistics and Clinical Trials⁶

23 Chris Salisbury, MD. Professor of Primary Health Care¹
24
25
26
27
28

29 ¹Centre for Academic Primary Care, School of Social and Community Medicine, University of Bristol,
30 UK

31 ²Health Economics Unit, School of Health & Population Sciences, University of Birmingham, UK

32 ³Arthritis Research UK Primary Care Centre, Primary Care Sciences, Keele University, UK

33 ⁴Imperial Clinical Trials Unit, School of Public Health Medicine, Imperial College, London, UK

34 ⁵Musculoskeletal Outpatient Department, Bristol Community Health, UK

35 ⁶Nottingham Clinical Trials Unit, Queen's Medical Centre, Nottingham, UK
36
37
38
39

40 **Correspondence:**

41 Sandra Hollinghurst, School of Social and Community Medicine, University of Bristol, Canynge Hall,
42 39 Whatley Road, Bristol BS8 2PS

43 s.p.hollinghurst@bristol.ac.uk

44 0117 331 3901
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50 Key Words: economic evaluation; physiotherapy; telehealth; primary care; cost & cost analysis
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3 **A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and**
4 **advice services for patients with musculoskeletal problems: economic evaluation**
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7 **ABSTRACT**
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10 **Objectives**

11 To compare the cost-effectiveness of PhysioDirect with usual physiotherapy care for patients
12 with musculoskeletal problems.
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17 **Design**

18 (i) Cost-consequences comparing cost to the NHS, to patients, and the value of lost productivity
19 with a range of outcomes. (ii) Cost-utility analysis comparing cost to the NHS with Quality
20 Adjusted Life Years (QALYs)
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25 **Setting**

26 Four physiotherapy services in England
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30 **Participants**

31 Adults (18+) referred by their general practitioner or self-referred for physiotherapy.
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35 **Interventions**

36 PhysioDirect involved telephone assessment and advice followed by face-to-face care if needed.
37 Usual care patients were placed on a waiting list for face-to-face care.
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42 **Primary and secondary outcome measures**

43 Primary clinical outcome: physical component summary measure from the SF-36v2 at six months.
44 Secondary outcomes included: Measure Yourself Medical Outcomes Profile; a Global Improvement
45 Score; response to treatment; patient satisfaction; waiting time.
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47 Outcome for the cost-utility analysis: QALYs
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52 **Results**

53 2249 patients took part (1506 PhysioDirect; 743 usual care).
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3 (i) Cost-consequences: there was no evidence of a difference between the two groups in the cost of
4 physiotherapy, other NHS services, personal costs or value of time off work. Outcomes were also
5 similar.
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8 (ii) Cost-utility analysis based on complete cases (n=1,272). Total NHS costs, including the cost of
9 physiotherapy were higher in the PhysioDirect group by £19.30 (95% CI: -£37.60 to £76.19) and
10 there was a QALY gain of 0.007 (95% CI: -0.003 to 0.016). The incremental cost-effectiveness ratio
11 was £2,889 and the net monetary benefit at λ =£20,000 was £117 (95% CI: -£86 to £310)
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14 15 16 **Conclusions**

17 PhysioDirect may be a cost-effective alternative to usual physiotherapy care, though only with
18 careful management of staff time. Physiotherapists providing the service must be more fully
19 occupied than was possible under trial conditions: consideration should be given to the scale of
20 operation, opening times of the service, and flexibility in the methods used to contact patients.
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Article Summary

Article focus

- What is the cost of providing PhysioDirect telephone assessment and advice, followed by face-to-face care if needed, to adults with musculoskeletal pain problems, compared with usual physiotherapy care?
- What are the patient benefits of PhysioDirect compared with usual care?
- Is PhysioDirect a cost-effective alternative to usual care for primary care patients with musculoskeletal conditions?

Key messages

- There was very little difference between the two groups in terms of cost or outcomes
- PhysioDirect has potential to be a cost-effective alternative to usual care but requires careful management of staff resources

Strengths and limitations of this study

- Findings are based on a large sample of patients with a wide range of musculoskeletal problems based in diverse locations
- The study takes a broad perspective, including the health care provider, patients, and a valuation of lost productivity
- Physiotherapists were constrained by trial conditions and were underutilised

1 INTRODUCTION

2 There is a trend to explore the use of new technology in the delivery of health care, particularly the
3 use of telephone assessment and triage, as for example in NHS Direct.¹ These services aim to better
4 manage patient demand, and research has shown that telephone based services can be safe,
5 clinically accurate, cost-effective, acceptable to patients, and reduce the workload of clinicians,²⁻⁵
6 although there have been some concerns about using telephone triage in patients presenting with
7 acute health problems.⁶

8
9 Musculoskeletal pain problems are one of the most common causes of disability. Over a quarter of
10 all patients registered in general practice will consult at least once for a musculoskeletal problem
11 each year,^{7,8} with musculoskeletal pain accounting for around 15% of all GP consultations.⁹ This high
12 prevalence of musculoskeletal problems results in large direct and indirect healthcare costs,¹⁰
13 estimated for low back pain alone at £10,668 million for the UK in 1998¹¹ and rising substantially
14 since then.¹² Most patients are managed with advice and analgesia but many are referred to
15 physiotherapists, with 1.23 million new referrals each year from GPs and 4.4 million in total.¹³
16 Ensuring timely access to physiotherapy has long been an issue within the UK NHS, with waiting
17 times of more than four months in some areas. Patients may suffer unnecessary pain and disability,
18 and there are high productivity losses: for example, back pain accounts for some 120 million days of
19 certified absence from work each year.¹¹ Delay may also cause NHS inefficiencies on the one hand as
20 some patients recover and do not attend their physiotherapy appointment when it finally arrives,
21 whilst on the other, some patients continue to access more expensive forms of treatment whilst
22 awaiting their appointment.

23
24 In response to these problems, physiotherapy services have drawn on the new service models and a
25 range of 'PhysioDirect' services have been developed. These vary in format though they commonly
26 involve a physiotherapist assessing a patient's musculoskeletal pain problem over the telephone,

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3 1 sometimes supported by computerised assessment templates, offering tailored, self-management
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5 2 advice supplemented by written advice sent by post. Alternatively if the assessment findings
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7 3 suggest that face-to-face care is needed this is arranged, and patients who are initially managed by
8
9 4 telephone advice can phone back for further advice and/or face-to-face treatment.¹⁴ There is,
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11 5 however, limited evidence about the costs and benefits of this approach within physiotherapy. Local
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13 6 evaluations and non-randomised studies suggest that these services may be popular with patients¹⁵⁻
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15 7 ¹⁷ and diagnoses made by physiotherapists over the telephone are comparable to diagnoses reached
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17 8 in face-to-face assessments¹⁸⁻²⁰ although there is some concern that the experience of the
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19 9 physiotherapist providing the telephone assessment might be important.^{18,21}
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25 11 In particular there is no information about the costs or cost-effectiveness of PhysioDirect services,
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27 12 despite: (i) a major underlying rationale for their development being to generate greater efficiency
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29 13 in the use of resources; and (ii) a ready presumption that telephone-based services result in lower
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31 14 costs (by assuming that services better use physiotherapy time, use less costly telephone
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33 15 consultations and reduce rates of appointment non-attendance). Without such evidence, preferably
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35 16 generated alongside high quality primary evidence obtained using rigorous study designs, it remains
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37 17 unclear whether such services should be more widely implemented. This paper reports the results of
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39 18 an economic evaluation conducted alongside a randomised controlled trial powered to generate
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41 19 evidence on whether PhysioDirect services for primary care patients with musculoskeletal problems
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43 20 produce equivalent outcomes to usual face-to-face services.
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51 **METHOD**

52 53 24 **Study design**

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55 25 We conducted an economic evaluation alongside a randomised controlled trial to establish the cost-
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57 26 effectiveness of PhysioDirect compared with usual care based only on face-to-face treatment over a
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1 period of 6 months. The trial and its clinical findings have been reported in full elsewhere.^{14,22} The
2 primary perspective for the economic evaluation was the health and social care provider, as that is
3 of greatest interest to UK policy makers.²³ However, the nature of the intervention suggests there
4 could be an impact on patients' costs, and as it is known that musculoskeletal conditions account for
5 a considerable amount of time off work^{10,11} we included these perspectives in the analysis. We used
6 a cost-consequences approach to compare cost from all three perspectives (health care provider,
7 patients and carers, lost productivity) with a range of clinical outcomes and used a cost-utility
8 analysis to compare cost to the National Health Service (NHS) with Quality-Adjusted Life-Years
9 (QALYs).

10

11 **Setting and participants**

12 We recruited adults aged 18 and over from four community physiotherapy services in England –
13 Bristol, Somerset, Stoke-on-Trent, and Cheshire – which provided diversity in terms of socio-
14 economic status and a mix of urban and rural communities. All patients referred by their general
15 practitioner (GP), or who referred themselves, for physiotherapy for a non-urgent musculoskeletal
16 problem were invited to take part. Patients were randomised to PhysioDirect or usual care on a two
17 to one basis to increase the chances of the PhysioDirect service being fully utilised.

18

19 **Interventions**

20 The intervention has been reported in detail elsewhere^{14,22}. Patients randomised to the PhysioDirect
21 service received an invitation to telephone a senior (band 6 or above) specially trained
22 physiotherapist, who assessed their musculoskeletal problem with the aid of previously developed
23 computerised templates.²² These templates were provided by Huntingdonshire Primary Care Trust,
24 which has been operating a similar service since 2001. Patients were then sent appropriate advice
25 leaflets about self-management and exercises to try at home, and invited to phone again and/or

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3 1 make a face-to-face appointment if necessary. Patients randomised to usual care were put on the
4
5 2 usual service waiting list for face-to-face assessment and treatment.
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4 **Outcome measures**

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11 5 We used the EQ-5D-3L²⁴, valued using the UK tariff,²⁵ to estimate QALYs gained for the cost-utility
12
13 6 analysis. The primary outcome for the trial was the physical component summary (PCS) measure
14
15 7 from the SF-36v2 questionnaire²⁶ and secondary clinical outcomes included: the Measure Yourself
16
17 8 Medical Outcomes Profile (MYMOP);²⁷ a Global Improvement Score – a single question about overall
18
19 9 improvement; a composite measure of response to treatment including pain, function and overall
20
21 10 improvement (OMERACT OARSI);²⁸ patient satisfaction; and waiting time to first treatment advice
22
23 11 from a physiotherapist. All outcomes (except the global improvement score and waiting time to first
24
25 12 treatment advice) were measured at baseline, 6 weeks and 6 months and were obtained from a self
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27 13 completed questionnaire administered at these three time points.
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15 **Resource use**

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35 16 The analysis was based on costs related to the reason for which the patient was referred to the
36
37 17 physiotherapy service. We identified relevant resources in discussion with participating
38
39 18 physiotherapists and service managers. Direct costs to the health care provider included: cost of
40
41 19 initial and follow-up physiotherapy consultations; primary and community consultations; hospital
42
43 20 care; and prescribed medication. Patient and carer costs included: telephone calls to the
44
45 21 PhysioDirect service; travel; over the counter medication; prescription costs; private therapy and
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47 22 purchase of equipment; extra domestic help; and loss of earnings. Lost productivity was estimated
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49 23 separately in relation to time off work to attend physiotherapy appointments and time off because
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51 24 of the musculoskeletal condition itself.
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3 1 Patient level data about all physiotherapy appointments and consultations were recorded either
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5 2 automatically by computer or by the physiotherapist treating the patient. For those in the
6
7 3 intervention group, the PhysioDirect assessment software recorded which physiotherapist
8
9 4 conducted each telephone call, and the duration of each call. In addition to the time logged on to
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11 5 the system physiotherapists had to carry out administrative activities following each telephone call,
12
13 6 such as collating information to send to the patient by post. The time spent on these activities was
14
15 7 estimated from information available at one site (Bristol) where manual recording of the entire
16
17 8 encounter supplemented the electronic recording.
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22 10 Physiotherapists assigned to the PhysioDirect service were required to be available throughout the
23
24 11 time the service was 'open' but they were not usually fully engaged in dealing with PhysioDirect
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26 12 patients during these hours. We conducted an observational time and motion study at each of the
27
28 13 four sites to determine how they occupied their non-PhysioDirect contact time in order to apportion
29
30 14 costs appropriately. Time and motion data were collected at points in the study when the sites were
31
32 15 expected to be fully operational, and across a mix of day, time of day, and location. The capital costs
33
34 16 required to run a telephone services are potentially less than for a face-to-face service. Each site
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36 17 provided information about space and equipment required to run their telephone service and we
37
38 18 used this to estimate an overall percentage reduction of capital costs for these compared with a
39
40 19 standard face-to-face service.
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46 21 Data about all face-to-face appointments were recorded routinely. These data included the length of
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48 22 appointment, the grade of the physiotherapist seen, and information about missed appointments.
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53 24 Information about other NHS resource use was collected, where possible, from general practice
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55 25 records and supplemented by information gained directly from patients. General practice notes
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57 26 were scrutinised for patient level data on primary care consultations and prescribed medication. We
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1 included all consultations at which the musculoskeletal condition for which the patient was referred
2 to physiotherapy was mentioned and these were recorded by type of consultation (for example,
3 face-to-face, telephone, out of hours, home visit) and by type of professional seen (for example, GP,
4 nurse). It was not feasible to distinguish between medication prescribed for the condition for which
5 the patient was referred for physiotherapy and any other musculoskeletal problem so we included
6 all medication of a potentially relevant type, defined using British National Formulary (BNF)²⁹ coding.
7 These were: Analgesics (chapters 4.7.1 – 4.7.2); Non-steroidal anti-inflammatory drugs (10.1.1);
8 Local corticosteroid injections (10.1.2.2); and Drugs for the relief of soft-tissue inflammation (10.3).

9
10 A questionnaire was administered to participants at 6 weeks and 6 months after randomisation to
11 obtain resource use data not available elsewhere. These included information about hospital care
12 related to the condition for which the patient was referred to physiotherapy: visits to Accident &
13 Emergency, outpatient appointments, and inpatient stays. Information about personal expenditure
14 relevant to the patient's musculoskeletal condition was also gained from the questionnaire at 6
15 weeks and 6 months. We asked about the cost of travel to physiotherapy and other health care
16 appointments, expenditure on over the counter medication, prescription costs, use of private
17 therapies and their cost, expenditure on equipment or devices, and extra help at home. In addition,
18 participants were asked about any time off work, and the associated loss of earnings, because of
19 their condition or to attend health care appointments relating to the condition including usual care
20 physiotherapy and PhysioDirect.

21 22 **Valuation of resource use**

23 Table 1 gives the unit costs and sources used to value the health care resources. We used Curtis³⁰ to
24 value primary and community health care and Department of Health reference costs³¹ for all
25 hospital-based care. The cost of prescribed medication was estimated from that published in the
26 BNF,²⁹ adjusted to allow for the discount available to the NHS, and the professional fee and

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3 1 container allowance in accordance with the Drug Tariff for England.³² Personal expenditure was
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5 2 reported directly by the participants, the exception being travel by car, which was reported as
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7 3 mileage and costed using the AA schedule of motoring costs.³³ Time off work was valued using the
8
9 4 median gross weekly earnings by age and sex.³⁴
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14 6 *Table 1 here*
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18 8 The cost of face-to-face physiotherapy consultations was estimated by adapting the methods of
19
20 9 Curtis³⁰ to obtain a different unit cost for each band of staff at each site. National median pay rates,
21
22 10 by band,³⁶ were adjusted to allow for National Insurance, superannuation, and overheads, as per
23
24 11 Curtis, then further adjusted to allow for band and site specific non-contact time. Information about
25
26 12 the proportion of time physiotherapists on each grade typically spend in direct contact with patients
27
28 13 was provided by the four physiotherapy service managers. This provided us with a cost per hour for
29
30 14 each band of staff at each site.
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35 16 The unit cost of physiotherapists working in the PhysioDirect service was estimated in a similar way,
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37 17 but allowing for the reduced cost of capital and overheads; information from the site managers
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39 18 indicated this to be about 50%. To obtain a cost per hour of telephone contact we used information
40
41 19 from the computerised records of the PhysioDirect service, which identified the proportion of time
42
43 20 spent by physiotherapists actually dealing with PhysioDirect patients. We then combined this with
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45 21 data from the time and motion study, which identified activities undertaken during non-contact
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47 22 time, for example, administration relating to face-to-face appointments or general administration, to
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49 23 give a cost per hour for each band of staff at each site.
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55 25 All costs were valued in £ sterling at 2009 prices, adjusted for inflation where necessary.³⁰
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1 Data analysis

2 We investigated the amount of each resource used by patients in each group using frequencies,
3 means and medians. Mean total cost per participant was derived by combining resource use with
4 unit costs.

5
6 QALYs were derived from responses to the EQ-5D-3L at baseline, 6 weeks and 6 months using
7 valuations from the UK general population.²⁵ These values, representing health-related quality of life
8 on a scale between zero (death) and 1 (best imaginable health), were used to compute QALYs
9 experienced over the 6 month period using the area under the curve approach and adjusting for any
10 difference between the groups at baseline.³⁷

11
12 A cost-consequences matrix was constructed using all available data. We compared costs from all
13 three perspectives (health care provider, patients and carers, lost productivity) with the SF-36v2 PCS,
14 MYMOP, Global Improvement Score, OMERACT OARS, patient satisfaction, waiting time, and QALYs.

15
16 The cost-utility analysis was carried out using data on patients for whom we had complete NHS cost
17 and QALY data. An incremental cost-effectiveness ratio (ICER) was constructed, comparing the
18 difference in mean total cost per patient with mean difference in QALYs. Uncertainty around the
19 ICER was captured by replicating it 5000 times using the bootstrapping technique, estimating a
20 confidence interval around the net monetary benefit, and constructing a cost-effectiveness
21 acceptability curve.

22
23 We used the multiple imputation by chained equation procedure to address the issue of missing cost
24 and EQ-5D data.³⁸ This technique uses a regression model to estimate missing values from known
25 values. In addition to cost and EQ-5D-3L variables the imputation model also included randomisation

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1 group, age, sex, and SF36v2 PCS. Stata v12³⁹ was used to generate five datasets using 10 switching
2 procedures.

3
4 Discounting was not carried out because the analysis was restricted to costs and outcomes over a
5 period of less than a year. All analyses were conducted using Microsoft Excel and Stata v12.³⁹

6 7 **Sensitivity Analyses**

8 We addressed three areas of uncertainty using one/two-way sensitivity analyses. First, we estimated
9 the cost of running the PhysioDirect service if it was operating at full capacity. It is likely that this was
10 not achieved during the trial because of: low demand due to exclusions and non-participation in the
11 trial; inflexible staffing levels to ensure consistency throughout the trial period; and the 'one-way'
12 system generally used, where physiotherapists waited for patients to call them but did not routinely
13 contact patients themselves (notwithstanding some limited use of answer-machines). Data from the
14 Bristol service, which continued to operate beyond the trial period and was then able to tailor
15 staffing levels to demand, were used to estimate the cost of running a more 'efficient but feasible'
16 PhysioDirect service once the trial had ended.

17
18 The second area of uncertainty addressed hospital costs. Patients in the trial were recruited from
19 primary care and for these, use of secondary care is infrequent but relatively expensive and this can
20 have a disproportionate effect on mean total cost. We tested this by excluding hospital costs from
21 the total.

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23 The third and fourth sensitivity analyses used the imputed missing data as described above first with
24 data collected during the trial and second by combining with results of the first sensitivity analysis,
25 mimicking an 'efficient but feasible' service.

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2 RESULTS

3 A total of 2,249 patients took part in the trial, 1506 allocated to PhysioDirect and 743 to usual care.

4 The mean age was 60, with slightly more females than males (60% vs 40%); they were
5 overwhelmingly white (97%), just over half (60%) were employed and all but a few were referred for
6 physiotherapy by their GP. Nearly all participants (2,223=99%) gave permission to access their GP
7 notes to obtain data about primary care encounters and prescribed medication. 81% returned
8 questionnaires at both 6 weeks and 6 months though not all participants completed all sections at
9 both time points. We had complete NHS cost and QALY data for 840 (56%) PhysioDirect and 432
10 (58%) usual care participants.

12 Resource use

13 Table 2 gives information about the different types of physiotherapy consultations by patients in
14 each group. Of the 1506 patients in the PhysioDirect group, 39% (586) were managed solely over the
15 telephone and only 46% (695) had any face-to-face consultations. In total, patients in the usual care
16 group had, on average, 0.38 (95% CI: 0.12 to 0.63) more consultations than those in the PhysioDirect
17 group and the mean total duration of all consultations was 20 minutes longer (95% CI: 12 to 28).

19 *Table 2 here*

21 Tables 3 and 4 give information about NHS and personal resource use. Just over a third of patients
22 (35%) had a GP consultation during the 6 months and 40% received a prescription for
23 musculoskeletal pain-related medication. There was very little difference between the two groups in
24 terms of health care use and the only important difference in personal expenditure was travel to
25 physiotherapy appointments.

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3 1 *Tables 3 and 4 here*
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7 3 **Costs and consequences**
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9 4 Table 5 summarises the mean cost per patient, by group, for each category of cost. All available data
10
11 5 are included giving variable denominators for each category. Comparing the two groups, there are
12
13 6 small differences in cost in some categories but for most of these the confidence intervals indicate
14
15 7 there is no evidence of a difference between the groups.
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17 8
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19 9
20 9 *Table 5 here*
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22 10
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24 11 Table 6 combines the results of the cost analysis with the full range of primary and secondary
25
26 12 outcomes, including QALYs.
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30 14
31 14 *Table 6 here*
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35 16 Results are presented for all available data, with cost categories combined. Again, denominators
36
37 17 vary within the table and they also differ from those in table 5 because sub-categories have been
38
39 18 collapsed. There was no evidence of a difference in the primary clinical outcome (the SF36v2 PCS)
40
41 19 between the groups, suggesting that PhysioDirect led to similar outcomes as usual physiotherapy
42
43 20 care. Patients in the PhysioDirect group had their first assessment and telephone advice 27 days
44
45 21 earlier than those in the usual care group, however patient satisfaction was slightly lower in those
46
47 22 receiving PhysioDirect. QALYs were higher in the PhysioDirect group by 0.009, which equates to
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49 23 about 3.3 extra days of full health over a year.
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55 25 **Cost-utility analysis**
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1 The cost-utility analysis presented in Table 7 uses complete cases, that is, we include only those
2 patients for whom we had complete NHS cost and QALY data: 432 (58%) from the usual care group
3 and 840 (56%) from PhysioDirect. The small extra cost of caring for patients in the PhysioDirect
4 group was compensated for by the extra QALY gain, giving an incremental cost-effectiveness ratio of
5 £2,889. If society is willing to pay £20,000 per QALY²³ the net monetary benefit is £117 (95% CI -£96
6 to £310) and there is 0.88 probability that the intervention is cost-effective. This is illustrated in the
7 cost-effectiveness acceptability curve in figure 1.

8
9 *Table 7 here*

10 *Figure 1 here*

11 **Sensitivity Analysis**

12 The results of the four sensitivity analyses are shown in table 8 and figure 2. Scenario (1) indicates
13 the potential cost-effectiveness of a more efficient PhysioDirect service. During the trial PhysioDirect
14 clinic opening hours, physiotherapists spent about 35% of their time on the phone or dealing with
15 directly related administration; in Bristol after the trial, this was increased to 57%. Under this
16 scenario, the cost per patient in the PhysioDirect group was £14.53 less than under trial conditions
17 and £2.11 less per patient in the usual care group. The ICER is therefore lower, at £1,045, the NMB
18 correspondingly higher at £127 (λ =£20,000). At low levels of λ , the probability of PhysioDirect being
19 cost-effective under this scenario is higher than with the base case, though at λ =£20,000 it reaches a
20 similar value (see figures 1 and 2).

21
22 *Table 8 here*

23 *Figure 2 here*

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3 1 The effect of removing hospital costs from the analysis is shown in sensitivity analysis (2). Hospital
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5 2 costs accounted for 75% of all NHS costs yet only 19% (n=252) participants reported using any
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7 3 secondary care. Hospital use was evenly divided between the two groups so removing these from
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9 4 the analysis made very little difference to incremental analysis.
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13 6 The effect of imputing missing NHS cost and QALY data is explored in sensitivity analysis (3). Using
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15 7 these data the cost of the interventions is lower but this is offset by higher NHS costs, giving a higher
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17 8 mean total cost in both groups, by £21.41 in the usual care group and £6.58 in the PhysioDirect
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19 9 group. QALYs using imputed data are lower, by 0.005 in the usual care group and by 0.010 in the
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21 10 PhysioDirect group. The net effect is a reduction of both incremental cost and incremental QALYs,
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23 11 giving an ICER of £2,260. Uncertainty around the ICER is reduced, as seen by the flatter CEAC in
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25 12 figure 2.
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31 14 Sensitivity analysis (4) combines analyses (1) and (3) by using imputed cost data in the 'efficient
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33 15 service' scenario. The results suggest a possible cost saving of £6.02 per patient; the probability that
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35 16 the service is cost-effective at λ =£20,000 is 0.72.
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42 **DISCUSSION**

44 **Statement of principal findings**

46 21 The results of this economic evaluation suggest that PhysioDirect services for patients with
47
48 22 musculoskeletal problems require careful management if they are to be a cost-effective alternative
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50 23 to usual physiotherapy care. There was very little difference between the two groups in terms of
51
52 24 either outcomes or costs, and the finding that PhysioDirect is cost-effective is based on evidence
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54 25 that it provides very slightly greater QALY benefits at very slightly greater cost.
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3 1 Clearer cost savings were observed in the sensitivity analysis that replicated the post-trial service,
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5 2 once greater flexibility in working arrangements was implemented. Without the restrictions of a trial
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7 3 environment staffing was adjusted to meet the anticipated demand, a call-back service was
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9 4 employed which accommodated fluctuations in activity during each session, referrals added to the
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11 5 system were adjusted regularly to reflect actual staffing and the number of patients waiting for
12
13 6 a call-back and a higher throughput of patients led to greater economies of scale. These changes
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15 7 ensured physiotherapists within the PhysioDirect service spent a higher proportion of their
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17 8 PhysioDirect clinic time on the telephone with patients. There was no evidence of a difference
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19 9 between PhysioDirect and usual care in cost to patients and their families, or to society through the
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21 10 costs of lost production.
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27 **Strengths and weaknesses of the study**

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29 13 The study has a number of strengths. It is the first study assessing the cost-effectiveness of a
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31 14 PhysioDirect service including a large sample of patients with a wide range of musculoskeletal
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33 15 problems based across a number of locations.¹⁴ It uses a rigorous study design and conforms to
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35 16 CONSORT guidelines.⁴⁰ Follow up from participating patients was good, a high proportion of the
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37 17 resource use data were collected from GP records, and there was collection of resource use
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39 18 information outside of the main health service perspective. Nevertheless, there are also limitations.
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41 19 The proportion of eligible individuals consenting to participate in the trial was only 50%.²² Further, a
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43 20 particular difficulty in conducting economic evaluation with new service developments is ensuring
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45 21 that they are fully utilised.⁴¹ Although there was a clear run-in period prior to data collection for the
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47 22 trial (ranging from 4 to 12 weeks in each of the four sites), to ensure that services were operating as
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49 23 well as they could, and a 2:1 randomisation ratio in favour of PhysioDirect was used, there was still
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51 24 considerable underutilisation of the new service. This was ameliorated by including a more fully
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53 25 utilised service within the sensitivity analysis. Finally, because the differences in both costs and
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55 26 effects are small, there is still some uncertainty around the findings.
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2 The meaning of the study and implications for policy makers

3 If the aim of health services is to achieve maximum health gain from an investment in health care,
4 then PhysioDirect has a high probability of being more cost-effective than usual physiotherapy care.
5 This research also, however, suggests that it cannot be assumed that PhysioDirect will reduce costs,
6 although it could potentially do so if PhysioDirect services are managed efficiently. Both the costs
7 and cost-effectiveness of services will depend on the productivity of physiotherapist time. If
8 physiotherapists are able to use most of their time dealing directly with patients during sessions
9 when they are available on the telephone, then the service will be less costly. This is most likely to be
10 achieved by operating a call-back service and/or by operating the service on a large scale to even out
11 fluctuations in demand. Further efficiencies may also be achieved if these services are, in the future,
12 provided in conjunction with direct access for patients (rather than following referral from another
13 health care professional), given that patients who self-refer are likely to contact the service with
14 musculoskeletal problems of shorter duration,⁴² and such patients may be particularly appropriate
15 for the initial assessment and advice provided by a PhysioDirect service. More generally, the study
16 has broader implications for telephone services, particularly around the implicit assumption that
17 such services will inevitably be money saving. Here this assumption was found to be false, largely
18 because the physiotherapists' time was underutilised during PhysioDirect clinic hours. Thus, for all
19 such services, it will be important for policy makers to ensure that easy assumptions about the costs
20 of these services are properly assessed in relation to factors such as how efficiently the service is
21 run, and what proportion of patients are subsequently invited for face to face care following an
22 initial telephone call.

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24 Unanswered questions and future research

25 As services evolve, further research should explore the costs and benefits of PhysioDirect under
26 different scenarios. These might include: comparing different skill levels of staff operating the

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3 1 service; the inclusion of patient self-referrals in addition to GP referrals; the use, or otherwise, of
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5 2 computerised support in assessing the patient; the extension to internet services (possibly combined
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7 3 with cameras);⁴³ and the use of mobile 'smartphone' technology, for example in rapid assessment of
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9 4 musculoskeletal injuries. In particular, however, it will be important to assess the costs and benefits
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11 5 of services once they are more established and provided on a wider scale. The costs and benefits of
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13 6 telehealth more generally need further exploration in relation to their cost effectiveness particularly
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15 7 given the negative findings of the Whole Systems Demonstrator project evaluating telehealth
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17 8 support and treatment for patients with long term conditions.⁴⁴ It would be helpful to identify those
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19 9 characteristics that are likely to make services both more cost-effective and less costly.
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3 **1 Competing interestes**

4 We have read and understood the BMJ Group policy on declaration of interests and declare the
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6
7

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23
24

25 **15 Aurthors' contributions**

26 CS was principal investigator on the trial, SH took the lead on the economic evaluation. JC, NF, SG,
27 JH, and AM were co-applicants and contributed to the conception and design. SH, JC and JB carried
28 out the analysis with help from CS and AM, and all authors contributed to the interpretation of the
29 data. SH and JC wrote the first draft of the paper with all authors contributing to subsequent
30 revisions. All authors have seen and approved the final version.
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40 Gamlin and Nick Deane who developed the PhysioDirect assessment algorithms and software used
41 in this trial.
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47 **28 Data sharing**

48 The datasets will be made freely available on application to any bone-fide suitable qualified
49 researcher upon submission of a protocol which provides a research question and research design
50 which could be addressed by the data from this study, has been peer reviewed and received
51 ethical and research governance approvals. Users of the data will also be subject to a written
52 agreement which complies with the MRC guidance. Data will be made available for sharing only
53 after the publication of the final project report and the main papers in peer reviewed journals.
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Table 1: Data sources and unit costs

	Unit cost (£)
Primary and Community Care³⁰	
General Practitioner	
Surgery	27.00
Telephone consultation	16.00
Home visit	91.00
Practice nurse	
Surgery	10.00
Telephone consultation	5.93
Health Care Assistant/phlebotomist	
Surgery	6.92
District Nurse	
Home visit	16.33
Out of Hours⁴¹	
General practitioner	23.50
Hospital care³¹	
A&E	103.00
Outpatient visits	By Healthcare Resource Group, differentiated by first and follow-up
Inpatient stays	By Healthcare Resource Group
Prescribed medication²⁹	per item, by name, strength and amount
Mileage³³	0.4612
Time off work³⁴	Median national wage by age and sex

Table 2: Number of physiotherapy consultations and mean duration, by type and group

		Usual care (n=743)	PhysioDirect (n=1506)
Face-to-face appointments	mean (SD) number	3.11(2.63)	1.91(2.72)
	mean (SD) total	107.51(88.92)	64.20(89.31)
	duration (minutes)		
Telephone appointments	mean (SD) number	0.13(0.44)	0.96 (0.63)
	mean (SD) total	4.21(14.64)	27.37(19.92)
	duration (minutes)		
Home visits	mean (SD) number	0.00 (0.06)	0.00 (0.06)
	mean (SD) total	0.14(2.27)	0.12(2.12)
	duration (minutes)		
All physiotherapy contacts	mean (SD) number	3.25(2.70)	2.87(2.94)
	mean (SD) total	111.86(90.50)	91.70 (95.40)
	duration (minutes)		

Table 3: Health services resource use, by group. All available data.

	Mean (SD) number of consultations			
	n	usual care	n	PhysioDirect
GP consultations	739	0.77(1.47)	1484	0.87 (1.68)
Nurse consultations	739	0.04 (0.22)	1484	0.06 (0.32)
Other primary care consultations	739	0.02(0.14)	1484	0.02 (0.17)
Total number of primary care contacts	739	0.83(1.56)	1484	0.96 (1.84)
Number of prescriptions	728	1.36 (2.73)	1469	1.68 (3.72)
A&E (visits)	467	0.02 (0.01)	912	0.03 (0.01)
Out-patient (consultations)	467	0.17 (0.83)	910	0.35 (1.03)
In-patient stays (Finished Consultant Episodes)	465	0.01 (0.10)	910	0.01 (0.10)

Table 4: Patient and societal resource use, by group. All available data.

Number (%) reporting:	n	usual care	n	PhysioDirect
Expenditure on travel to physiotherapy	462	242 (52.4)	1232	308 (25.8)
Expenditure on travel to primary care	669	116 (17.3)	1337	237 (17.7)
Expenditure on over-the-counter medication	506	256 (50.6)	1028	512 (49.8)
Expenditure on prescriptions	559	264 (47.2)	1085	508 (46.8)
Expenditure on private therapy	484	89 (18.4)	934	167 (17.9)
Equipment purchase	480	139 (29.0)	939	233 (24.8)
Payments for extra domestic help	459	35 (7.6)	928	76 (8.2)
Loss of earnings	598	30 (5.5)	1209	64 (5.3)
Any time off to attend physiotherapy consultation	692	218 (31.5)	1416	380 (26.8)
Work has been affected because of condition	477	141 (29.6)	959	317 (33.1)

Table 5: Mean total cost per patient, by group and category. All available data^a.

		usual care			Incremental difference
	n	mean (SD) cost	n	mean (SD) cost	(95% Confidence Interval)
Physiotherapy services					
Face-to-face appointments	743	£64.42 (£53.00)	1506	£38.76 (£53.92)	-£25.66 (-£30.37 to -£20.95)
Telephone appointments	743	£5.22 (£18.01)	1506	£35.17 (£26.34)	£29.94 (£27.84 to £32.05)
Home visits	743	£0.08 (£1.33)	1506	£0.08 (£1.46)	£0.00 (-£0.12 to £0.13)
Total physiotherapy cost	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Primary care services					
GP consultations	739	£19.21 (£35.91)	1484	£21.69 (£41.66)	£2.48 (-£1.04 to £6.00)
Nurse consultations	739	£0.44 (£2.37)	1484	£0.61 (£3.17)	£0.16 (-£0.10 to £0.42)
Other primary care consultations	739	£0.03 (£0.57)	1484	£0.07 (£1.31)	£0.05 (-£0.05 to £0.15)
Total primary care cost	739	£19.68 (£36.68)	1484	£22.37 (£42.83)	£2.69 (-£0.92 to £6.30)
Medication cost	728	£11.04 (£51.61)	1469	£10.33 (£55.43)	-£0.72 (-£5.53 to £4.10)
Hospital services					
A&E	467	£1.99 (£17.12)	912	£3.17 (£20.84)	£1.18 (-£1.01 to £3.37)
Out-patient	467	£30.74 (£98.36)	910	£38.35 (£126.05)	£7.61 (-£5.50 to £20.72)
In-patient	465	£51.02 (£520.48)	910	£34.99 (£399.62)	-£16.03 (-£65.70 to £33.64)
Total hospital cost	459	£83.04 (£561.68)	899	£77.00 (£446.24)	-£6.04 (-£60.99 to £48.91)
Personal expenditure					
Cost of all calls to physiotherapy service	743	£0.97 (£0.99)	1506	£1.75 (£1.29)	£0.79 (£0.68 to £0.89)
Travel to physiotherapy	462	£6.11 (£11.48)	1232	£3.11 (£8.51)	-£3.01 (-£4.01 to -£2.00)
Travel for primary care	669	£0.65 (£2.93)	1337	£0.75 (£4.10)	£0.11 (-£0.24 to £0.45)
Over-the-counter medication	490	£7.67 (£14.09)	987	£8.61 (£22.38)	£0.94 (-£1.23 to £3.11)

Cost of prescriptions	553	£2.72 (£8.95)	1076	£2.67 (£8.33)	-£0.05 (-£0.93 to £0.82)
Private therapy	475	£21.98 (£70.34)	915	£39.34 (£296.94)	£17.36 (-£9.76 to £44.48)
Equipment purchase	473	£17.16 (£169.12)	924	£9.12 (£56.42)	-£8.04 (-£20.08 to £4.00)
Extra domestic help	451	£10.93 (£64.31)	905	£13.68 (£96.02)	£2.75 (-£7.07 to £12.56)
Cost associated with loss of earnings	598	£46.69 (409.72)	1209	£82.78 (£885.85)	£36.09 (-£38.63 to £110.81)
Value of time off work					
Time off work to attend physiotherapy	598	£12.90 (£38.99)	1211	£11.91 (£57.86)	£0.95 (-£3.81 to £5.70)
Time off work associated with the condition	452	£265.92 (£1350.82)	884	£226.61 (£1139.84)	£111.31 (-£159.04 to £379.67)

^a Uses all available data, so denominators differ by category.

Table 6: Cost-consequences. All available data^a.

	n (%)	usual care	n (%)	PhysioDirect	Incremental difference (95% Confidence Interval)
Mean (SD) Cost					
Total physiotherapy cost	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Cost of NHS services including physiotherapy	453 (61%)	£189.19 (£557.61)	888 (59%)	£196.43 (£472.02)	£7.24 (-£49.68 to £64.10)
Total personal expenditure	310 (42%)	£121.10 (£571.15)	714 (47%)	£166.40 (£1040.27)	£45.30 (-£78.01 to £168.61)
Total value of all time off work ^b	451 (61%)	£276.75 (£1355.00)	883 (59%)	£240.74 (£1147.20)	-£36.01 (-£174.69 to £102.66)
Consequences^c					
					Difference/odds ratio (95% confidence interval)^d
SF36v2 PCS	629 (85%)	44.18 (10.84)	1283 (85%)	43.50 (10.94)	-0.01 (-0.80 to 0.79)
MYMOP ^e	518 (70%)	2.40 (1.38)	1033 (69%)	2.40 (1.43)	-0.02 (-0.16 to 0.11)
Global improvement score	501 (67%)	4.07 (1.40)	1001 (66%)	4.01 (1.44)	-0.08 (-0.23 to 0.08)
Response to treatment (OMERACT OARSI)	510 (69%)	197 (38.6%)	1029 (68%)	430 (41.8%)	1.14 (0.92 to 1.43)
Waiting time to first assessment and advice	618 (83%)	34 (20 to 55) ^f	1281 (85%)	7 (4 to 15) ^f	0.32 (0.29 to 0.35) ^g
Patient overall satisfaction	367 (49%)	79.7 (26.5)	739 (49%)	75.9 (28.3)	-3.8 (-7.3 to -0.3)
QALYs ^h	454 (61%)	0.322 (0.079)	881 (58%)	0.331 (0.082)	0.009 (-0.000 to 0.018)

^a Uses all available data, so denominators differ by category

^b Total of time off to attend physiotherapy and associated with the condition

^c At 6 month follow-up time point

^d Adjusted for outcome at baseline, gender, age, referral problem, PCT

^e Lower score is better

^f Median (IQR)

^g Accelerated failure time analysis

^h Adjusted for outcome at baseline

Table 7: Cost-effectiveness analysis. Includes cases with complete data on NHS costs and QALYs

	n	usual care mean (SD) cost	n	PhysioDirect Mean (SD) cost	Incremental difference (95% CI)
Cost of physiotherapy	432	£78.77 (£57.08)	840	£86.75 (£65.47)	£7.98 (£0.69 to £15.27)
Cost of NHS services other than physiotherapy	432	£100.91 (£502.02)	840	£112.23 (£476.91)	£11.32 (-£45.08 to £67.72)
Total cost including physiotherapy	432	£179.68 (£504.73)	840	£198.98 (482.12)	£19.30 (-£37.60 to £76.19)
QALYs	432	0.325 (0.077)	840	0.332 (0.081)	0.007 (-0.003 to 0.016)
Incremental cost-effectiveness ratio (ICER)					£2,889
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£117 (-£86 to £310)
probability of intervention being cost-effective					0.88
λ=£30,000					£184 (-£106 to £461)
probability of intervention being cost-effective					0.90

Table 8: Sensitivity Analysis

	n	Usual care mean (SD)	n	PhysioDirect mean (SD)	Incremental difference (95% confidence interval)
(1) mimicking an efficient service					
Cost of physiotherapy	432	£76.56 (£55.34)	840	£72.22 (£61.55)	-£4.34 (-£11.25 to £2.57)
Cost of NHS services	432	£100.91 (£502.02)	840	£112.23 (476.91)	£11.32 (-£45.08 to £67.72)
Total cost	432	£177.46 (£504.49)	840	£184.44 (£481.83)	£6.98 (-£49.89 to £63.85)
Incremental cost-effectiveness ratio (ICER)					£1,045
Median Net Monetary Benefit (95% CI) based on bootstrapped results: λ=£20,000					£127 (-£74 to £319)
λ=£30,000					£193 (-£95 to £473)
(2) Excluding hospital costs					
Cost of physiotherapy	448	£78.49 (£57.14)	869	£86.84 (£65.25)	£8.35 (£1.21 to £15.50)
Cost of NHS services excluding secondary care	448	£33.75 (£76.46)	869	£33.49 (£63.76)	-£0.25 (-£8.05 to £7.54)
Total cost of NHS services including physiotherapy	448	£112.23 (£99.621)	869	£120.33 (£98.85)	£8.10 (-£3.21 to £19.41)
Incremental cost-effectiveness ratio (ICER)					£1,084
Median Net Monetary Benefit (95% CI) based on bootstrapped results: λ=£20,000					£142 (-£41 to £324)
λ=£30,000					£217 (-£56 to £489)
(3) Imputed data					
Cost of physiotherapy	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Cost of NHS services	743	£131.37 (£465.49)	1506	£131.51 (£384.36)	£0.17 (-£36.13 to £36.48)
Total cost of NHS services including physiotherapy	743	£201.09 (£467.51)	1506	£205.55 (£390.04)	£4.46 (-£32.22 to £41.14)
Quality Adjusted Life Years	743	0.320 (0.003)	1506	0.322 (0.002)	0.002 (-0.006 to 0.009)

Incremental cost-effectiveness ratio (ICER) £2,260

Median Net Monetary Benefit (95% CI) based on bootstrapped results:

λ=£20,000 £34 (-£119 to £193)

λ=£30,000 £52 (-£172 to £285)

(4) Imputed data and 'efficient' service

Cost of physiotherapy 743 £67.61 (£54.19) 1506 £61.41 (£59.13) -£6.20 (-£11.26 to -£1.14)

Cost of NHS services 743 £131.37 (£465.49) 1506 £131.54 (384.36) £0.17 (-£36.13 to £36.48)

Total cost of NHS services 743 £198.98 (£467.48) 1506 £192.95 (£389.52) -£6.02 (-£42.68 to £30.63)

including physiotherapy

Quality Adjusted Life Years 743 0.320 (0.003) 1506 0.322(0.002) 0.002 (-0.006 to 0.009)

Incremental cost-effectiveness ratio (ICER) -£3,054

Median Net Monetary Benefit (95% CI) based on bootstrapped results:

λ=£20,000 £47 (-£113 to £202)

λ=£30,000 £67 (-£165 to £293)

Figure 1. Cost-effectiveness acceptability curve showing the probability that the intervention is cost-effective at different levels of willingness to pay for one Quality Adjusted Life Year

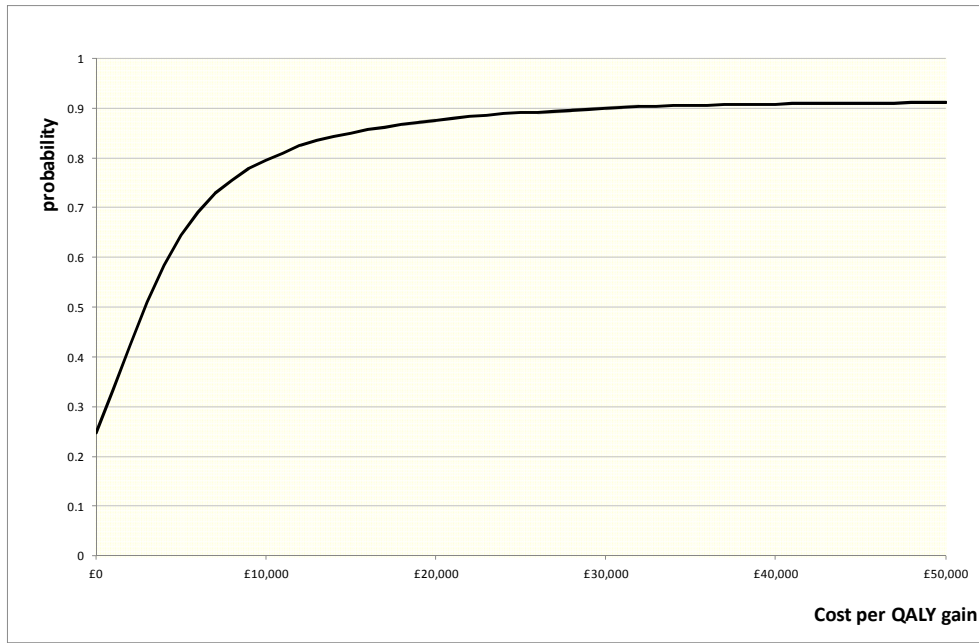
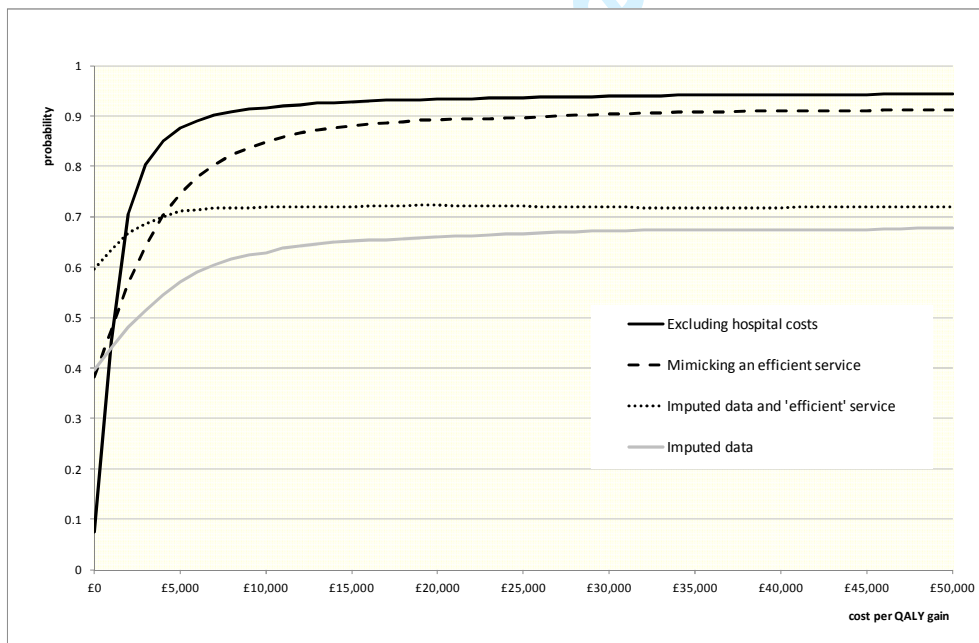


Figure 2. Cost-effectiveness acceptability curve showing the probability that the intervention is cost-effective at different levels of willingness to pay for one Quality Adjusted Life Year: Sensitivity Analyses



CHEERS checklist—Items to include when reporting economic evaluations of health interventions

Section/item	Item No	Recommendation	Reported on page No/line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as “cost-effectiveness analysis”, and describe the interventions compared.	1/1-3
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	P2-3
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	5/1 – 6/20
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	7/12-16
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	7/12-16
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	7/1-9
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	7/20 - 8/2
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	6/25 - 7/1
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	13/4-5
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	8/5-13
Measurement of effectiveness	11a	<i>Single study-based estimates:</i> Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	6/25-7/1 7/12-17
	11b	<i>Synthesis-based estimates:</i> Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	n/a

Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	8/5-6 12/6-7
Estimating resources and costs	13a	<i>Single study-based economic evaluation:</i> Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	8/16 – 11/23
	13b	<i>Model-based economic evaluation:</i> Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	n/a
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	11/25
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	n/a
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	n/a
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	12/7-10 12/23-13/2
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	n/a
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	15/1-23 Tables 5,6,7

Characterising uncertainty	20a	<i>Single study-based economic evaluation:</i> Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	16/1-7 Table 7 Figure 1 16/13 – 17/16 Table 8 Figure 2
	20b	<i>Model-based economic evaluation:</i> Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	n/a
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	n/a
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	17/21 – 18/26
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	26/6-11
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	26/1-3

For consistency, the CHEERS statement checklist format is based on the format of the CONSORT statement checklist



A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and advice services for patients with musculoskeletal problems: economic evaluation

Journal:	<i>BMJ Open</i>
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Keywords:	economic evaluation, physiotherapy, telehealth, PRIMARY CARE, costs & cost analysis

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Manuscripts

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3 **A pragmatic randomised controlled trial of 'PhysioDirect' telephone**
4 **assessment and advice services for patients with musculoskeletal problems:**
5 **economic evaluation**
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7

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9 Sandra Hollinghurst, Joanna Coast, John Busby, Annette Bishop, Nadine E Foster, Angelo Franchini,
10 Sean Grove, Jeanette Hall, Cherida Hopper, Surinder Kaur, Alan A Montgomery, Chris Salisbury
11

12 Sandra Hollinghurst, PhD. Senior Lecturer in Health Economics¹

13 Joanna Coast, PhD. Professor of Health Economics²

14 John Busby, MSc. Research Assistant in Health Economics¹

15 Annette Bishop, PhD. Research Physiotherapist³

16 Nadine E Foster, D.Phil. NIHR Professor of Musculoskeletal Health in Primary Care³

17 Angelo Franchini, MSc. Research Associate⁴

18 Sean Grove, MSc. Clinical Lead Physiotherapy⁵

19 Jeanette Hall, Grad Dip Phys. Operational lead for Outpatient Physiotherapy⁵

20 Cherida Hopper, PhD. Trial Manager¹

21 Surinder Kaur, BSc. Research Associate¹

22 Alan A Montgomery, PhD. Professor of Medical Statistics and Clinical Trials⁶

23 Chris Salisbury, MD. Professor of Primary Health Care¹
24
25
26
27
28

29 ¹Centre for Academic Primary Care, School of Social and Community Medicine, University of Bristol,
30 UK

31 ²Health Economics Unit, School of Health & Population Sciences, University of Birmingham, UK

32 ³Arthritis Research UK Primary Care Centre, Primary Care Sciences, Keele University, UK

33 ⁴Imperial Clinical Trials Unit, School of Public Health Medicine, Imperial College, London, UK

34 ⁵Musculoskeletal Outpatient Department, Bristol Community Health, UK

35 ⁶Nottingham Clinical Trials Unit, Queen's Medical Centre, Nottingham, UK
36
37
38
39

40 **Correspondence:**

41 Sandra Hollinghurst, School of Social and Community Medicine, University of Bristol, Canynge Hall,
42 39 Whatley Road, Bristol BS8 2PS

43 s.p.hollinghurst@bristol.ac.uk

44 0117 331 3901
45
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49

50 Key Words: economic evaluation; physiotherapy; telehealth; primary care; cost & cost analysis
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3 **A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and**
4 **advice services for patients with musculoskeletal problems: economic evaluation**
5
6

7 **ABSTRACT**
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9
10 **Objectives**

11 To compare the cost-effectiveness of PhysioDirect with usual physiotherapy care for patients
12 with musculoskeletal problems.
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17 **Design**

18 (i) Cost-consequences comparing cost to the NHS, to patients, and the value of lost productivity
19 with a range of outcomes. (ii) Cost-utility analysis comparing cost to the NHS with Quality
20 Adjusted Life Years (QALYs)
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25 **Setting**

26 Four physiotherapy services in England
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30 **Participants**

31 Adults (18+) referred by their general practitioner or self-referred for physiotherapy.
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35 **Interventions**

36 PhysioDirect involved telephone assessment and advice followed by face-to-face care if needed.
37 Usual care patients were placed on a waiting list for face-to-face care.
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42 **Primary and secondary outcomes**

43 Primary clinical outcome: physical component summary from the SF-36v2 at six months. Also
44 included in the cost-consequences: Measure Yourself Medical Outcomes Profile; a Global
45 Improvement Score; response to treatment; patient satisfaction; waiting time.
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47 Outcome for the cost-utility analysis: QALYs
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52 **Results**

53 2249 patients took part (1506 PhysioDirect; 743 usual care).
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3 (i) Cost-consequences: there was no evidence of a difference between the two groups in the cost of
4 physiotherapy, other NHS services, personal costs or value of time off work. Outcomes were also
5 similar.
6

7
8 (ii) Cost-utility analysis based on complete cases (n=1,272). Total NHS costs, including the cost of
9 physiotherapy were higher in the PhysioDirect group by £19.30 (95% CI: -£37.60 to £76.19) and
10 there was a QALY gain of 0.007 (95% CI: -0.003 to 0.016). The incremental cost-effectiveness ratio
11 was £2,889 and the net monetary benefit at λ =£20,000 was £117 (95% CI: -£86 to £310)
12
13

14 15 16 **Conclusions**

17 PhysioDirect may be a cost-effective alternative to usual physiotherapy care, though only with
18 careful management of staff time. Physiotherapists providing the service must be more fully
19 occupied than was possible under trial conditions: consideration should be given to the scale of
20 operation, opening times of the service, and flexibility in the methods used to contact patients.
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Article Summary

Article focus

- What is the cost of providing PhysioDirect telephone assessment and advice, followed by face-to-face care if needed, to adults with musculoskeletal pain problems, compared with usual physiotherapy care?
- What are the patient benefits of PhysioDirect compared with usual care?
- Is PhysioDirect a cost-effective alternative to usual care for primary care patients with musculoskeletal conditions?

Key messages

- There was very little difference between the two groups in terms of cost or outcomes
- PhysioDirect has potential to be a cost-effective alternative to usual care but requires careful management of staff resources

Strengths and limitations of this study

- Findings are based on a large sample of patients with a wide range of musculoskeletal problems based in diverse locations
- The study takes a broad perspective, including the health care provider, patients, and a valuation of lost productivity
- Physiotherapists were constrained by trial conditions and were underutilised

1 INTRODUCTION

2 There is a trend to explore the use of new technology in the delivery of health care, particularly the
3 use of telephone assessment and triage, as for example in NHS Direct.¹ These services aim to better
4 manage patient demand, and research has shown that telephone based services can be safe,
5 clinically accurate, cost-effective, acceptable to patients, and reduce the workload of clinicians,²⁻⁵
6 although there have been some concerns about using telephone triage in patients presenting with
7 acute health problems.⁶

8
9 Musculoskeletal pain problems are one of the most common causes of disability. Over a quarter of
10 all patients registered in general practice will consult at least once for a musculoskeletal problem
11 each year,^{7,8} with musculoskeletal pain accounting for around 15% of all GP consultations.⁹ This high
12 prevalence of musculoskeletal problems¹⁰ results in large direct and indirect healthcare costs: for
13 example, low back pain alone has recently been estimated to cost the UK economy £15.84 billion a
14 year.^{11, 12} Most patients are managed with advice and analgesia but many are referred to
15 physiotherapists, with 1.23 million new referrals each year from GPs and 4.4 million in total.¹³
16 Ensuring timely access to physiotherapy has long been an issue within the UK NHS, with waiting
17 times of more than four months in some areas. Patients may suffer unnecessary pain and disability,
18 and there are high productivity losses: for example, back pain accounts for some 120 million days of
19 certified absence from work each year.¹⁴ Delay may also cause NHS inefficiencies on the one hand as
20 some patients recover and do not attend their physiotherapy appointment when it finally arrives,
21 whilst on the other, some patients continue to access more expensive forms of treatment whilst
22 awaiting their appointment.

23
24 In response to these problems, physiotherapy services have drawn on the new service models and a
25 range of 'PhysioDirect' services have been developed. These vary in format though they commonly
26 involve a physiotherapist assessing a patient's musculoskeletal pain problem over the telephone,

1
2
3 1 sometimes supported by computerised assessment templates, offering tailored, self-management
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5 2 advice supplemented by written advice sent by post. Alternatively if the assessment findings
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7 3 suggest that face-to-face care is needed this is arranged, and patients who are initially managed by
8
9 4 telephone advice can phone back for further advice and/or face-to-face treatment.¹⁵ There is,
10
11 5 however, limited evidence about the costs and benefits of this approach within physiotherapy. Local
12
13 6 evaluations and non-randomised studies suggest that these services may be popular with patients¹⁶⁻
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15 7 ¹⁸ and diagnoses made by physiotherapists over the telephone are comparable to diagnoses reached
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17 8 in face-to-face assessments¹⁹⁻²¹ although there is some concern that the experience of the
18
19 9 physiotherapist providing the telephone assessment might be important.^{19,22}
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25 11 In particular there is no information about the costs or cost-effectiveness of PhysioDirect services,
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27 12 despite: (i) a major underlying rationale for their development being to generate greater efficiency
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29 13 in the use of resources; and (ii) a ready presumption that telephone-based services result in lower
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31 14 costs (by assuming that services better use physiotherapy time, use less costly telephone
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33 15 consultations and reduce rates of appointment non-attendance). Without such evidence, preferably
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35 16 generated alongside high quality primary evidence obtained using rigorous study designs, it remains
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37 17 unclear whether such services should be more widely implemented. This paper reports the results of
38
39 18 an economic evaluation conducted alongside a randomised controlled trial powered to generate
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41 19 evidence on whether PhysioDirect services for primary care patients with musculoskeletal problems
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43 20 produce equivalent outcomes to usual face-to-face services.
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51 **METHOD**

52 53 24 **Study design**

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55 25 We conducted an economic evaluation alongside a randomised controlled trial to establish the cost-
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57 26 effectiveness of PhysioDirect compared with usual care based only on face-to-face treatment over a
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1 period of 6 months. The trial and its clinical findings have been reported in full elsewhere.^{15,23} The
2 aim of the evaluation was to provide information about the long-run costs and benefits of the
3 alternative methods of running a physiotherapy service for this patient group so with that in mind
4 we excluded the initial set up costs associated with establishing the new telephone service, including
5 the training undertaken by the practitioners.²⁴ As the nature of the intervention suggests there could
6 be an impact on patients' costs, and as it is known that musculoskeletal conditions account for a
7 considerable amount of time off work¹⁴ we chose to use a cost-consequences approach, comparing
8 cost from all three perspectives (health care provider, patients and carers, lost productivity) with a
9 range of clinical outcomes.^{25,26} However, the perspective of greatest interest to UK policy makers is
10 the health and social care provider²³ so we also conducted a cost-utility analysis to compare cost to
11 the National Health Service (NHS) with Quality-Adjusted Life-Years (QALYs).

12

13 **Setting and participants**

14 We recruited adults aged 18 and over from four community physiotherapy services in England –
15 Bristol, Somerset, Stoke-on-Trent, and Cheshire – which provided diversity in terms of socio-
16 economic status and a mix of urban and rural communities. All patients referred by their general
17 practitioner (GP), or who referred themselves, for physiotherapy for a non-urgent musculoskeletal
18 problem were invited to take part. Patients were randomised to PhysioDirect or usual care on a two
19 to one basis to increase the chances of the PhysioDirect service being fully utilised.

20

21 **Interventions**

22 The intervention has been reported in detail elsewhere^{15,25}. Patients randomised to the PhysioDirect
23 service received an invitation to telephone a senior (band 6 or above) specially trained
24 physiotherapist, who assessed their musculoskeletal problem with the aid of previously developed
25 computerised templates.²³ These templates were provided by Huntingdonshire Primary Care Trust,
26 which has been operating a similar service since 2001. Patients were then sent appropriate advice

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3 1 leaflets about self-management and exercises to try at home, and invited to phone again and/or
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5 2 make a face-to-face appointment if necessary. If the service was engaged when the patient called
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7 3 the call was answered by a receptionist who added the patient to a 'call-back' list and the
8
9 4 physiotherapist would return the call when they were free. Patients randomised to usual care were
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11 5 put on the usual service waiting list for face-to-face assessment and treatment.
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7 **Outcome measures**

8 We used the EQ-5D-3L²⁸, valued using the UK tariff,²⁹ to estimate QALYs gained for the cost-utility
9
10 9 analysis. The primary outcome for the trial was the physical component summary (PCS) measure
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12 10 from the SF-36v2 questionnaire³⁰ and secondary clinical outcomes included: the Measure Yourself
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14 11 Medical Outcomes Profile (MYMOP);³¹ a Global Improvement Score – a single question about overall
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16 12 improvement; a composite measure of response to treatment including pain, function and overall
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18 13 improvement (OMERACT OARSI);³² patient satisfaction; and waiting time to first treatment advice
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20 14 from a physiotherapist. All outcomes (except the global improvement score and waiting time to first
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22 15 treatment advice) were measured at baseline, 6 weeks and 6 months and were obtained from a self
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24 16 completed questionnaire administered at these three time points.
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18 **Resource use**

19 The analysis was based on costs related to the reason for which the patient was referred to the
20
21 20 physiotherapy service. We identified relevant resources in discussion with participating
22
23 21 physiotherapists and service managers. Direct costs to the health care provider included: cost of
24
25 22 initial and follow-up physiotherapy consultations; primary and community consultations; hospital
26
27 23 care; and prescribed medication. Patient and carer costs included: telephone calls to the
28
29 24 PhysioDirect service; travel; over the counter medication; prescription costs; private therapy and
30
31 25 purchase of equipment; extra domestic help; and loss of earnings. Lost productivity was estimated

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3 1 separately in relation to time off work to attend physiotherapy appointments and time off because
4
5 2 of the musculoskeletal condition itself.
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9 4 Patient level data about all physiotherapy appointments and consultations were recorded either
10
11 5 automatically by computer or by the physiotherapist treating the patient. For those in the
12
13 6 intervention group, the PhysioDirect assessment software recorded which physiotherapist
14
15 7 conducted each telephone call, and the duration of each call. In addition to the time logged on to
16
17 8 the system physiotherapists had to carry out administrative activities following each telephone call,
18
19 9 such as collating information to send to the patient by post. The time spent on these activities was
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21 10 estimated from information available at one site (Bristol) where manual recording of the entire
22
23 11 encounter supplemented the electronic recording.
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29 13 Physiotherapists assigned to the PhysioDirect service were required to be available throughout the
30
31 14 time the service was 'open' but they were not usually fully engaged in dealing with PhysioDirect
32
33 15 patients during these hours. We conducted an observational time and motion study at each of the
34
35 16 four sites to determine how they occupied their non-PhysioDirect contact time in order to apportion
36
37 17 costs appropriately. Time and motion data were collected at points in the study when the sites were
38
39 18 expected to be fully operational, and across a mix of day, time of day, and location. The capital costs
40
41 19 required to run a telephone service are potentially less than for a face-to-face service. Each site
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43 20 provided information about space and equipment required to run their telephone service and we
44
45 21 used this to estimate an overall percentage reduction of capital costs for these compared with a
46
47 22 standard face-to-face service.
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53 24 Data about all face-to-face appointments were recorded routinely. These data included the length of
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55 25 appointment, the grade of the physiotherapist seen, and information about missed appointments.
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3 1 Information about other NHS resource use was collected, where possible, from general practice
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5 2 records and supplemented by information gained directly from patients. General practice notes
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7 3 were scrutinised for patient level data on primary care consultations and prescribed medication. We
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9 4 included all consultations at which the musculoskeletal condition for which the patient was referred
10
11 5 to physiotherapy was mentioned and these were recorded by type of consultation (for example,
12
13 6 face-to-face, telephone, out of hours, home visit) and by type of professional seen (for example, GP,
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15 7 nurse). It was not feasible to distinguish between medication prescribed for the condition for which
16
17 8 the patient was referred for physiotherapy and any other musculoskeletal problem so we included
18
19 9 all medication of a potentially relevant type, defined using British National Formulary (BNF)³³ coding.
20
21 10 These were: Analgesics (chapters 4.7.1 – 4.7.2); Non-steroidal anti-inflammatory drugs (10.1.1);
22
23 11 Local corticosteroid injections (10.1.2.2); and Drugs for the relief of soft-tissue inflammation (10.3).
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29 13 A questionnaire was administered to participants at 6 weeks and 6 months after randomisation to
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31 14 obtain resource use data not available elsewhere. The questionnaire was designed specifically for
32
33 15 this study but was similar in content and structure to others used for the same purpose³⁴ Questions
34
35 16 included information about hospital care related to the condition for which the patient was referred
36
37 17 to physiotherapy: visits to Accident & Emergency, outpatient appointments, and inpatient stays.
38
39 18 Information about personal expenditure relevant to the patient's musculoskeletal condition was also
40
41 19 gained from the questionnaire at 6 weeks and 6 months. We asked about the cost of travel to
42
43 20 physiotherapy and other health care appointments, expenditure on over the counter medication,
44
45 21 prescription costs, use of private therapies and their cost, expenditure on equipment or devices, and
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47 22 extra help at home. In addition, participants were asked about any time off work, and the associated
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49 23 loss of earnings, because of their condition or to attend health care appointments relating to the
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51 24 condition including usual care physiotherapy and PhysioDirect.
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56 57 26 **Valuation of resource use**

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3 1 Table 1 gives the unit costs and sources used to value the health care resources. We used Curtis³⁵ to
4
5 2 value primary and community health care and Department of Health reference costs³⁶ for all
6
7 3 hospital-based care. The cost of prescribed medication was estimated from that published in the
8
9 4 BNF,³³ adjusted to allow for the discount available to the NHS, and the professional fee and
10
11 5 container allowance in accordance with the Drug Tariff for England.³⁷ Personal expenditure was
12
13 6 reported directly by the participants, the exception being travel by car, which was reported as
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15 7 mileage and costed using the AA schedule of motoring costs.³⁸ Time off work was valued using the
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17 8 median gross weekly earnings by age and sex.³⁹
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Table 1 here

12 The cost of face-to-face physiotherapy consultations was estimated by adapting the methods of
13
14 Curtis³⁵ to obtain a different unit cost for each band of staff at each site. National median pay rates,
15
16 by band,⁴⁰ were adjusted to allow for National Insurance, superannuation, and overheads, as per
17
18 Curtis, then further adjusted to allow for band and site specific non-contact time. Information about
19
20 the proportion of time physiotherapists on each grade typically spend in direct contact with patients
21
22 was provided by the four physiotherapy service managers. This provided us with a cost per hour for
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24 each band of staff at each site.
25

20 The unit cost of physiotherapists working in the PhysioDirect service was estimated in a similar way,
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22 but allowing for the reduced cost of capital and overheads; information from the site managers
23
24 indicated this to be about 50%. To obtain a cost per hour of telephone contact we used information
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26 from the computerised records of the PhysioDirect service, which identified the proportion of time
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28 spent by physiotherapists actually dealing with PhysioDirect patients. We then combined this with
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30 data from the time and motion study, which identified activities undertaken during non-contact
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1 time, for example, administration relating to face-to-face appointments or general administration, to
2 give a cost per hour for each band of staff at each site.

3
4 All costs were valued in £ sterling at 2009 prices, adjusted for inflation where necessary.³⁵

6 **Data analysis**

7 We investigated the amount of each resource used by patients in each group using frequencies,
8 means and medians. Mean total cost per participant was derived by combining resource use with
9 unit costs.

10
11 QALYs were derived from responses to the EQ-5D-3L at baseline, 6 weeks and 6 months using
12 valuations from the UK general population.²⁹ These values, representing health-related quality of life
13 on a scale between zero (death) and 1 (best imaginable health), were used to compute QALYs
14 experienced over the 6 month period using the area under the curve approach and adjusting for any
15 difference between the groups at baseline.⁴³

16
17 A cost-consequences matrix was constructed using all available data. We compared costs from all
18 three perspectives (health care provider, patients and carers, lost productivity) with the SF-36v2 PCS,
19 MYMOP, Global Improvement Score, OMERACT OARSI, patient satisfaction, waiting time, and QALYs.

20
21 The cost-utility analysis was carried out using data on all patients for whom we had complete NHS
22 cost and QALY data. An incremental cost-effectiveness ratio (ICER) was constructed, comparing the
23 difference in mean total cost per patient with mean difference in QALYs, thus the lower the ICER, the
24 greater the cost-effectiveness and the better the value for money. Uncertainty around the ICER was
25 captured using the bootstrapping technique: 5000 replicates of the cost and QALY data were created
26 by sampling from the original data, with replacement. The range and spread of the 5000 ICERs was

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3 1 used to construct a cost-effectiveness acceptability curve to indicate the likelihood of the
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5 2 intervention being cost-effective. The net monetary benefit (NMB) of the intervention was
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7 3 estimated from the point estimate of the ICER for values of societal willingness-to-pay of £20,000
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9 4 and £30,000 per QALY. If the NMB is positive at a given level of willingness to pay, the intervention is
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11 5 regarded as cost-effective. Confidence intervals around the NMB were formed from the
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13 6 bootstrapped estimates.
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19 8 We used the multiple imputation by chained equation procedure to address the issue of missing cost
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21 9 and EQ-5D data.⁴⁴ This technique uses a regression model to estimate missing values from known
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23 10 values. In addition to cost and EQ-5D-3L variables the imputation model also included randomisation
24
25 11 group, age, sex, and SF36v2 PCS. Stata v12⁴⁵ was used to generate five datasets using 10 switching
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27 12 procedures.
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31 14 Discounting was not carried out because the analysis was restricted to costs and outcomes over a
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33 15 period of less than a year. All analyses were conducted using Microsoft Excel and Stata v12.⁴⁴
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38 17 **Sensitivity Analyses**

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40 18 We addressed three areas of uncertainty using four one/two-way sensitivity analyses. First, we
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42 19 estimated the cost of running the PhysioDirect service if it was operating at full capacity. It is likely
43
44 20 that this was not achieved during the trial because of: low demand due to exclusions and non-
45
46 21 participation in the trial; inflexible staffing levels to ensure consistency throughout the trial period;
47
48 22 and the 'one-way' system generally used, where physiotherapists waited for patients to call them
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50 23 but did not routinely contact patients themselves (notwithstanding some limited use of answer-
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52 24 machines). Data from the Bristol service, which continued to operate beyond the trial period and
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54 25 was then able to tailor staffing levels to demand, were used to estimate the cost of running a more
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56 26 'efficient but feasible' PhysioDirect service once the trial had ended.
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5 2 The second area of uncertainty addressed hospital costs. Patients in the trial were recruited from
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7 3 primary care and for these use of secondary care is infrequent but relatively expensive and this can
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9 4 have a disproportionate effect on mean total cost. We tested this by excluding hospital costs from
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11 5 the total.
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16 7 The third area of uncertainty tested the effect of using imputed data rather than complete cases; the
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18 8 third sensitivity analysis used trial data with missing values imputed.
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22 10 Finally, in a two-way sensitivity analysis, we re-estimated the results of the first, (mimicking an
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24 11 'efficient but feasible' service) in this instance using the imputed dataset.
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30 31 14 **RESULTS**

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33 15 A total of 2,249 patients were recruited between July 2009 and December 2009, and followed up
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35 16 until June 2010, 1506 allocated to PhysioDirect and 743 to usual care. The mean age was 60, with
36
37 17 slightly more females than males (60% vs 40%); they were overwhelmingly white (97%), just over
38
39 18 half (60%) were employed and all but a few were referred for physiotherapy by their GP. Lower limb
40
41 19 problems were the most prevalent (30%) reason for referral, 27% patients had a lumbar problem
42
43 20 and 23% upper limb problems. Nearly all participants (2,223=99%) gave permission to access their
44
45 21 GP notes to obtain data about primary care encounters and prescribed medication. 81% returned
46
47 22 questionnaires at both 6 weeks and 6 months though not all participants completed all sections at
48
49 23 both time points. We had complete NHS cost and QALY data for 840 (56%) PhysioDirect and 432
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51 24 (58%) usual care participants.
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58 59 26 **Resource use**

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1 Table 2 gives information about the different types of physiotherapy consultations by patients in
2 each group. Of the 1506 patients in the PhysioDirect group, 39% (586) were managed solely over the
3 telephone and only 46% (695) had any face-to-face consultations. In total, patients in the usual care
4 group had, on average, 0.38 (95% CI: 0.12 to 0.63) more consultations than those in the PhysioDirect
5 group and the mean total duration of all consultations was 20 minutes longer (95% CI: 12 to 28).

6
7 *Table 2 here*
8

9 Tables 3 and 4 give information about NHS and personal resource use. Just over a third of patients
10 (35%) had a GP consultation during the 6 months and 40% received a prescription for
11 musculoskeletal pain-related medication. There was very little difference between the two groups in
12 terms of health care use and the only notable difference in personal expenditure was travel to
13 physiotherapy appointments.

14
15 *Tables 3 and 4 here*
16

17 **Costs and consequences**

18 Table 5 summarises the mean cost per patient, by group, for each category of cost. All available data
19 are included giving variable denominators for each category. Comparing the two groups, there are
20 small differences in cost in some categories but for most of these the confidence intervals indicate
21 there is no evidence of a difference between the groups.

22
23 *Table 5 here*
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25 Table 6 combines the results of the cost analysis with the full range of primary and secondary
26 outcomes, including QALYs.

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Table 6 here

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4 Results are presented for all available data, with cost categories combined. Denominators vary
5 within the table and they also differ from those in table 5 because sub-categories have been
6 collapsed. There was no evidence of a difference in the primary clinical outcome (the SF36v2 PCS)
7 between the groups, suggesting that PhysioDirect led to similar outcomes as usual physiotherapy
8 care. Patients in the PhysioDirect group had their first assessment and telephone advice 27 days
9 earlier than those in the usual care group, however patient satisfaction was slightly lower in those
10 receiving PhysioDirect. QALYs were higher in the PhysioDirect group by 0.009, which equates to
11 about 3.3 extra days of full health over a year.

12

13 **Cost-utility analysis**

14 The cost-utility analysis presented in Table 7 uses complete cases, that is, we include only those
15 patients for whom we had complete NHS cost and QALY data: 432 (58%) from the usual care group
16 and 840 (56%) from PhysioDirect. The small extra cost of caring for patients in the PhysioDirect
17 group was compensated for by the extra QALY gain, giving an incremental cost-effectiveness ratio of
18 £2,889. Values below £20,000 are regarded by NICE to indicate a cost-effective intervention²⁷ At this
19 threshold level of willingness to pay for a QALY there is a positive net monetary benefit of £117 (95%
20 CI -£96 to £310) and there is 0.88 probability that the intervention is cost-effective. This is illustrated
21 in the cost-effectiveness acceptability curve in figure 1.

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Table 7 here

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Figure 1 here

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26 **Sensitivity Analysis**

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3 1 The results of the four sensitivity analyses are shown in table 8 and figure 2. Scenario (1) indicates
4
5 2 the potential cost-effectiveness of a more efficient PhysioDirect service. During the trial PhysioDirect
6
7 3 clinic opening hours, physiotherapists spent about 35% of their time on the phone or dealing with
8
9 4 directly related administration; in Bristol after the trial, this was increased to 57%. Under this
10
11 5 scenario, the cost per patient in the PhysioDirect group was £14.53 less than under trial conditions
12
13 6 and £2.11 less per patient in the usual care group. The ICER is therefore lower, at £1,045, the NMB
14
15 7 correspondingly higher at £127 (λ =£20,000). At low levels of λ , the probability of PhysioDirect being
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17 8 cost-effective under this scenario is higher than with the base case, though at λ =£20,000 it reaches a
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19 9 similar value (see figures 1 and 2).
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25 11 *Table 8 here*

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27 12 *Figure 2 here*
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31 14 The effect of removing hospital costs from the analysis is shown in sensitivity analysis (2). Hospital
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33 15 costs accounted for 75% of all NHS costs yet only 19% (n=252) participants reported using any
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35 16 secondary care. Hospital use was evenly divided between the two groups so removing these from
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37 17 the analysis made very little difference to incremental analysis.
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42 19 The effect of imputing missing NHS cost and QALY data is explored in sensitivity analysis (3). Using
43
44 20 these data the cost of the interventions is lower but this is offset by higher NHS costs, giving a higher
45
46 21 mean total cost in both groups, by £21.41 in the usual care group and £6.58 in the PhysioDirect
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48 22 group. QALYs using imputed data are lower, by 0.005 in the usual care group and by 0.010 in the
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50 23 PhysioDirect group. The net effect is a reduction of both incremental cost and incremental QALYs,
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52 24 giving an ICER of £2,260. Uncertainty around the ICER is reduced, as seen by the flatter CEAC in
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54 25 figure 2.
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3 1 Sensitivity analysis (4) combines analyses (1) and (3) by using imputed cost data in the 'efficient
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5 2 service' scenario. In this case the results indicate that PhysioDirect is, on average, cheaper than usual
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7 3 care with a possible saving of £6.02 per patient, which gives a negative value for the ICER, indicating
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9 4 the intervention is superior in terms of both cost and outcome. The probability that the service is
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11 5 cost-effective at $\lambda = \text{£}20,000$ is 0.72.
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18 **DISCUSSION**

19 **Statement of principal findings**

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22 10 The results of this economic evaluation suggest that PhysioDirect services for patients with
23
24 11 musculoskeletal problems require careful management if they are to be a cost-effective alternative
25
26 12 to usual physiotherapy care. There was very little difference between the two groups in terms of
27
28 13 either outcomes or costs, and the finding that PhysioDirect is cost-effective is based on evidence
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30 14 that it provides very slightly greater QALY benefits at very slightly greater cost.
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35 16 Clearer cost savings were observed in the sensitivity analysis that replicated the post-trial service,
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37 17 once greater flexibility in working arrangements was implemented. Without the restrictions of a trial
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39 18 environment staffing was adjusted to meet the anticipated demand, a call-back service was
40
41 19 employed which accommodated fluctuations in activity during each session, referrals added to the
42
43 20 system were adjusted regularly to reflect actual staffing and the number of patients waiting for
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45 21 a call-back and a higher throughput of patients led to greater economies of scale. These changes
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47 22 ensured physiotherapists within the PhysioDirect service spent a higher proportion of their
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49 23 PhysioDirect clinic time on the telephone with patients. There was no evidence of a difference
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51 24 between PhysioDirect and usual care in cost to patients and their families, or to society through the
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53 25 costs of lost production.
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1 Strengths and weaknesses of the study

2 The study has a number of strengths. It is the first study assessing the cost-effectiveness of a
3 PhysioDirect service including a large sample of patients with a wide range of musculoskeletal
4 problems based across a number of locations.¹⁵ It uses a rigorous study design and conforms to
5 CONSORT guidelines.⁴⁶ The follow up rate from participating patients was in line with other primary
6 care trials,^{47,48} a high proportion of the resource use data were collected from GP records, and there
7 was collection of resource use information outside of the main health service perspective. The cost
8 consequences analysis provides complete information on costs from different perspectives
9 compared with a range of outcomes so although this approach is sometimes criticised for leaving the
10 reader to evaluate the findings it does have the advantage of transparency. Furthermore, in this
11 study we have also presented a cost-utility analysis that conforms to the recommendations of NICE.
12 Nevertheless, there are also limitations. The practices recruited to the trial had a low proportion of
13 ethnic minority patients, a slightly lower proportion of patients from deprived areas were judged to
14 be eligible, and the proportion of eligible individuals consenting to participate in the trial was only
15 50%.²³ These factors limit the generalisability of the results though none of these selection effects
16 was large. Further, a particular difficulty in conducting economic evaluation with new service
17 developments is ensuring that they are fully utilised,²⁴ particularly when conducting analysis from a
18 long-run perspective, as here. Although there was a clear run-in period prior to data collection for
19 the trial (ranging from 4 to 12 weeks in each of the four sites), to ensure that services were
20 operating as well as they could, and a 2:1 randomisation ratio in favour of PhysioDirect was used,
21 there was still considerable underutilisation of the new service. This was ameliorated by including a
22 more fully utilised service within the sensitivity analysis. It should also be noted that, because of the
23 use of a long-run perspective in the analysis, set up costs, which may, in the short-term be important
24 in a financially constrained service, are not included here. Finally, because the differences in both
25 costs and effects are small, there is still some uncertainty around the findings.

1 **The meaning of the study and implications for policy makers**

2 If the aim of health services is to achieve maximum health gain from an investment in health care,
3 then PhysioDirect has a high probability of being more cost-effective than usual physiotherapy care.
4 This research also, however, suggests that it cannot be assumed that PhysioDirect will reduce costs,
5 although it could potentially do so if PhysioDirect services are managed efficiently. Both the costs
6 and cost-effectiveness of services will depend on the productivity of physiotherapist time. If
7 physiotherapists are able to use most of their time dealing directly with patients during sessions
8 when they are available on the telephone, then the service will be less costly. This is most likely to be
9 achieved by operating a call-back service and/or by operating the service on a large scale to even out
10 fluctuations in demand. Operating a system on larger scale might also offer other economies of
11 scale, particularly in terms of infrastructure. Further efficiencies may also be achieved if these
12 services are, in the future, provided in conjunction with direct access for patients (rather than
13 following referral from another health care professional), given that patients who self-refer are likely
14 to contact the service with musculoskeletal problems of shorter duration,⁴⁹ and such patients may
15 be particularly appropriate for the initial assessment and advice provided by a PhysioDirect service.
16 More generally, the study has broader implications for telephone services, particularly around the
17 implicit assumption that such services will inevitably be money saving. Here this assumption was
18 found to be false, largely because the physiotherapists' time was underutilised during PhysioDirect
19 clinic hours. Thus, for all such services, it will be important for policy makers to ensure that easy
20 assumptions about the costs of these services are properly assessed in relation to factors such as
21 how efficiently the service is run, and what proportion of patients are subsequently invited for face
22 to face care following an initial telephone call.

24 **Unanswered questions and future research**

25 As services evolve, further research should explore the costs and benefits of PhysioDirect under
26 different scenarios. These might include: comparing different skill levels of staff operating the

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3 1 service; the inclusion of patient self-referrals in addition to GP referrals; the use, or otherwise, of
4
5 2 computerised support in assessing the patient; the extension to internet services (possibly combined
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7 3 with cameras);⁵⁰ and the use of mobile 'smartphone' technology, for example in rapid assessment of
8
9 4 musculoskeletal injuries. In particular, however, it will be important to assess the costs and benefits
10
11 5 of services once they are more established and provided on a wider scale. The costs and benefits of
12
13 6 telehealth more generally need further exploration in relation to their cost effectiveness particularly
14
15 7 given the negative findings of the Whole Systems Demonstrator project evaluating telehealth
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17 8 support and treatment for patients with long term conditions.⁵¹ It would be helpful to identify those
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19 9 characteristics that are likely to make services both more cost-effective and less costly.
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32 **19 Aurthors' contributions**

33 CS was principal investigator on the trial, SH took the lead on the economic evaluation. JC, NF, SG,
34 JH, and AM were co-applicants and contributed to the conception and design. SH, JC and JB carried
35 out the analysis with help from CS and AM, and all authors contributed to the interpretation of the
36 data. SH and JC wrote the first draft of the paper with all authors contributing to subsequent
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Table 1: Data sources and unit costs

	Unit cost (£)
Primary and Community Care ³⁵	
General Practitioner	
Surgery	27.00
Telephone consultation	16.00
Home visit	91.00
Practice nurse	
Surgery	10.00
Telephone consultation	5.93
Health Care Assistant/phlebotomist	
Surgery	6.92
District Nurse	
Home visit	16.33
Out of Hours ^{41,42}	
General practitioner	23.50
Hospital care ³⁶	
A&E	103.00
Outpatient visits	By Healthcare Resource Group, differentiated by first and follow-up
Inpatient stays	By Healthcare Resource Group
Prescribed medication ³³	per item, by name, strength and amount
Mileage ³⁸	0.4612
Time off work ³⁹	Median national wage by age and sex

Table 2: Number of physiotherapy consultations and mean duration, by type and group

		Usual care (n=743)	PhysioDirect (n=1506)
Face-to-face appointments	mean (SD) number	3.11(2.63)	1.91(2.72)
	mean (SD) total	107.51(88.92)	64.20(89.31)
	duration (minutes)		
Telephone appointments	mean (SD) number	0.13(0.44)	0.96 (0.63)
	mean (SD) total	4.21(14.64)	27.37(19.92)
	duration (minutes)		
Home visits	mean (SD) number	0.00 (0.06)	0.00 (0.06)
	mean (SD) total	0.14(2.27)	0.12(2.12)
	duration (minutes)		
All physiotherapy contacts	mean (SD) number	3.25(2.70)	2.87(2.94)
	mean (SD) total	111.86(90.50)	91.70 (95.40)
	duration (minutes)		

Table 3: Health services resource use, by group. All available data.

	Mean (SD) number of consultations			
	n	usual care	n	PhysioDirect
GP consultations	739	0.77(1.47)	1484	0.87 (1.68)
Nurse consultations	739	0.04 (0.22)	1484	0.06 (0.32)
Other primary care consultations	739	0.02(0.14)	1484	0.02 (0.17)
Total number of primary care contacts	739	0.83(1.56)	1484	0.96 (1.84)
Number of prescriptions	728	1.36 (2.73)	1469	1.68 (3.72)
A&E (visits)	467	0.02 (0.01)	912	0.03 (0.01)
Out-patient (consultations)	467	0.17 (0.83)	910	0.35 (1.03)
In-patient stays (Finished Consultant Episodes)	465	0.01 (0.10)	910	0.01 (0.10)

Table 4: Patient and societal resource use, by group. All available data.

Number (%) reporting:	n	usual care	n	PhysioDirect
Expenditure on travel to physiotherapy	462	242 (52.4)	1232	308 (25.8)
Expenditure on travel to primary care	669	116 (17.3)	1337	237 (17.7)
Expenditure on over-the-counter medication	506	256 (50.6)	1028	512 (49.8)
Expenditure on prescriptions	559	264 (47.2)	1085	508 (46.8)
Expenditure on private therapy	484	89 (18.4)	934	167 (17.9)
Equipment purchase	480	139 (29.0)	939	233 (24.8)
Payments for extra domestic help	459	35 (7.6)	928	76 (8.2)
Loss of earnings	598	30 (5.5)	1209	64 (5.3)
Any time off to attend physiotherapy consultation	692	218 (31.5)	1416	380 (26.8)
Work has been affected because of condition	477	141 (29.6)	959	317 (33.1)

Table 5: Mean total cost per patient, by group and category. All available data^a.

	usual care		PhysioDirect		Incremental difference (95% Confidence Interval)
	n	mean (SD) cost	n	mean (SD) cost	
Physiotherapy services					
Face-to-face appointments	743	£64.42 (£53.00)	1506	£38.76 (£53.92)	-£25.66 (-£30.37 to -£20.95)
Telephone appointments	743	£5.22 (£18.01)	1506	£35.17 (£26.34)	£29.94 (£27.84 to £32.05)
Home visits	743	£0.08 (£1.33)	1506	£0.08 (£1.46)	£0.00 (-£0.12 to £0.13)
Total physiotherapy cost	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Primary care services					
GP consultations	739	£19.21 (£35.91)	1484	£21.69 (£41.66)	£2.48 (-£1.04 to £6.00)
Nurse consultations	739	£0.44 (£2.37)	1484	£0.61 (£3.17)	£0.16 (-£0.10 to £0.42)
Other primary care consultations	739	£0.03 (£0.57)	1484	£0.07 (£1.31)	£0.05 (-£0.05 to £0.15)
Total primary care cost	739	£19.68 (£36.68)	1484	£22.37 (£42.83)	£2.69 (-£0.92 to £6.30)
Medication cost	728	£11.04 (£51.61)	1469	£10.33 (£55.43)	-£0.72 (-£5.53 to £4.10)
Hospital services					
A&E	467	£1.99 (£17.12)	912	£3.17 (£20.84)	£1.18 (-£1.01 to £3.37)
Out-patient	467	£30.74 (£98.36)	910	£38.35 (£126.05)	£7.61 (-£5.50 to £20.72)
In-patient	465	£51.02 (£520.48)	910	£34.99 (£399.62)	-£16.03 (-£65.70 to £33.64)
Total hospital cost	459	£83.04 (£561.68)	899	£77.00 (£446.24)	-£6.04 (-£60.99 to £48.91)
Personal expenditure					
Cost of all calls to physiotherapy service	743	£0.97 (£0.99)	1506	£1.75 (£1.29)	£0.79 (£0.68 to £0.89)
Travel to physiotherapy	462	£6.11 (£11.48)	1232	£3.11 (£8.51)	-£3.01 (-£4.01 to -£2.00)
Travel for primary care	669	£0.65 (£2.93)	1337	£0.75 (£4.10)	£0.11 (-£0.24 to £0.45)
Over-the-counter medication	490	£7.67 (£14.09)	987	£8.61 (£22.38)	£0.94 (-£1.23 to £3.11)
Cost of prescriptions	553	£2.72 (£8.95)	1076	£2.67 (£8.33)	-£0.05 (-£0.93 to £0.82)

Private therapy	475	£21.98 (£70.34)	915	£39.34 (£296.94)	£17.36 (-£9.76 to £44.48)
Equipment purchase	473	£17.16 (£169.12)	924	£9.12 (£56.42)	-£8.04 (-£20.08 to £4.00)
Extra domestic help	451	£10.93 (£64.31)	905	£13.68 (£96.02)	£2.75 (-£7.07 to £12.56)
Cost associated with loss of earnings	598	£46.69 (409.72)	1209	£82.78 (£885.85)	£36.09 (-£38.63 to £110.81)
Value of time off work					
Time off work to attend physiotherapy	598	£12.90 (£38.99)	1211	£11.91 (£57.86)	£0.95 (-£3.81 to £5.70)
Time off work associated with the condition	452	£265.92 (£1350.82)	884	£226.61 (£1139.84)	£111.31 (-£159.04 to £379.67)

^a Uses all available data, so denominators differ by category.

Table 6: Cost-consequences. All available data^a.

	n (%)	usual care	n (%)	PhysioDirect	Incremental difference (95% Confidence Interval)
Mean (SD) Cost					
Total physiotherapy cost	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Cost of NHS services including physiotherapy	453 (61%)	£189.19 (£557.61)	888 (59%)	£196.43 (£472.02)	£7.24 (-£49.68 to £64.10)
Total personal expenditure	310 (42%)	£121.10 (£575)	714 (47%)	£166.40 (£1040.27)	£45.30 (-£78.01 to £168.61)
Total value of all time off work ^b	451 (61%)	£276.75 (£1355.00)	883 (59%)	£240.74 (£1147.20)	-£36.01 (-£174.69 to £102.66)
Consequences^c					
					Difference/odds ratio (95% confidence interval)^d
SF36v2 PCS	629 (85%)	44.18 (10.84)	1283 (85%)	43.50 (10.94)	-0.01 (-0.80 to 0.79)
MYMOP ^e	518 (70%)	2.40 (1.38)	1033 (69%)	2.40 (1.43)	-0.02 (-0.16 to 0.11)
Global improvement score	501 (67%)	4.07 (1.40)	1001 (66%)	4.01 (1.44)	-0.08 (-0.23 to 0.08)
Response to treatment (OMERACT OARSI)	510 (69%)	197 (38.6%)	1029 (68%)	430 (41.8%)	1.14 (0.92 to 1.43)
Waiting time to first assessment and advice	618 (83%)	34 (20 to 55) ^f	1281 (85%)	7 (4 to 15) ^f	0.32 (0.29 to 0.35) ^g
Patient overall satisfaction	367 (49%)	79.7 (26.5)	739 (49%)	75.9 (28.3)	-3.8 (-7.3 to -0.3)
QALYs ^h	454 (61%)	0.322 (0.079)	881 (58%)	0.331 (0.082)	0.009 (-0.000 to 0.018)

^a Uses all available data, so denominators differ by category

^b Total of time off to attend physiotherapy and associated with the condition

^c At 6 month follow-up time point

^d Adjusted for outcome at baseline, gender, age, referral problem, PCT

^e Lower score is better

^f Median (IQR)

^g Accelerated failure time analysis

^h Adjusted for outcome at baseline

Table 7: Cost-effectiveness analysis. Includes cases with complete data on NHS costs and QALYs

	n	usual care mean (SD) cost	n	PhysioDirect Mean (SD) cost	Incremental difference (95% CI)
Cost of physiotherapy	432	£78.77 (£57.08)	840	£86.75 (£65.47)	£7.98 (£0.69 to £15.27)
Cost of NHS services other than physiotherapy	432	£100.91 (£502.02)	840	£112.23 (£476.91)	£11.32 (-£45.08 to £67.72)
Total cost including physiotherapy	432	£179.68 (£504.73)	840	£198.98 (482.12)	£19.30 (-£37.60 to £76.19)
QALYs	432	0.325 (0.077)	840	0.332 (0.081)	0.007 (-0.003 to 0.016)
Incremental cost-effectiveness ratio (ICER)					£2,889
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£117 (-£86 to £310)
probability of intervention being cost-effective					0.88
λ=£30,000					£184 (-£106 to £461)
probability of intervention being cost-effective					0.90

Table 8: Sensitivity Analysis

	Usual care		PhysioDirect		Incremental difference (95% confidence interval)
	n	mean (SD)	n	mean (SD)	
(1) mimicking an efficient service					
Cost of physiotherapy	432	£76.56 (£55.34)	840	£72.22 (£61.55)	-£4.34 (-£11.25 to £2.57)
Cost of NHS services	432	£100.91 (£502.02)	840	£112.23 (476.91)	£11.32 (-£45.08 to £67.72)
Total cost	432	£177.46 (£504.49)	840	£184.44 (£481.83)	£6.98 (-£49.89 to £63.85)
Incremental cost-effectiveness ratio (ICER)					£1,045
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£127 (-£74 to £319)
λ=£30,000					£193 (-£95 to £473)
(2) Excluding hospital costs					
Cost of physiotherapy	448	£78.49 (£57.14)	869	£86.84 (£65.25)	£8.35 (£1.21 to £15.50)
Cost of NHS services excluding secondary care	448	£33.75 (£76.46)	869	£33.49 (£63.76)	-£0.25 (-£8.05 to £7.54)
Total cost of NHS services including physiotherapy	448	£112.23 (£99.621)	869	£120.33 (£98.85)	£8.10 (-£3.21 to £19.41)
Incremental cost-effectiveness ratio (ICER)					£1,084
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£142 (-£41 to £324)
λ=£30,000					£217 (-£56 to £489)
(3) Imputed data					
Cost of physiotherapy	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Cost of NHS services	743	£131.37 (£465.49)	1506	£131.51 (£384.36)	£0.17 (-£36.13 to £36.48)
Total cost of NHS services including physiotherapy	743	£201.09 (£467.51)	1506	£205.55 (£390.04)	£4.46 (-£32.22 to £41.14)
Quality Adjusted Life Years	743	0.320 (0.003)	1506	0.322 (0.002)	0.002 (-0.006 to 0.009)
Incremental cost-effectiveness ratio (ICER)					£2,260
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£34 (-£119 to £193)
λ=£30,000					£52 (-£172 to £285)
(4) Imputed data and 'efficient' service					
Cost of physiotherapy	743	£67.61 (£54.19)	1506	£61.41 (£59.13)	-£6.20 (-£11.26 to -£1.14)
Cost of NHS services	743	£131.37 (£465.49)	1506	£131.54 (384.36)	£0.17 (-£36.13 to £36.48)
Total cost of NHS services including physiotherapy	743	£198.98 (£467.48)	1506	£192.95 (£389.52)	-£6.02 (-£42.68 to £30.63)
Quality Adjusted Life Years	743	0.320 (0.003)	1506	0.322(0.002)	0.002 (-0.006 to 0.009)
Incremental cost-effectiveness ratio (ICER)					-£3,054
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£47 (-£113 to £202)
λ=£30,000					£67 (-£165 to £293)

Figure 1. Cost-effectiveness acceptability curve showing the probability that the intervention is cost-effective at different levels of willingness to pay for one Quality Adjusted Life Year

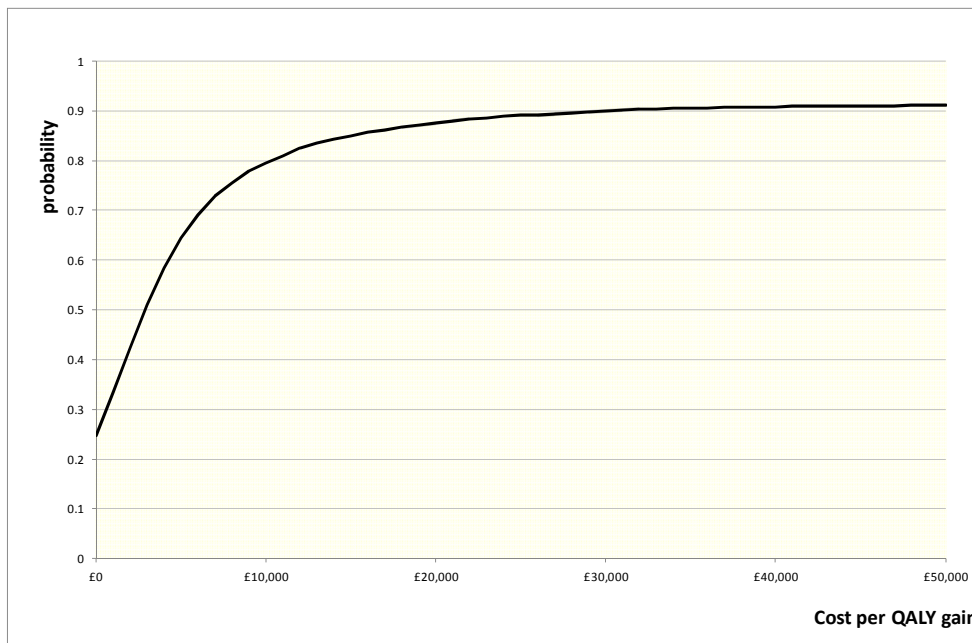
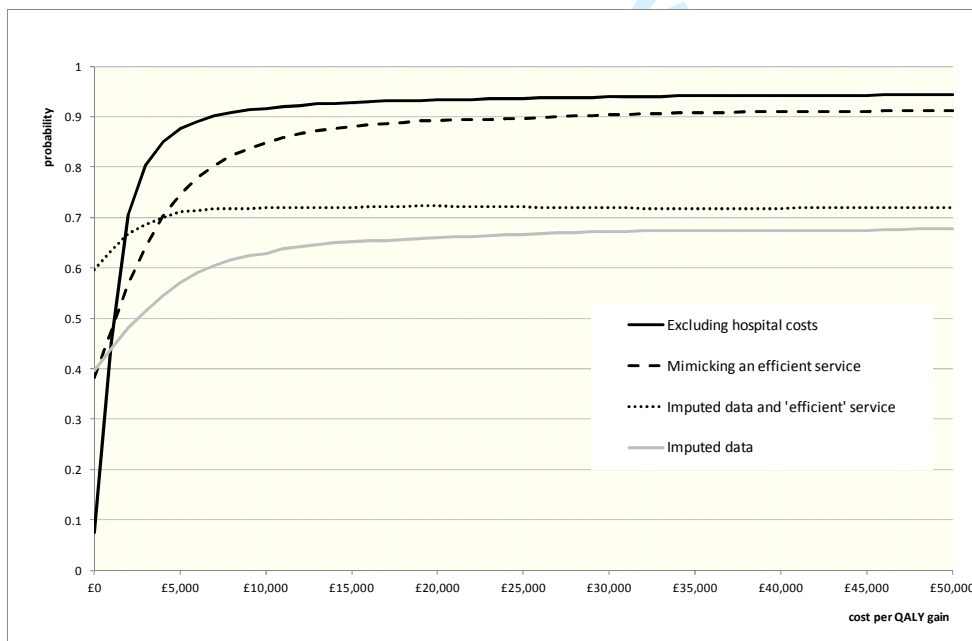


Figure 2. Cost-effectiveness acceptability curve showing the probability that the intervention is cost-effective at different levels of willingness to pay for one Quality Adjusted Life Year: Sensitivity Analyses



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7 **A pragmatic randomised controlled trial of 'PhysioDirect' telephone**
8 **assessment and advice services for patients with musculoskeletal problems:**
9 **economic evaluation**
10

11 Sandra Hollinghurst, Joanna Coast, John Busby, Annette Bishop, Nadine E Foster, Angelo Franchini,
12 Sean Grove, Jeanette Hall, Cherida Hopper, Surinder Kaur, Alan A Montgomery, Chris Salisbury
13

14
15 Sandra Hollinghurst, PhD. Senior Lecturer in Health Economics¹

16 Joanna Coast, PhD. Professor of Health Economics²

17 John Busby, MSc. Research Assistant in Health Economics¹

18 Annette Bishop, PhD. Research Physiotherapist³

19 Nadine E Foster, D.Phil. NIHR Professor of Musculoskeletal Health in Primary Care³

20 Angelo Franchini, MSc. Research Associate⁴

21 Sean Grove, MSc. Clinical Lead Physiotherapy⁵

22 Jeanette Hall, Grad Dip Phys. Operational lead for Outpatient Physiotherapy⁵

23 Cherida Hopper, PhD. Trial Manager¹

24 Surinder Kaur, BSc. Research Associate¹

25 Alan A Montgomery, PhD. Professor of Medical Statistics and Clinical Trials⁶

26 Chris Salisbury, MD. Professor of Primary Health Care¹
27
28

29 ¹Centre for Academic Primary Care, School of Social and Community Medicine, University of Bristol,
30 UK

31 ²Health Economics Unit, School of Health & Population Sciences, University of Birmingham, UK

32 ³Arthritis Research UK Primary Care Centre, Primary Care Sciences, Keele University, UK

33 ⁴Imperial Clinical Trials Unit, School of Public Health Medicine, Imperial College, London, UK

34 ⁵Musculoskeletal Outpatient Department, Bristol Community Health, UK

35 ⁶Nottingham Clinical Trials Unit, Queen's Medical Centre, Nottingham, UK
36
37
38

39 **Correspondence:**

40 Sandra Hollinghurst, School of Social and Community Medicine, University of Bristol, Canynge Hall,
41 39 Whatley Road, Bristol BS8 2PS

42 s.p.hollinghurst@bristol.ac.uk

43 0117 331 3901
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7 **A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and**
8 **advice services for patients with musculoskeletal problems: economic evaluation**
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10 **ABSTRACT**

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12 **Objectives**

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14 To compare the cost-effectiveness of PhysioDirect with usual physiotherapy care for patients
15 with musculoskeletal problems.
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18 **Design**

19
20 (i) Cost-consequences comparing cost to the NHS, to patients, and the value of lost productivity
21 with a range of outcomes. (ii) Cost-utility analysis comparing cost to the NHS with Quality
22 Adjusted Life Years (QALYs)
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25 **Setting**

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27 Four physiotherapy services in England
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30 **Participants**

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32 Adults (18+) referred by their general practitioner or self-referred for physiotherapy.
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35 **Interventions**

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37 PhysioDirect involved telephone assessment and advice followed by face-to-face care if needed.
38 Usual care patients were placed on a waiting list for face-to-face care.
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40 **Primary and secondary outcome measures**

41
42 Primary clinical outcome: physical component summary ~~measure~~ from the SF-36v2 at six months.

43 Also included in the cost-consequences~~Secondary outcomes included~~: Measure Yourself Medical
44 Outcomes Profile; a Global Improvement Score; response to treatment; patient satisfaction; waiting
45 time.
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48 Outcome for the cost-utility analysis: QALYs
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50 **Results**

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52 2249 patients took part (1506 PhysioDirect; 743 usual care).
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7 (i) Cost-consequences: there was no evidence of a difference between the two groups in the cost of
8 physiotherapy, other NHS services, personal costs or value of time off work. Outcomes were also
9 similar.
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11 (ii) Cost-utility analysis based on complete cases (n=1,272). Total NHS costs, including the cost of
12 physiotherapy were higher in the PhysioDirect group by £19.30 (95% CI: -£37.60 to £76.19) and
13 there was a QALY gain of 0.007 (95% CI: -0.003 to 0.016). The incremental cost-effectiveness ratio
14 was £2,889 and the net monetary benefit at λ =£20,000 was £117 (95% CI: -£86 to £310)
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16

17 **Conclusions**

18 PhysioDirect may be a cost-effective alternative to usual physiotherapy care, though only with
19 careful management of staff time. Physiotherapists providing the service must be more fully
20 occupied than was possible under trial conditions: consideration should be given to the scale of
21 operation, opening times of the service, and flexibility in the methods used to contact patients.
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Article Summary

Article focus

- What is the cost of providing PhysioDirect telephone assessment and advice, followed by face-to-face care if needed, to adults with musculoskeletal pain problems, compared with usual physiotherapy care?
- What are the patient benefits of PhysioDirect compared with usual care?
- Is PhysioDirect a cost-effective alternative to usual care for primary care patients with musculoskeletal conditions?

Key messages

- There was very little difference between the two groups in terms of cost or outcomes
- PhysioDirect has potential to be a cost-effective alternative to usual care but requires careful management of staff resources

Strengths and limitations of this study

- Findings are based on a large sample of patients with a wide range of musculoskeletal problems based in diverse locations
- The study takes a broad perspective, including the health care provider, patients, and a valuation of lost productivity
- Physiotherapists were constrained by trial conditions and were underutilised

1 INTRODUCTION

2 There is a trend to explore the use of new technology in the delivery of health care, particularly the
 3 use of telephone assessment and triage, as for example in NHS Direct.¹ These services aim to better
 4 manage patient demand, and research has shown that telephone based services can be safe,
 5 clinically accurate, cost-effective, acceptable to patients, and reduce the workload of clinicians,²⁻⁵
 6 although there have been some concerns about using telephone triage in patients presenting with
 7 acute health problems.⁶

8
 9 Musculoskeletal pain problems are one of the most common causes of disability. Over a quarter of
 10 all patients registered in general practice will consult at least once for a musculoskeletal problem
 11 each year,^{7,8} with musculoskeletal pain accounting for around 15% of all GP consultations.⁹ This high

12 prevalence of musculoskeletal problems¹⁰ results in large direct and indirect healthcare costs:¹⁰

13 ~~estimated for for example, low back pain alone has recently been estimated to cost the UK economy~~
 14 ~~£15.84 billion a year at £10,668 million for the UK in 1998¹¹ and rising substantially since then.^{11,12}~~

15 Most patients are managed with advice and analgesia but many are referred to physiotherapists,
 16 with 1.23 million new referrals each year from GPs and 4.4 million in total.¹³ Ensuring timely access
 17 to physiotherapy has long been an issue within the UK NHS, with waiting times of more than four
 18 months in some areas. Patients may suffer unnecessary pain and disability, and there are high
 19 productivity losses: for example, back pain accounts for some 120 million days of certified absence
 20 from work each year.¹⁴ Delay may also cause NHS inefficiencies on the one hand as some patients
 21 recover and do not attend their physiotherapy appointment when it finally arrives, whilst on the
 22 other, some patients continue to access more expensive forms of treatment whilst awaiting their
 23 appointment.

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 25 In response to these problems, physiotherapy services have drawn on the new service models and a
 26 range of 'PhysioDirect' services have been developed. These vary in format though they commonly

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7 1 involve a physiotherapist assessing a patient's musculoskeletal pain problem over the telephone,
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9 2 sometimes supported by computerised assessment templates, offering tailored, self-management
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11 3 advice supplemented by written advice sent by post. Alternatively if the assessment findings
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13 4 suggest that face-to-face care is needed this is arranged, and patients who are initially managed by
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15 5 telephone advice can phone back for further advice and/or face-to-face treatment.¹⁵⁴ There is,
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17 6 however, limited evidence about the costs and benefits of this approach within physiotherapy. Local
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19 7 evaluations and non-randomised studies suggest that these services may be popular with patients¹⁶⁵⁻
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21 8 ¹⁸⁷ and diagnoses made by physiotherapists over the telephone are comparable to diagnoses
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23 9 reached in face-to-face assessments¹⁹⁸⁻²¹⁹ although there is some concern that the experience of the
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25 10 physiotherapist providing the telephone assessment might be important.^{198,221}
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27 12 In particular there is no information about the costs or cost-effectiveness of PhysioDirect services,
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29 13 despite: (i) a major underlying rationale for their development being to generate greater efficiency
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31 14 in the use of resources; and (ii) a ready presumption that telephone-based services result in lower
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33 15 costs (by assuming that services better use physiotherapy time, use less costly telephone
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35 16 consultations and reduce rates of appointment non-attendance). Without such evidence, preferably
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37 17 generated alongside high quality primary evidence obtained using rigorous study designs, it remains
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39 18 unclear whether such services should be more widely implemented. This paper reports the results of
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41 19 an economic evaluation conducted alongside a randomised controlled trial powered to generate
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43 20 evidence on whether PhysioDirect services for primary care patients with musculoskeletal problems
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45 21 produce equivalent outcomes to usual face-to-face services.
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50 24 **METHOD**

51 52 25 **Study design**

1 We conducted an economic evaluation alongside a randomised controlled trial to establish the cost-
 2 effectiveness of PhysioDirect compared with usual care based only on face-to-face treatment over a
 3 period of 6 months. The trial and its clinical findings have been reported in full elsewhere.^{15,23,32} The

4 aim of the evaluation was to provide information about the long-run costs and benefits of the

5 alternative methods of running a physiotherapy service for this patient group so with that in mind

6 we excluded the initial set up costs associated with establishing the new telephone service, including

7 the training undertaken by the practitioners.²⁴ As the nature of the intervention suggests there could

8 be an impact on patients' costs, and as it is known that musculoskeletal conditions account for a

9 considerable amount of time off work¹⁴ we chose to use a cost-consequences approach, comparing

10 cost from all three perspectives (health care provider, patients and carers, lost productivity) with a

11 range of clinical outcomes.^{25,26} However, the perspective of greatest interest to UK policy makers is

12 the health and social care provider,²³ so we also conducted a cost-utility analysis to compare cost to

13 the National Health Service (NHS) with Quality-Adjusted Life-Years (QALYs). However, the nature of

14 the intervention suggests there could be an impact on patients' costs, and as it is known that

15 musculoskeletal conditions account for a considerable amount of time off work^{10,11} we included

16 these perspectives in the analysis. We used a cost-consequences approach to compare cost from all

17 three perspectives (health care provider, patients and carers, lost productivity) with a range of

18 clinical outcomes and used a cost-utility analysis to compare cost to the National Health Service

19 (NHS) with Quality-Adjusted Life-Years (QALYs).

20 The primary perspective for the economic evaluation was the health and social care provider, as that

21 is of greatest interest to UK policy makers.²³ However, the nature of the intervention suggests there

22 could be an impact on patients' costs, and as it is known that musculoskeletal conditions account for

23 a considerable amount of time off work^{10,11} we included these perspectives in the analysis. We used

24 a cost-consequences approach to compare cost from all three perspectives (health care provider,

25 patients and carers, lost productivity) with a range of clinical outcomes and used a cost-utility

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~~analysis to compare cost to the National Health Service (NHS) with Quality Adjusted Life Years~~

~~(QALYs)~~

Setting and participants

We recruited adults aged 18 and over from four community physiotherapy services in England – Bristol, Somerset, Stoke-on-Trent, and Cheshire – which provided diversity in terms of socio-economic status and a mix of urban and rural communities. All patients referred by their general practitioner (GP), or who referred themselves, for physiotherapy for a non-urgent musculoskeletal problem were invited to take part. Patients were randomised to PhysioDirect or usual care on a two to one basis to increase the chances of the PhysioDirect service being fully utilised.

Interventions

The intervention has been reported in detail elsewhere^{154,252}. Patients randomised to the PhysioDirect service received an invitation to telephone a senior (band 6 or above) specially trained physiotherapist, who assessed their musculoskeletal problem with the aid of previously developed computerised templates.²³² These templates were provided by Huntingdonshire Primary Care Trust, which has been operating a similar service since 2001. Patients were then sent appropriate advice leaflets about self-management and exercises to try at home, and invited to phone again and/or make a face-to-face appointment if necessary. If the service was engaged when the patient called the call was answered by a receptionist who added the patient to a 'call-back' list and the physiotherapist would return the call when they were free. Patients randomised to usual care were put on the usual service waiting list for face-to-face assessment and treatment.

Outcome measures

We used the EQ-5D-3L²⁸⁴, valued using the UK tariff,²⁹⁵ to estimate QALYs gained for the cost-utility analysis. The primary outcome for the trial was the physical component summary (PCS) measure

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1 from the SF-36v2 questionnaire²⁶³⁰ and secondary clinical outcomes included: the Measure Yourself
2 Medical Outcomes Profile (MYMOP);²⁷³¹ a Global Improvement Score – a single question about
3 overall improvement; a composite measure of response to treatment including pain, function and
4 overall improvement (OMERACT OARS);²⁸³² patient satisfaction; and waiting time to first treatment
5 advice from a physiotherapist. All outcomes (except the global improvement score and waiting time
6 to first treatment advice) were measured at baseline, 6 weeks and 6 months and were obtained
7 from a self completed questionnaire administered at these three time points.

8

9 **Resource use**

10 The analysis was based on costs related to the reason for which the patient was referred to the
11 physiotherapy service. We identified relevant resources in discussion with participating
12 physiotherapists and service managers. Direct costs to the health care provider included: cost of
13 initial and follow-up physiotherapy consultations; primary and community consultations; hospital
14 care; and prescribed medication. Patient and carer costs included: telephone calls to the
15 PhysioDirect service; travel; over the counter medication; prescription costs; private therapy and
16 purchase of equipment; extra domestic help; and loss of earnings. Lost productivity was estimated
17 separately in relation to time off work to attend physiotherapy appointments and time off because
18 of the musculoskeletal condition itself.

19
20 Patient level data about all physiotherapy appointments and consultations were recorded either
21 automatically by computer or by the physiotherapist treating the patient. For those in the
22 intervention group, the PhysioDirect assessment software recorded which physiotherapist
23 conducted each telephone call, and the duration of each call. In addition to the time logged on to
24 the system physiotherapists had to carry out administrative activities following each telephone call,
25 such as collating information to send to the patient by post. The time spent on these activities was

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7 1 estimated from information available at one site (Bristol) where manual recording of the entire
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9 2 encounter supplemented the electronic recording.
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12 4 Physiotherapists assigned to the PhysioDirect service were required to be available throughout the
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14 5 time the service was 'open' but they were not usually fully engaged in dealing with PhysioDirect
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16 6 patients during these hours. We conducted an observational time and motion study at each of the
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18 7 four sites to determine how they occupied their non-PhysioDirect contact time in order to apportion
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20 8 costs appropriately. Time and motion data were collected at points in the study when the sites were
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22 9 expected to be fully operational, and across a mix of day, time of day, and location. The capital costs
23
24 10 required to run a telephone services are potentially less than for a face-to-face service. Each site
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26 11 provided information about space and equipment required to run their telephone service and we
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28 12 used this to estimate an overall percentage reduction of capital costs for these compared with a
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30 13 standard face-to-face service.
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33 15 Data about all face-to-face appointments were recorded routinely. These data included the length of
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35 16 appointment, the grade of the physiotherapist seen, and information about missed appointments.
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38 18 Information about other NHS resource use was collected, where possible, from general practice
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40 19 records and supplemented by information gained directly from patients. General practice notes
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42 20 were scrutinised for patient level data on primary care consultations and prescribed medication. We
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44 21 included all consultations at which the musculoskeletal condition for which the patient was referred
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46 22 to physiotherapy was mentioned and these were recorded by type of consultation (for example,
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48 23 face-to-face, telephone, out of hours, home visit) and by type of professional seen (for example, GP,
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50 24 nurse). It was not feasible to distinguish between medication prescribed for the condition for which
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52 25 the patient was referred for physiotherapy and any other musculoskeletal problem so we included
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54 26 all medication of a potentially relevant type, defined using British National Formulary (BNF)²⁹³³

1 coding. These were: Analgesics (chapters 4.7.1 – 4.7.2); Non-steroidal anti-inflammatory drugs
2 (10.1.1); Local corticosteroid injections (10.1.2.2); and Drugs for the relief of soft-tissue inflammation
3 (10.3).

4
5 A questionnaire was administered to participants at 6 weeks and 6 months after randomisation to
6 obtain resource use data not available elsewhere. The questionnaire was designed specifically for
7 this study but was similar in content and structure to others used for the same purpose³⁴ Questions
8 ~~These~~ included information about hospital care related to the condition for which the patient was
9 referred to physiotherapy: visits to Accident & Emergency, outpatient appointments, and inpatient
10 stays. Information about personal expenditure relevant to the patient's musculoskeletal condition
11 was also gained from the questionnaire at 6 weeks and 6 months. We asked about the cost of travel
12 to physiotherapy and other health care appointments, expenditure on over the counter medication,
13 prescription costs, use of private therapies and their cost, expenditure on equipment or devices, and
14 extra help at home. In addition, participants were asked about any time off work, and the associated
15 loss of earnings, because of their condition or to attend health care appointments relating to the
16 condition including usual care physiotherapy and PhysioDirect.

17 18 **Valuation of resource use**

19 Table 1 gives the unit costs and sources used to value the health care resources. We used Curtis³⁶³⁵
20 to value primary and community health care and Department of Health reference costs³⁶⁴ for all
21 hospital-based care. The cost of prescribed medication was estimated from that published in the
22 BNF,²⁹³³ adjusted to allow for the discount available to the NHS, and the professional fee and
23 container allowance in accordance with the Drug Tariff for England.³⁷² Personal expenditure was
24 reported directly by the participants, the exception being travel by car, which was reported as
25 mileage and costed using the AA schedule of motoring costs.³⁸³ Time off work was valued using the
26 median gross weekly earnings by age and sex.³²⁴

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Table 1 here

The cost of face-to-face physiotherapy consultations was estimated by adapting the methods of Curtis³⁵⁹ to obtain a different unit cost for each band of staff at each site. National median pay rates, by band,³⁶⁴⁰ were adjusted to allow for National Insurance, superannuation, and overheads, as per Curtis, then further adjusted to allow for band and site specific non-contact time. Information about the proportion of time physiotherapists on each grade typically spend in direct contact with patients was provided by the four physiotherapy service managers. This provided us with a cost per hour for each band of staff at each site.

The unit cost of physiotherapists working in the PhysioDirect service was estimated in a similar way, but allowing for the reduced cost of capital and overheads; information from the site managers indicated this to be about 50%. To obtain a cost per hour of telephone contact we used information from the computerised records of the PhysioDirect service, which identified the proportion of time spent by physiotherapists actually dealing with PhysioDirect patients. We then combined this with data from the time and motion study, which identified activities undertaken during non-contact time, for example, administration relating to face-to-face appointments or general administration, to give a cost per hour for each band of staff at each site.

All costs were valued in £ sterling at 2009 prices, adjusted for inflation where necessary.³⁵⁹

1 Data analysis

2 We investigated the amount of each resource used by patients in each group using frequencies,
3 means and medians. Mean total cost per participant was derived by combining resource use with
4 unit costs.

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6 QALYs were derived from responses to the EQ-5D-3L at baseline, 6 weeks and 6 months using
7 valuations from the UK general population.²⁹⁵ These values, representing health-related quality of
8 life on a scale between zero (death) and 1 (best imaginable health), were used to compute QALYs
9 experienced over the 6 month period using the area under the curve approach and adjusting for any
10 difference between the groups at baseline.³⁷⁴³

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12 A cost-consequences matrix was constructed using all available data. We compared costs from all
13 three perspectives (health care provider, patients and carers, lost productivity) with the SF-36v2 PCS,
14 MYMOP, Global Improvement Score, OMERACT OARSI, patient satisfaction, waiting time, and QALYs.

15
16 The cost-utility analysis was carried out using data on all patients for whom we had complete NHS
17 cost and QALY data. An incremental cost-effectiveness ratio (ICER) was constructed, comparing the
18 difference in mean total cost per patient with mean difference in QALYs, thus the lower the ICER, the
19 greater the cost-effectiveness and the better the value for money. Uncertainty around the ICER was
20 captured by using the bootstrapping technique: 5000 replicates of the cost and QALY data were
21 created by sampling from the original data, with replacement. The range and spread of the 5000
22 ICERs was used to replicating it 5000 times using the bootstrapping technique, construct a cost-
23 effectiveness acceptability curve to indicate the likelihood of the intervention being cost-effective.
24 The net monetary benefit (NMB) of the intervention was estimated from the point estimate of the
25 ICER for values of societal willingness-to-pay of £20,000 and £30,000 per QALY. If the NMB is positive

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7 1 at a given level of willingness to pay, the intervention is regarded as cost-effective. Confidence
8 2 intervals around the NMB were formed from the bootstrapped estimates.
9 3 ~~estimating a confidence interval around the net monetary benefit, and constructing a cost-~~
10 4 ~~effectiveness-acceptability curve.~~
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16 6 We used the multiple imputation by chained equation procedure to address the issue of missing cost
17 7 and EQ-5D data.³⁸⁴⁴ This technique uses a regression model to estimate missing values from known
18 8 values. In addition to cost and EQ-5D-3L variables the imputation model also included randomisation
19 9 group, age, sex, and SF36v2 PCS. Stata v12³⁹⁴⁵ was used to generate five datasets using 10 switching
20 10 procedures.
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27 12 Discounting was not carried out because the analysis was restricted to costs and outcomes over a
28 13 period of less than a year. All analyses were conducted using Microsoft Excel and Stata v12.³⁹⁴⁴
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33 15 **Sensitivity Analyses**

34 16 We addressed three areas of uncertainty using four one/two-way sensitivity analyses. First, we
35 17 estimated the cost of running the PhysioDirect service if it was operating at full capacity. It is likely
36 18 that this was not achieved during the trial because of: low demand due to exclusions and non-
37 19 participation in the trial; inflexible staffing levels to ensure consistency throughout the trial period;
38 20 and the 'one-way' system generally used, where physiotherapists waited for patients to call them
39 21 but did not routinely contact patients themselves (notwithstanding some limited use of answer-
40 22 machines). Data from the Bristol service, which continued to operate beyond the trial period and
41 23 was then able to tailor staffing levels to demand, were used to estimate the cost of running a more
42 24 'efficient but feasible' PhysioDirect service once the trial had ended.
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7 1 The second area of uncertainty addressed hospital costs. Patients in the trial were recruited from
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9 2 | primary care and for these, use of secondary care is infrequent but relatively expensive and this can
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11 3 have a disproportionate effect on mean total cost. We tested this by excluding hospital costs from
12
13 4 the total.
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16 6 | The third ~~area of uncertainty tested the effect of using imputed data rather than complete cases; the~~
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18 7 ~~third and fourth~~ sensitivity analyses used ~~the trial imputed missing data with missing values~~
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20 8 ~~imputed.~~
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24 10 ~~Finally, in a two-way sensitivity as described above first with data collected during the trial and~~
25
26 11 ~~analysis, we re-estimated second by combining with~~ results of the first ~~sensitivity analysis,~~
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28 12 ~~(mimicking an 'efficient but feasible' service) in this instance using the imputed dataset. -~~
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33 15 RESULTS

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35 16 | A total of 2,249 patients ~~were recruited between July 2009 and December 2009, and followed up~~
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37 17 ~~until June 2010 took part in the trial,~~ 1506 allocated to PhysioDirect and 743 to usual care. The mean
38
39 18 age was 60, with slightly more females than males (60% vs 40%); they were overwhelmingly white
40
41 19 (97%), just over half (60%) were employed and all but a few were referred for physiotherapy by their
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43 20 | GP. ~~Lower limb problems were the most prevalent (30%) reason for referral, 27% patients had a~~
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45 21 ~~lumbar problem and 23% upper limb problems.~~ Nearly all participants (2,223=99%) gave permission
46
47 22 to access their GP notes to obtain data about primary care encounters and prescribed medication.
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49 23 81% returned questionnaires at both 6 weeks and 6 months though not all participants completed
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51 24 all sections at both time points. We had complete NHS cost and QALY data for 840 (56%)
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53 25 PhysioDirect and 432 (58%) usual care participants.
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1 Resource use

2 Table 2 gives information about the different types of physiotherapy consultations by patients in
3 each group. Of the 1506 patients in the PhysioDirect group, 39% (586) were managed solely over the
4 telephone and only 46% (695) had any face-to-face consultations. In total, patients in the usual care
5 group had, on average, 0.38 (95% CI: 0.12 to 0.63) more consultations than those in the PhysioDirect
6 group and the mean total duration of all consultations was 20 minutes longer (95% CI: 12 to 28).

7
8 *Table 2 here*

9
10 Tables 3 and 4 give information about NHS and personal resource use. Just over a third of patients
11 (35%) had a GP consultation during the 6 months and 40% received a prescription for
12 musculoskeletal pain-related medication. There was very little difference between the two groups in
13 terms of health care use and the only important-notable difference in personal expenditure was
14 travel to physiotherapy appointments.

15
16 *Tables 3 and 4 here*

17 Costs and consequences

18 Table 5 summarises the mean cost per patient, by group, for each category of cost. All available data
19 are included giving variable denominators for each category. Comparing the two groups, there are
20 small differences in cost in some categories but for most of these the confidence intervals indicate
21 there is no evidence of a difference between the groups.

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24 *Table 5 here*

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7 Table 6 combines the results of the cost analysis with the full range of primary and secondary
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9 outcomes, including QALYs.

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12 *Table 6 here*

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16 Results are presented for all available data, with cost categories combined. ~~Again,~~ denominators
17
18 vary within the table and they also differ from those in table 5 because sub-categories have been
19
20 collapsed. There was no evidence of a difference in the primary clinical outcome (the SF36v2 PCS)
21
22 between the groups, suggesting that PhysioDirect led to similar outcomes as usual physiotherapy
23
24 care. Patients in the PhysioDirect group had their first assessment and telephone advice 27 days
25
26 earlier than those in the usual care group, however patient satisfaction was slightly lower in those
27
28 receiving PhysioDirect. QALYs were higher in the PhysioDirect group by 0.009, which equates to
29
30 about 3.3 extra days of full health over a year.

31 32 33 **Cost-utility analysis**

34
35 The cost-utility analysis presented in Table 7 uses complete cases, that is, we include only those
36
37 patients for whom we had complete NHS cost and QALY data: 432 (58%) from the usual care group
38
39 and 840 (56%) from PhysioDirect. The small extra cost of caring for patients in the PhysioDirect
40
41 group was compensated for by the extra QALY gain, giving an incremental cost-effectiveness ratio of
42
43 £2,889. Values below £20,000 are regarded by NICE to indicate a cost-effective intervention²⁷. At this
44
45 threshold level of if society is willingness to pay for a £20,000 per QALY²³ there is a positive -net
46
47 monetary benefit of is -£117 (95% CI -£96 to £310) and there is 0.88 probability that the intervention
48
49 is cost-effective. This is illustrated in the cost-effectiveness acceptability curve in figure 1.

50
51
52 *Table 7 here*

53
54
55 *Figure 1 here*

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Sensitivity Analysis

The results of the four sensitivity analyses are shown in table 8 and figure 2. Scenario (1) indicates the potential cost-effectiveness of a more efficient PhysioDirect service. During the trial PhysioDirect clinic opening hours, physiotherapists spent about 35% of their time on the phone or dealing with directly related administration; in Bristol after the trial, this was increased to 57%. Under this scenario, the cost per patient in the PhysioDirect group was £14.53 less than under trial conditions and £2.11 less per patient in the usual care group. The ICER is therefore lower, at £1,045, the NMB correspondingly higher at £127 (λ =£20,000). At low levels of λ , the probability of PhysioDirect being cost-effective under this scenario is higher than with the base case, though at λ =£20,000 it reaches a similar value (see figures 1 and 2).

Table 8 here

Figure 2 here

The effect of removing hospital costs from the analysis is shown in sensitivity analysis (2). Hospital costs accounted for 75% of all NHS costs yet only 19% (n=252) participants reported using any secondary care. Hospital use was evenly divided between the two groups so removing these from the analysis made very little difference to incremental analysis.

The effect of imputing missing NHS cost and QALY data is explored in sensitivity analysis (3). Using these data the cost of the interventions is lower but this is offset by higher NHS costs, giving a higher mean total cost in both groups, by £21.41 in the usual care group and £6.58 in the PhysioDirect group. QALYs using imputed data are lower, by 0.005 in the usual care group and by 0.010 in the PhysioDirect group. The net effect is a reduction of both incremental cost and incremental QALYs,

1 giving an ICER of £2,260. Uncertainty around the ICER is reduced, as seen by the flatter CEAC in
2 figure 2.

3
4 Sensitivity analysis (4) combines analyses (1) and (3) by using imputed cost data in the 'efficient
5 service' scenario. In this case the results indicate that PhysioDirect is, on average, cheaper than usual
6 care with a possible saving of £6.02 per patient, which gives a negative value for the ICER, indicating
7 the intervention is superior in terms of both cost and outcome. ~~The results suggest a possible cost
8 saving of £6.02 per patient; the~~ probability that the service is cost-effective at λ =£20,000 is 0.72.

11 DISCUSSION

12 Statement of principal findings

13 The results of this economic evaluation suggest that PhysioDirect services for patients with
14 musculoskeletal problems require careful management if they are to be a cost-effective alternative
15 to usual physiotherapy care. There was very little difference between the two groups in terms of
16 either outcomes or costs, and the finding that PhysioDirect is cost-effective is based on evidence
17 that it provides very slightly greater QALY benefits at very slightly greater cost.

18
19 Clearer cost savings were observed in the sensitivity analysis that replicated the post-trial service,
20 once greater flexibility in working arrangements was implemented. Without the restrictions of a trial
21 environment staffing was adjusted to meet the anticipated demand, a call-back service was
22 employed which accommodated fluctuations in activity during each session, referrals added to the
23 system were adjusted regularly to reflect actual staffing and the number of patients waiting for
24 a call-back and a higher throughput of patients led to greater economies of scale. These changes
25 ensured physiotherapists within the PhysioDirect service spent a higher proportion of their
26 PhysioDirect clinic time on the telephone with patients. There was no evidence of a difference

1 between PhysioDirect and usual care in cost to patients and their families, or to society through the
2 costs of lost production.

3 4 **Strengths and weaknesses of the study**

5 The study has a number of strengths. It is the first study assessing the cost-effectiveness of a
6 PhysioDirect service including a large sample of patients with a wide range of musculoskeletal
7 problems based across a number of locations.¹⁵⁴ It uses a rigorous study design and conforms to
8 CONSORT guidelines.⁴⁶⁹ The follow up rate from participating patients was in line with other
9 primary care trials^{47,48} a high proportion of the resource use data were collected from GP
10 records, and there was collection of resource use information outside of the main health service
11 perspective. ~~Nevertheless, there are also limitations.~~ The cost consequences analysis provides
12 complete information on costs from different perspectives compared with a range of outcomes so
13 although this approach is sometimes criticised for leaving the reader to evaluate the findings it does
14 have the advantage of transparency. Furthermore, in this study we have also presented a cost-utility
15 analysis that conforms to the recommendations of NICE. The proportion of eligible individuals
16 consenting to participate in the trial was only 50%.²² ~~Nevertheless, there are also limitations.~~ The
17 practices recruited to the trial had a low proportion of ethnic minority patients, a slightly lower
18 proportion of patients from deprived areas were judged to be eligible, and the proportion of eligible
19 individuals consenting to participate in the trial was only 50%.²³ These factors limit the
20 generalisability of the results though none of these selection effects was large. Further, a particular
21 difficulty in conducting economic evaluation with new service developments is ensuring that they
22 are fully utilised,^{44,24} particularly when conducting analysis from a long-run perspective, as here.
23 Although there was a clear run-in period prior to data collection for the trial (ranging from 4 to 12
24 weeks in each of the four sites), to ensure that services were operating as well as they could, and a
25 2:1 randomisation ratio in favour of PhysioDirect was used, there was still considerable
26 underutilisation of the new service. This was ameliorated by including a more fully utilised service

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1 within the sensitivity analysis. It should also be noted that, because of the use of a long-run
2 perspective in the analysis, set up costs, which may, in the short-term be important in a financially
3 constrained service, are not included here. Finally, because the differences in both costs and effects
4 are small, there is still some uncertainty around the findings.

6 **The meaning of the study and implications for policy makers**

7 If the aim of health services is to achieve maximum health gain from an investment in health care,
8 then PhysioDirect has a high probability of being more cost-effective than usual physiotherapy care.

9 This research also, however, suggests that it cannot be assumed that PhysioDirect will reduce costs,
10 although it could potentially do so if PhysioDirect services are managed efficiently. Both the costs
11 and cost-effectiveness of services will depend on the productivity of physiotherapist time. If
12 physiotherapists are able to use most of their time dealing directly with patients during sessions
13 when they are available on the telephone, then the service will be less costly. This is most likely to be
14 achieved by operating a call-back service and/or by operating the service on a large scale to even out
15 fluctuations in demand. Operating a system on larger scale might also offer other economies of
16 scale, particularly in terms of infrastructure. Further efficiencies may also be achieved if these
17 services are, in the future, provided in conjunction with direct access for patients (rather than
18 following referral from another health care professional), given that patients who self-refer are likely
19 to contact the service with musculoskeletal problems of shorter duration,⁴⁹² and such patients may
20 be particularly appropriate for the initial assessment and advice provided by a PhysioDirect service.

21 More generally, the study has broader implications for telephone services, particularly around the
22 implicit assumption that such services will inevitably be money saving. Here this assumption was
23 found to be false, largely because the physiotherapists' time was underutilised during PhysioDirect
24 clinic hours. Thus, for all such services, it will be important for policy makers to ensure that easy
25 assumptions about the costs of these services are properly assessed in relation to factors such as

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7 1 how efficiently the service is run, and what proportion of patients are subsequently invited for face
8 2 to face care following an initial telephone call.
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12 4 **Unanswered questions and future research**

14 5 As services evolve, further research should explore the costs and benefits of PhysioDirect under
15 6 different scenarios. These might include: comparing different skill levels of staff operating the
16 7 service; the inclusion of patient self-referrals in addition to GP referrals; the use, or otherwise, of
17 8 computerised support in assessing the patient; the extension to internet services (possibly combined
18 9 with cameras);⁴⁴⁵⁰ and the use of mobile 'smartphone' technology, for example in rapid assessment
19 10 of musculoskeletal injuries. In particular, however, it will be important to assess the costs and
20 11 benefits of services once they are more established and provided on a wider scale. The costs and
21 12 benefits of telehealth more generally need further exploration in relation to their cost effectiveness
22 13 particularly given the negative findings of the Whole Systems Demonstrator project evaluating
23 14 telehealth support and treatment for patients with long term conditions.⁴⁴⁵¹ It would be helpful to
24 15 identify those characteristics that are likely to make services both more cost-effective and less
25 16 costly.
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7 **Competing interestes**

8 2 We have read and understood the BMJ Group policy on declaration of interests and declare the
9 3 following interests: none.
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12 6
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22 16 Health.
23 17
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25 19 **Aurthors' contributions**

26 20 CS was principal investigator on the trial, SH took the lead on the economic evaluation. JC, NF, SG,
27 21 JH, and AM were co-applicants and contributed to the conception and design. SH, JC and JB carried
28 22 out the analysis with help from CS and AM, and all authors contributed to the interpretation of the
29 23 data. SH and JC wrote the first draft of the paper with all authors contributing to subsequent
30 24 revisions. All authors have seen and approved the final version.
31 25
32 26

33 27 **Acknowledgments**

34 28 [We would like to dedicate this paper to the memory of Cherida Hopper, trial manager of the](#)
35 29 [PhysioDirect study, who sadly died in June 2013.](#)
36 30

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1 Gamlin and Nick Deane who developed the PhysioDirect assessment algorithms and software used
2 in this trial.

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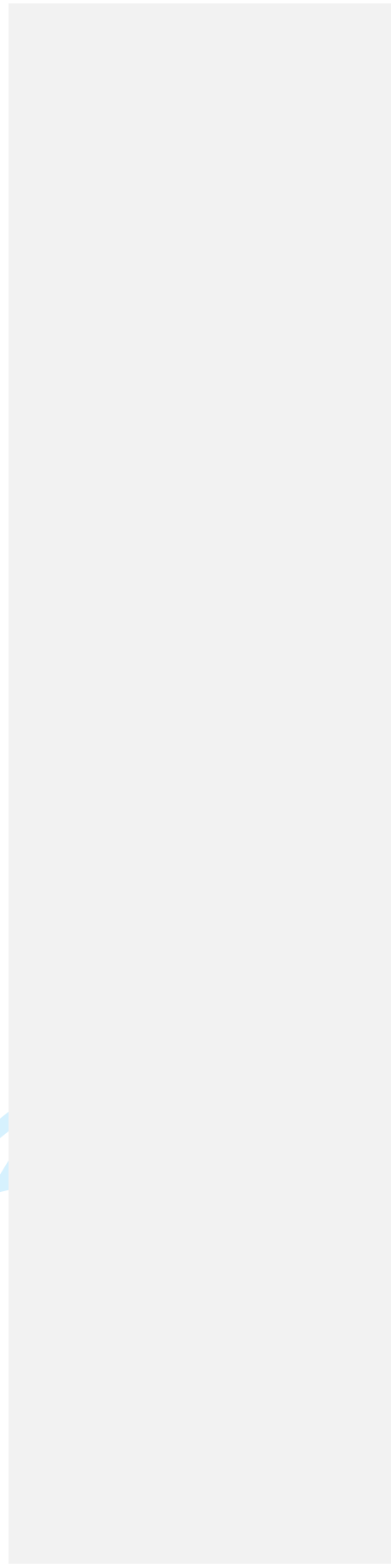


Table 1: Data sources and unit costs

	Unit cost (£)
Primary and Community Care³⁵⁰	
General Practitioner	
Surgery	27.00
Telephone consultation	16.00
Home visit	91.00
Practice nurse	
Surgery	10.00
Telephone consultation	5.93
Health Care Assistant/phlebotomist	
Surgery	6.92
District Nurse	
Home visit	16.33
Out of Hours^{41,42}	
General practitioner	23.50
Hospital care³⁶³	
A&E	103.00
Outpatient visits	By Healthcare Resource Group, differentiated by first and follow-up
Inpatient stays	By Healthcare Resource Group
Prescribed medication²⁹³³	per item, by name, strength and amount
Mileage³⁸³	0.4612
Time off work³⁹⁴	Median national wage by age and sex

Table 2: Number of physiotherapy consultations and mean duration, by type and group

		Usual care (n=743)	PhysioDirect (n=1506)
Face-to-face appointments	mean (SD) number	3.11(2.63)	1.91(2.72)
	mean (SD) total	107.51(88.92)	64.20(89.31)
	duration (minutes)		
Telephone appointments	mean (SD) number	0.13(0.44)	0.96 (0.63)
	mean (SD) total	4.21(14.64)	27.37(19.92)
	duration (minutes)		
Home visits	mean (SD) number	0.00 (0.06)	0.00 (0.06)
	mean (SD) total	0.14(2.27)	0.12(2.12)
	duration (minutes)		
All physiotherapy contacts	mean (SD) number	3.25(2.70)	2.87(2.94)
	mean (SD) total	111.86(90.50)	91.70 (95.40)
	duration (minutes)		

Table 3: Health services resource use, by group. All available data.

	Mean (SD) number of consultations			
	n	usual care	n	PhysioDirect
GP consultations	739	0.77(1.47)	1484	0.87 (1.68)
Nurse consultations	739	0.04 (0.22)	1484	0.06 (0.32)
Other primary care consultations	739	0.02(0.14)	1484	0.02 (0.17)
Total number of primary care contacts	739	0.83(1.56)	1484	0.96 (1.84)
Number of prescriptions	728	1.36 (2.73)	1469	1.68 (3.72)
A&E (visits)	467	0.02 (0.01)	912	0.03 (0.01)
Out-patient (consultations)	467	0.17 (0.83)	910	0.35 (1.03)
In-patient stays (Finished Consultant Episodes)	465	0.01 (0.10)	910	0.01 (0.10)

Table 4: Patient and societal resource use, by group. All available data.

Number (%) reporting:	n	usual care	n	PhysioDirect
Expenditure on travel to physiotherapy	462	242 (52.4)	1232	308 (25.8)
Expenditure on travel to primary care	669	116 (17.3)	1337	237 (17.7)
Expenditure on over-the-counter medication	506	256 (50.6)	1028	512 (49.8)
Expenditure on prescriptions	559	264 (47.2)	1085	508 (46.8)
Expenditure on private therapy	484	89 (18.4)	934	167 (17.9)
Equipment purchase	480	139 (29.0)	939	233 (24.8)
Payments for extra domestic help	459	35 (7.6)	928	76 (8.2)
Loss of earnings	598	30 (5.5)	1209	64 (5.3)
Any time off to attend physiotherapy consultation	692	218 (31.5)	1416	380 (26.8)
Work has been affected because of condition	477	141 (29.6)	959	317 (33.1)

Table 5: Mean total cost per patient, by group and category. All available data^a.

	usual care		PhysioDirect		Incremental difference (95% Confidence Interval)
	mean (SD) cost		mean (SD) cost		
	n	mean (SD) cost	n	mean (SD) cost	
Physiotherapy services					
Face-to-face appointments	743	£64.42 (£53.00)	1506	£38.76 (£53.92)	-£25.66 (-£30.37 to -£20.95)
Telephone appointments	743	£5.22 (£18.01)	1506	£35.17 (£26.34)	£29.94 (£27.84 to £32.05)
Home visits	743	£0.08 (£1.33)	1506	£0.08 (£1.46)	£0.00 (-£0.12 to £0.13)
Total physiotherapy cost	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Primary care services					
GP consultations	739	£19.21 (£35.91)	1484	£21.69 (£41.66)	£2.48 (-£1.04 to £6.00)
Nurse consultations	739	£0.44 (£2.37)	1484	£0.61 (£3.17)	£0.16 (-£0.10 to £0.42)
Other primary care consultations	739	£0.03 (£0.57)	1484	£0.07 (£1.31)	£0.05 (-£0.05 to £0.15)
Total primary care cost	739	£19.68 (£36.68)	1484	£22.37 (£42.83)	£2.69 (-£0.92 to £6.30)
Medication cost	728	£11.04 (£51.61)	1469	£10.33 (£55.43)	-£0.72 (-£5.53 to £4.10)
Hospital services					
A&E	467	£1.99 (£17.12)	912	£3.17 (£20.84)	£1.18 (-£1.01 to £3.37)
Out-patient	467	£30.74 (£98.36)	910	£38.35 (£126.05)	£7.61 (-£5.50 to £20.72)
In-patient	465	£51.02 (£520.48)	910	£34.99 (£399.62)	-£16.03 (-£65.70 to £33.64)
Total hospital cost	459	£83.04 (£561.68)	899	£77.00 (£446.24)	-£6.04 (-£60.99 to £48.91)
Personal expenditure					
Cost of all calls to physiotherapy service	743	£0.97 (£0.99)	1506	£1.75 (£1.29)	£0.79 (£0.68 to £0.89)
Travel to physiotherapy	462	£6.11 (£11.48)	1232	£3.11 (£8.51)	-£3.01 (-£4.01 to -£2.00)
Travel for primary care	669	£0.65 (£2.93)	1337	£0.75 (£4.10)	£0.11 (-£0.24 to £0.45)
Over-the-counter medication	490	£7.67 (£14.09)	987	£8.61 (£22.38)	£0.94 (-£1.23 to £3.11)
Cost of prescriptions	553	£2.72 (£8.95)	1076	£2.67 (£8.33)	-£0.05 (-£0.93 to £0.82)

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Private therapy	475	£21.98 (£70.34)	915	£39.34 (£296.94)	£17.36 (-£9.76 to £44.48)
Equipment purchase	473	£17.16 (£169.12)	924	£9.12 (£56.42)	-£8.04 (-£20.08 to £4.00)
Extra domestic help	451	£10.93 (£64.31)	905	£13.68 (£96.02)	£2.75 (-£7.07 to £12.56)
Cost associated with loss of earnings	598	£46.69 (409.72)	1209	£82.78 (£885.85)	£36.09 (-£38.63 to £110.81)
Value of time off work					
Time off work to attend physiotherapy	598	£12.90 (£38.99)	1211	£11.91 (£57.86)	£0.95 (-£3.81 to £5.70)
Time off work associated with the condition	452	£265.92 (£1350.82)	884	£226.61 (£1139.84)	£111.31 (-£159.04 to £379.67)

^a Uses all available data, so denominators differ by category.

Table 6: Cost-consequences. All available data^a.

	n (%)	usual care	n (%)	PhysioDirect	Incremental difference (95% Confidence Interval)
Mean (SD) Cost					
Total physiotherapy cost	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (-£1.12 to £9.69)
Cost of NHS services including physiotherapy	453 (61%)	£189.19 (£557.61)	888 (59%)	£196.43 (£472.02)	£7.24 (-£49.68 to £64.10)
Total personal expenditure	310 (42%)	£121.10 (£574.45)	714 (47%)	£166.40 (£1040.27)	£45.30 (-£78.01 to £168.61)
Total value of all time off work ^b	451 (61%)	£276.75 (£1355.00)	883 (59%)	£240.74 (£1147.20)	-£36.01 (-£174.69 to £102.66)
Consequences^c					
					Difference/odds ratio (95% confidence interval)^d
SF36v2 PCS	629 (85%)	44.18 (10.84)	1283 (85%)	43.50 (10.94)	-0.01 (-0.80 to 0.79)
MYMOP ^e	518 (70%)	2.40 (1.38)	1033 (69%)	2.40 (1.43)	-0.02 (-0.16 to 0.11)
Global improvement score	501 (67%)	4.07 (1.40)	1001 (66%)	4.01 (1.44)	-0.08 (-0.23 to 0.08)
Response to treatment (OMERACT OARSI)	510 (69%)	197 (38.6%)	1029 (68%)	430 (41.8%)	1.14 (0.92 to 1.43)
Waiting time to first assessment and advice	618 (83%)	34 (20 to 55) ^f	1281 (85%)	7 (4 to 15) ^f	0.32 (0.29 to 0.35) ^g
Patient overall satisfaction	367 (49%)	79.7 (26.5)	739 (49%)	75.9 (28.3)	-3.8 (-7.3 to -0.3)
QALYs ^h	454 (61%)	0.322 (0.079)	881 (58%)	0.331 (0.082)	0.009 (-0.000 to 0.018)

^a Uses all available data, so denominators differ by category

^b Total of time off to attend physiotherapy and associated with the condition

^c At 6 month follow-up time point

^d Adjusted for outcome at baseline, gender, age, referral problem, PCT

^e Lower score is better

^f Median (IQR)

^g Accelerated failure time analysis

^h Adjusted for outcome at baseline

Table 7: Cost-effectiveness analysis. Includes cases with complete data on NHS costs and QALYs

	n	usual care mean (SD) cost	n	PhysioDirect Mean (SD) cost	Incremental difference (95% CI)
Cost of physiotherapy	432	£78.77 (£57.08)	840	£86.75 (£65.47)	£7.98 (£0.69 to £15.27)
Cost of NHS services other than physiotherapy	432	£100.91 (£502.02)	840	£112.23 (£476.91)	£11.32 (-£45.08 to £67.72)
Total cost including physiotherapy	432	£179.68 (£504.73)	840	£198.98 (482.12)	£19.30 (-£37.60 to £76.19)
QALYs	432	0.325 (0.077)	840	0.332 (0.081)	0.007 (-0.003 to 0.016)
Incremental cost-effectiveness ratio (ICER)					£2,889
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£117 (-£86 to £310)
probability of intervention being cost-effective					0.88
λ=£30,000					£184 (-£106 to £461)
probability of intervention being cost-effective					0.90

Table 8: Sensitivity Analysis

	Usual care		PhysioDirect		Incremental difference (-95% confidence interval)
	n	mean (SD) Usual care mean (SD)	n	PhysioDirect mean (SD)	
(1) mimicking an efficient service					
Cost of physiotherapy	432	£76.56 (£55.34)	840	£72.22 (£61.55)	£-4.34 (£-11.25 to £2.57)
Cost of NHS services	432	£100.91 (£502.02)	840	£112.23 (£476.91)	£11.32 (£-45.08 to £67.72)
Total cost	432	£177.46 (£504.49)	840	£184.44 (£481.83)	£6.98 (£-49.89 to £63.85)
Incremental cost-effectiveness ratio (ICER)					£1,045
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£127 (£-74 to £319)
λ=£30,000					£193 (£-95 to £473)
(2) Excluding hospital costs					
Cost of physiotherapy	448	£78.49 (£57.14)	869	£86.84 (£65.25)	£8.35 (£1.21 to £15.50)
Cost of NHS services excluding secondary care	448	£33.75 (£76.46)	869	£33.49 (£63.76)	£-0.25 (£-8.05 to £7.54)
Total cost of NHS services including physiotherapy	448	£112.23 (£99.621)	869	£120.33 (£98.85)	£8.10 (£-3.21 to £19.41)
Incremental cost-effectiveness ratio (ICER)					£1,084
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£142 (£-41 to £324)
λ=£30,000					£217 (£-56 to £489)
(3) Imputed data					
Cost of physiotherapy	743	£69.73 (£56.17)	1506	£74.01 (£63.97)	£4.28 (£-1.12 to £9.69)
Cost of NHS services	743	£131.37 (£465.49)	1506	£131.51 (£384.36)	£0.17 (£-36.13 to £36.48)
Total cost of NHS services including physiotherapy	743	£201.09 (£467.51)	1506	£205.55 (£390.04)	£4.46 (£-32.22 to £41.14)
Quality Adjusted Life Years	743	0.320 (0.003)	1506	0.322 (0.002)	0.002 (£-0.006 to 0.009)
Incremental cost-effectiveness ratio (ICER)					£2,260
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£34 (£-119 to £193)
λ=£30,000					£52 (£-172 to £285)
(4) Imputed data and 'efficient' service					
Cost of physiotherapy	743	£67.61 (£54.19)	1506	£61.41 (£59.13)	£-6.20 (£-11.26 to £-1.14)
Cost of NHS services	743	£131.37 (£465.49)	1506	£131.54 (£384.36)	£0.17 (£-36.13 to £36.48)
Total cost of NHS services including physiotherapy	743	£198.98 (£467.48)	1506	£192.95 (£389.52)	£-6.02 (£-42.68 to £30.63)
Quality Adjusted Life Years	743	0.320 (0.003)	1506	0.322 (0.002)	0.002 (£-0.006 to 0.009)
Incremental cost-effectiveness ratio (ICER)					£-3,054
Median Net Monetary Benefit (95% CI) based on bootstrapped results:					
λ=£20,000					£47 (£-113 to £202)
λ=£30,000					£67 (£-165 to £293)

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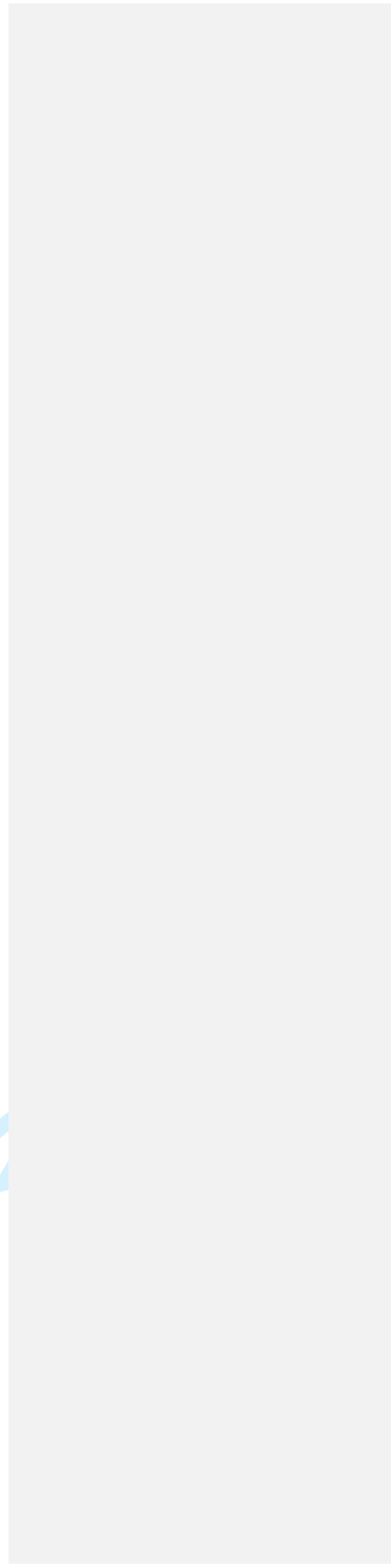


Figure 1. Cost-effectiveness acceptability curve showing the probability that the intervention is cost-effective at different levels of willingness to pay for one Quality Adjusted Life Year

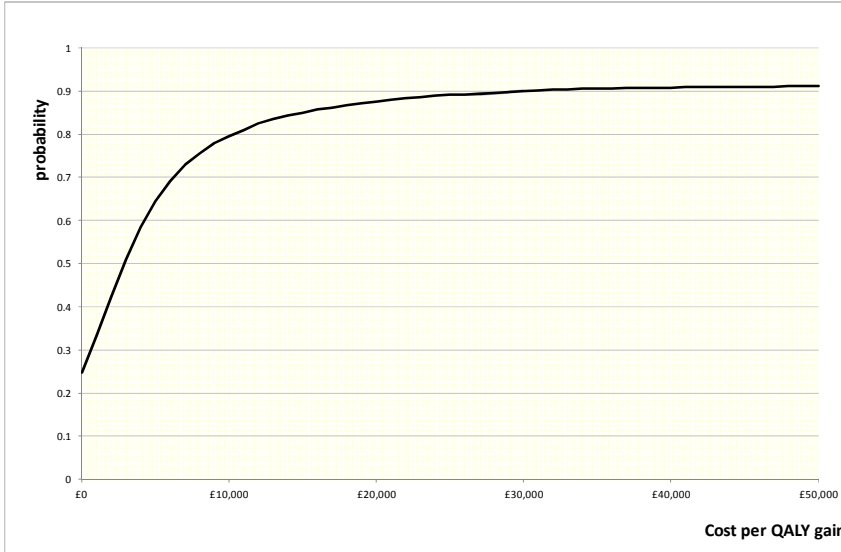
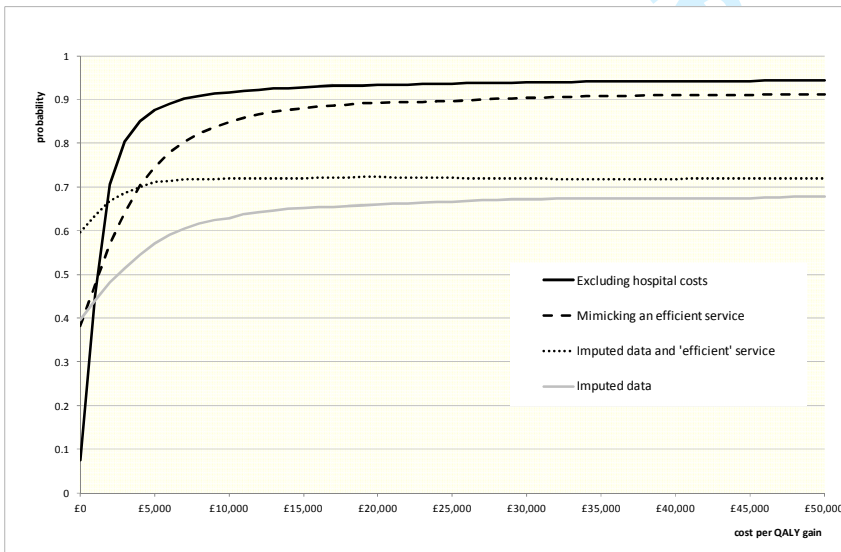


Figure 2. Cost-effectiveness acceptability curve showing the probability that the intervention is cost-effective at different levels of willingness to pay for one Quality Adjusted Life Year: Sensitivity Analyses



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CHEERS checklist—Items to include when reporting economic evaluations of health interventions

Section/item	Item No	Recommendation	Reported on page No/line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as “cost-effectiveness analysis”, and describe the interventions compared.	1/1-3
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	P2-3
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	5/1 – 6/20
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	7/14-18
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	7/14-18
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	7/1-11
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	7/22 - 8/5
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	6/25 - 7/1
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	13/14-15
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	8/8-16
Measurement of effectiveness	11a	<i>Single study-based estimates:</i> Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	6/25-7/1 7/14-19
	11b	<i>Synthesis-based estimates:</i> Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	n/a

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4	Measurement and	12	If applicable, describe the population and methods used to elicit
5	valuation of preference		preferences for outcomes.
6			8/8-9
7	based outcomes		12/11-12
8	Estimating resources	13a	<i>Single study-based economic evaluation:</i> Describe approaches used to
9	and costs		estimate resource use associated with the alternative interventions.
10			Describe primary or secondary research methods for valuing each
11			resource item in terms of its unit cost. Describe any adjustments made
12			to approximate to opportunity costs.
13			9/19 – 12/2
14		13b	<i>Model-based economic evaluation:</i> Describe approaches and data
15			sources used to estimate resource use associated with model health
16			states. Describe primary or secondary research methods for valuing
17			each resource item in terms of its unit cost. Describe any adjustments
18			made to approximate to opportunity costs.
19			n/a
20			
21			
22	Currency, price date,	14	Report the dates of the estimated resource quantities and unit costs.
23	and conversion		Describe methods for adjusting estimated unit costs to the year of
24			reported costs if necessary. Describe methods for converting costs into
25			a common currency base and the exchange rate.
26			12/4
27			
28	Choice of model	15	Describe and give reasons for the specific type of decision-analytical
29			model used. Providing a figure to show model structure is strongly
30			recommended.
31			n/a
32	Assumptions	16	Describe all structural or other assumptions underpinning the decision-
33			analytical model.
34			n/a
35	Analytical methods	17	Describe all analytical methods supporting the evaluation. This could
36			include methods for dealing with skewed, missing, or censored data;
37			extrapolation methods; methods for pooling data; approaches to
38			validate or make adjustments (such as half cycle corrections) to a
39			model; and methods for handling population heterogeneity and
40			uncertainty.
41			12/12-15
42			13/8-12
43			
44	Results		
45	Study parameters	18	Report the values, ranges, references, and, if used, probability
46			distributions for all parameters. Report reasons or sources for
47			distributions used to represent uncertainty where appropriate.
48			n/a
49			Providing a table to show the input values is strongly recommended.
50			
51	Incremental costs and	19	For each intervention, report mean values for the main categories of
52	outcomes		estimated costs and outcomes of interest, as well as mean differences
53			between the comparator groups. If applicable, report incremental cost-
54			effectiveness ratios.
55			15/17-16/11
56			Tables 5,6,7
57			
58			
59			
60			

Characterising uncertainty	20a	<i>Single study-based economic evaluation:</i> Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	16/13-21 Table 7 Figure 1 16/26 – 18/5 Table 8 Figure 2
	20b	<i>Model-based economic evaluation:</i> Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	n/a
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	n/a
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	18/9 – 19/25
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	28/6-11
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	28/1-3

For consistency, the CHEERS statement checklist format is based on the format of the CONSORT statement checklist