



Emergency department treatments and physiotherapy for acute whiplash: a pragmatic, two-step, randomised controlled trial

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Summary

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Background Little is known about the effectiveness of treatments for acute whiplash injury. We aimed to estimate whether training of staff in emergency departments to provide active management consultations was more effective than usual consultations (Step 1) and to estimate whether a physiotherapy package was more effective than one additional physiotherapy advice session in patients with persisting symptoms (Step 2).

Methods Step 1 was a pragmatic, cluster randomised trial of 12 NHS Trust hospitals including 15 emergency departments who treated patients with acute whiplash associated disorder of grades I–III. The hospitals were randomised by clusters to either active management or usual care consultations. In Step 2, we used a nested individually randomised trial. Patients were randomly assigned to receive either a package of up to six physiotherapy sessions or a single advice session. Randomisation in Step 2 was stratified by centre. Investigator-masked outcomes were obtained at 4, 8, and 12 months. Masking of clinicians and patients was not possible in all steps of the trial. The primary outcome was the Neck Disability Index (NDI). Analysis was intention to treat, and included an economic evaluation. The study is registered ISRCTN33302125.

Findings Recruitment ran from Dec 5, 2005 to Nov 30, 2007. Follow-up was completed on Dec 19, 2008. In Step 1, 12 NHS Trusts were randomised, and 3851 of 6952 eligible patients agreed to participate (1598 patients were assigned to usual care and 2253 patients were assigned to active management). 2704 (70%) of 3851 patients provided data at 12 months. NDI score did not differ between active management and usual care consultations (difference at 12 months 0.5, 95% CI –1.5 to 2.5). In Step 2, 599 patients were randomly assigned to receive either advice (299 patients) or a physiotherapy package (300 patients). 479 (80%) patients provided data at 12 months. The physiotherapy package at 4 months showed a modest benefit compared to advice (NDI difference –3.7, –6.1 to –1.3), but not at 8 or 12 months. Active management consultations and the physiotherapy package were more expensive than usual care and single advice session. No treatment-related serious adverse events or deaths were noted.

Interpretation Provision of active management consultation did not show additional benefit. A package of physiotherapy gave a modest acceleration to early recovery of persisting symptoms but was not cost effective from a UK NHS perspective. Usual consultations in emergency departments and a single physiotherapy advice session for persistent symptoms are recommended.

Funding NIHR Health Technology Assessment programme.

Introduction

The annual cost of whiplash injuries to the UK economy is £3.1 billion per year, mostly attributed to health service costs associated with the treatment of people who develop chronic symptoms and to the subsequent loss of work.¹ Injury severity is classified in five categories of whiplash associated disorder, ranging from 0 (no symptoms) to IV (fracture or dislocation of the neck).² About 30–50% of patients report chronic symptoms.^{2,3}

Both the Quebec Task Force on Whiplash Injury (QTF)² and Bone and Joint Decade expert task force⁴ concluded that many treatments used for whiplash associated disorder were not supported by sufficient evidence. In the absence of data, the QTF suggested a stepped care approach such as provision of advice in the early stages and administration of intensive

treatments such as physiotherapy if symptoms persist.² Mirroring developments in the management of back pain, where brief interventions to promote positive messages about recovery, exercise, early return to normal activities, and pain management (known as active management consultations), are becoming standard. Several research groups have suggested that training staff in the emergency department in active management consultations might be effective in the management of whiplash associated disorder.^{2,5} A patient education booklet (*The Whiplash Book*) designed for use alongside an active management consultation was effective in modifying beliefs and negative health behaviours induced by whiplash associated disorder,⁶ but evidence is missing regarding clinical or health economic outcomes.

Physiotherapy is recommended by several clinical guidelines, without supporting evidence.^{4,7} Recommended treatments include manual therapy, exercise, advice, and recognition of anxiety and psychological problems.⁸

Therefore, our aim was to estimate if, in 1 year, training of staff in the emergency department to provide active management consultations supplemented by *The Whiplash Book*⁹ at initial presentation with acute whiplash injury was more effective than usual consultation. In a follow on, nested randomisation, we assessed whether a physiotherapy package was more effective than a single physiotherapy advice session in patients having persisting symptoms and wanting to have additional treatment. Finally, we investigated cost-effectiveness from a UK National Health Service (UK NHS) perspective.

Methods

Study design and participants

A copy of the published study protocol is available online. This study consisted of a pragmatic, cluster randomised controlled trial, identified as Step 1 and a nested randomised substudy, identified as Step 2.

In Step 1, we recruited 12 NHS Trust Hospitals comprising 15 emergency departments, and randomly assigned them as clusters to either active management (including *The Whiplash Book*)⁹ or usual care consultations in the emergency department. The emergency departments were selected from large teaching and district general hospitals, and served a mix of urban and semirural catchments. The treatments being investigated were relevant to mild to severe soft tissue injury, but not to fracture or dislocation of the neck or serious associated internal or head injuries. Hence, clinicians were requested to provide treatments in accordance with the protocol to all people attending the department with an acute (<6 weeks duration) whiplash injury, and with a whiplash associated disorder of grades I–III (I=complaint of pain, stiffness, or tenderness, no physical signs; II=complaint of pain, stiffness, or tenderness, musculoskeletal signs; and III=complaint of pain, stiffness, or tenderness, neurological signs). We excluded people younger than 18 years, those with more than a transient loss of consciousness, a Glasgow Coma Score of 12 or less, fractures or dislocations of the spine and other bones, and those requiring admission or having severe psychiatric illness. Patients were informed that, if they had substantial symptoms persisting beyond 3 weeks and they wished to participate, they would be potentially eligible for a further study of physiotherapy interventions (Step 2). The invitation to participate in Step 2 was provided in a standard way to all participants of Step 1.

Step 2 was a nested, individual randomisation to a package of up to six physiotherapy sessions, or a single physiotherapy session to reinforce the advice provided to the patient in the emergency department. Physiotherapy was always provided in the NHS Trust at which the patient made their initial presentation to the emergency

department, and reinforcement of advice was tailored to ensure fit with the allocation in Step 1. Inclusion criteria for Step 2 were assessed at a minimum of 3 weeks after initial presentation to the emergency department, and were active symptoms in the previous 24 h resulting in a whiplash associated disorder of grades I–III and no contra-indications to physiotherapy (such as central cord compression or upper or lower motor neuron lesions, complete nerve root compression, suspected vascular injury, or haemorrhagic event).

The study was approved by the Trent Multicentre Research Ethics Committee (reference MREC/04/4/003). In Step 1, the emergency departments provided consent to participate—ie, there was no individual consent for trial treatment. All follow-up data collection was done with consent. In Step 2, patients gave written, individual consent.

Randomisation and masking

The cluster randomisation of NHS trusts was prepared by the Wolfson Institute of Preventive Medicine, University of London. We matched trusts for size and allocated in pairs. The randomisation schedule was prepared a priori from a random number table. Cluster randomisation was done before the start of recruitment. We had intended to match also for ethnic origin and star rating of NHS trusts, but both variables were confounded with trust size. The individual randomisation was a computer-generated random allocation given via an independent central telephone randomisation service, and stratified by centre. Members of the same household were assigned together. Allocations were concealed before assignment. Masking of clinicians and patients was not possible.

Statisticians and research assistants who followed up patients, entered data onto the study database, or undertook analyses were masked to allocation until the final analysis was complete.

Procedures

Staff from the emergency department were asked to complete a short registration document for all attendees with whiplash associated disorder of grades I–III, which was consistent with information usually recorded during a consultation in the emergency department and included injury severity according to whiplash associated disorder criteria,² age, and sex. These data were provided in an anonymised format to the study team to provide a baseline dataset. Once completed, clinicians from the emergency department provided the assigned intervention (active management or usual care consultation). Patients were informed by the clinicians that the emergency department was taking part in a study of treatment for neck injury, provided with an information sheet, and asked to give verbal consent to be approached by the research team to provide data on their recovery in the following year. An invitation and information letter was sent to all consenting

For the study protocol see <http://www.biomedcentral.com/1471-2474/8/7>

patients within 3 days of attendance to the emergency department, asking them to complete a few questionnaires. Also, patients were informed of Step 2, and that they would need to contact a physiotherapist based in the trial office if they wished to be considered.

About 3 weeks later, patients meeting the criteria for Step 2 were asked to attend a clinic appointment to confirm eligibility, provide consent, and complete a baseline assessment before randomisation. Research physiotherapists or nurses who registered the participant and did the randomisation, completed a standardised clinic assessment. The examination included the Neck Disability Index (NDI) and whiplash associated disorder injury severity score.²

In Step 1, we trained clinicians and health professionals of the emergency department randomly assigned to the active management consultation approach, using previously published programmes.^{10,11} We used training slots of 30–40 min duration, repeated every 4 months to coincide with medical staff rotations. We also provided training to clinicians assigned to usual care. For both groups of the trial, training included an overview of whiplash injury and study procedures. Additionally, the active management staff were trained to provide reassurance that prognosis is good after whiplash associated disorder; encourage return to normal activities as soon as possible and to practise neck exercises; inform patients that pain is a normal response, that analgesia should be used consistently, that a neck collar should be avoided, and to ensure all patients received a copy of *The Whiplash Book*.⁹ Departments assigned to usual care continued with their usual advice leaflet. We monitored treatment fidelity through audit of structured treatment records, and by monitoring the supply and provision of *The Whiplash Book* or advice leaflets in all emergency departments. *The Whiplash Book* was available in English, Bengali, Gujarati, Hindi, Punjabi, and Urdu.

In Step 2, the rationale and content of the physiotherapy package is detailed elsewhere.⁸ The package was standardised and based on present clinical guidelines. Briefly, therapists were asked to provide up to six sessions in 8 weeks, limited to manual therapy (joint mobilisations excluding manipulation), other soft-tissue techniques, exercise, tips on management of pain and on resumption of normal activities, some simple psychological strategies to deal with travel anxiety, and a screen for post-traumatic stress. For the reinforcement of advice group, physiotherapists provided a 30–40 min session where they examined the patient and provided advice. Intervention fidelity was checked by regular review of structured treatment records and site visits.

Outcome measurements

Data collection was done by postal questionnaires at 4, 8, and 12 months after the initial attendance to the emergency department. The primary outcome was the NDI, which has been used successfully in postal format in

previous trials of acute and chronic neck problems.¹² The NDI measures pain-related activity restrictions in ten areas, including personal care, lifting, sleeping, driving, concentration, reading, and work (low score indicates little disability).¹² Secondary outcomes were the acute version of the Short Form 12 version 1 (low score indicates low health-related quality of life);¹³ a global indicator of change in neck symptoms (measured on a five-point scale, from 1 for much better to 5 for much worse); self-reported NHS and private health-care resource use; compensation claim history (at 12 months); work days lost, and EQ-5D scores.¹³ Serious adverse events were defined as death or admission to hospital attributable to the intervention or events that caused unwarranted distress to a participant.

We made substantial effort to minimise loss to follow-up, with two separate questionnaire mailings and two reminder letters. If participants did not respond, we supplemented postal follow-up with up to two attempts at telephone calls to secure the primary outcome and some economic variables. For a subsample of 2144, we randomly assigned participants to receive either an unconditional gift voucher worth £5 with their questionnaire mail out (1070) or no additional incentive (1074; results reported elsewhere).¹⁴

Sample size

The minimal clinically important difference for an individual on the NDI is 3–5 percentage points, with a standard deviation of about 8%.¹⁵ We selected a between group standardised difference of three points (ie, 0.375 SD), for both Step 1 and Step 2 comparisons, with 90% power and 1% significance level, and assuming 30% loss to follow up. For Step 2, 300 people per group were needed. The Step 1 comparison of advice in emergency departments originally planned to recruit 4800 patients from eight emergency departments, assuming an intracluster correlation coefficient (ICC) of 0.02 and average cluster size of 120. The sample size estimate was revised, with Data Monitoring Committee approval, in July 2006, when four additional centres were recruited because the recruitment rate from the original centres was lower than expected.¹⁶ This revision reduced the number of participants needed to 3000 (1500 per group) without changing the effect size, power, alpha levels, or the value of the ICC. This sample size allowed sufficient power to detect meaningful differences in secondary and economic outcomes.

Economic evaluation

We did a within-trial economic evaluation, from a UK NHS perspective. Resource use questions completed by participants at 4, 8, and 12 months provided a profile of all hospital inpatient and outpatient service use, diagnostic tests, prescribed medications, and community health resource use. Unit costs (£, 2009 prices) were obtained from national sources in accordance with guidelines¹⁷ and attached to every item of resource use. Patients also

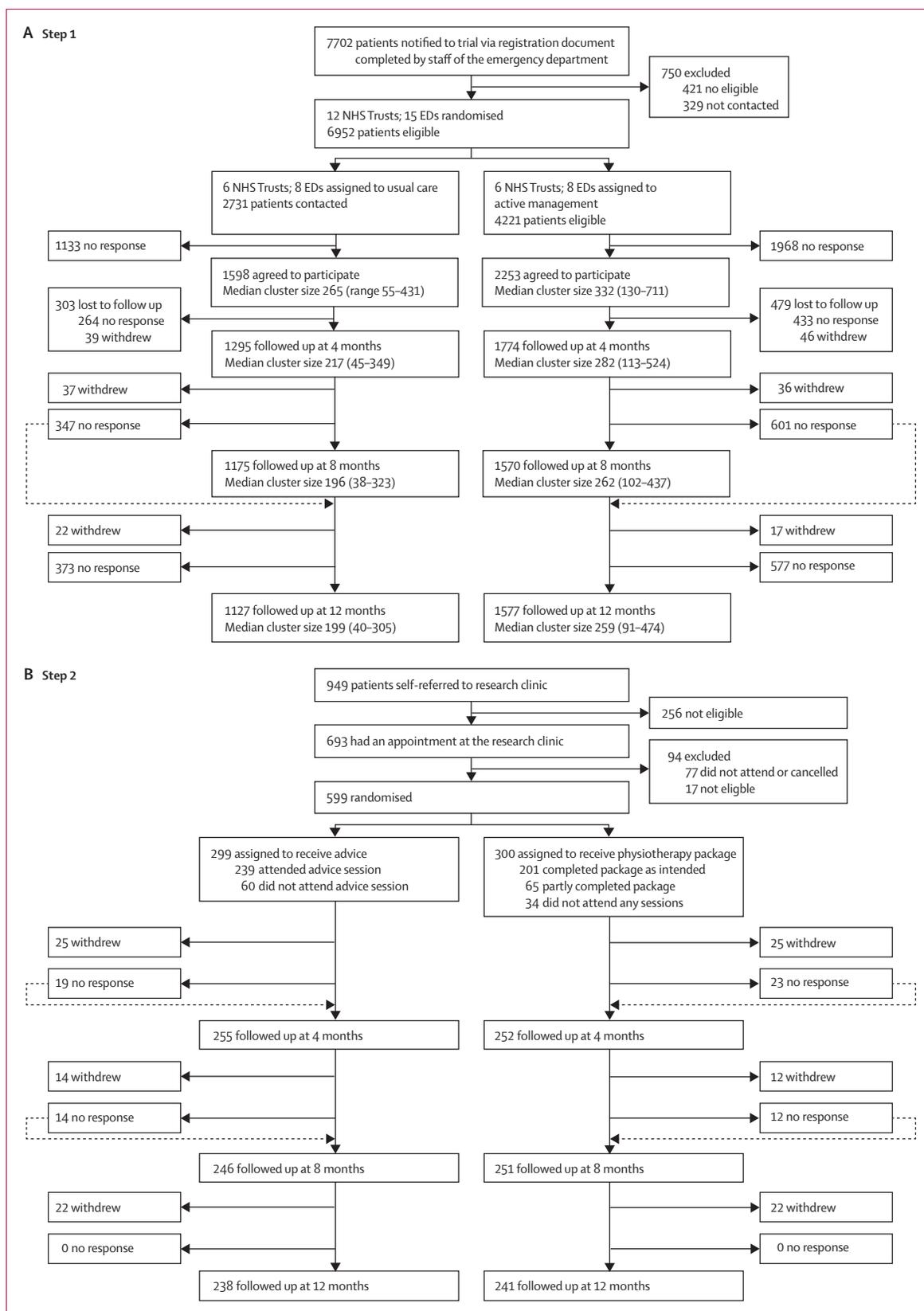


Figure: Trial profiles for Step 1 and Step 2
ED=emergency department.
(A) Step 1. (B) Step 2.

	Step 1		Step 2	
	Usual care (n=1598)	Active management (n=2253)	Advice (n=299)	Physiotherapy package (n=300)
Age (years)				
Mean (SD)	37 (13)	37 (13)	40 (13)	40 (13)
Sex				
Men	666 (42%)	995 (44%)	115 (38%)	106 (35%)
Missing	18 (1%)	39 (2%)	0	0
Ethnic group				
White	1336 (84%)	1586 (70%)	229 (77%)	226 (75%)
Mixed	19 (1%)	42 (2%)	2 (1%)	3 (1%)
Indian	49 (3%)	95 (4%)	18 (6%)	19 (6%)
Pakistani	24 (2%)	179 (8%)	19 (6%)	19 (6%)
Bangladeshi	9 (<1%)	21 (1%)	2 (1%)	1 (<1%)
Black or black British	31 (2%)	69 (3%)	10 (3%)	7 (2%)
Chinese or other	12 (<1%)	37 (2%)	3 (1%)	5 (2%)
No information	118 (7%)	224 (10%)	16 (5%)	20 (7%)
Mechanism of injury				
Road traffic accident	1495 (94%)	2127 (94%)	284 (95%)	286 (95%)
Other	88 (6%)	112 (5%)	13 (4%)	13 (4%)
Not known	15 (1%)	14 (1%)	2 (1%)	1 (<1%)
Pain intensity at initial presentation to emergency department (/10)				
Mean (SD)	4.9 (1.9)	5.3 (1.9)	5.4 (1.9)	5.6 (1.9)
Missing	349 (22%)	574 (25%)	69 (23%)	91 (30%)
Previous neck problems				
Yes	77 (5%)	119 (5%)	36 (12%)	41 (14%)
Missing	58 (4%)	94 (4%)	21 (7%)	19 (6%)
WAD grade* at presentation to emergency department				
WAD grade I	883 (55%)	1205 (53%)	133 (44%)	142 (47%)
WAD grade II	662 (41%)	997 (44%)	155 (52%)	144 (48%)
WAD grade III	53 (3%)	51 (2%)	11 (4%)	14 (5%)
Employment				
Working or learning†	1185 (74%)	1549 (69%)	225 (75%)	210 (70%)
Unpaid work	4 (<1%)	7 (<1%)	0	2 (<1%)
Not working‡	254 (16%)	425 (19%)	52 (17%)	59 (20%)
No information	155 (10%)	272 (12%)	22 (7%)	29 (10%)
At Step 2 registration only				
Numbers from Step 1 usual care	..	..	136 (45%)	136 (45%)
Numbers from Step 2 active management	..	..	163 (55%)	164 (55%)
Neck disability index (/100)				
Mean (SD)	..	..	39 (16)	44 (16)
Missing	..	..	3 (1%)	7 (2%)
WAD grade* at Step 2 registration				
WAD grade I	..	..	39 (13%)	45 (15%)
WAD grade II	..	..	222 (74%)	220 (73%)
WAD grade III	..	..	38 (13%)	35 (12%)

Data are number of patients (%) unless otherwise stated. For Step 1, data are from the initial attendance to the emergency department; for Step 2, data are from the Step 2 baseline assessment. *WAD grades: 0=no symptoms. I=complaint of pain, stiffness, or tenderness; no physical signs. II=complaint of pain, stiffness, or tenderness; musculoskeletal signs. III=complaint of pain, stiffness, or tenderness; neurological signs. IV=fracture or dislocation of the neck. †Full time employed, part-time employed, and self employed. ‡Unemployed, full-time student, and retired, looking after home, or inactive.

Table 1: Characteristics of participants by trial group

provided a record of privately purchased health care at the same timepoints. We used health utilities generated from EQ-5D responses at every timepoint of evaluation to estimate quality-adjusted life-year (QALY) profiles for every participant; these were calculated as the area under the baseline-adjusted utility curve, assuming linear interpolation between utility measurements. We derived baseline EQ-5D scores from published general health population estimates, matched for age.¹⁸ We estimated cost-effectiveness, expressed in terms of incremental cost per QALY gained, for all participants of Step 1, and also for those participants of Step 2 alone. We used the non-parametric bootstrap method to construct cost-effectiveness acceptability curves at alternative cost-effectiveness thresholds relevant to decision makers.¹⁷ All analyses of costs, QALYs, and incremental cost-effectiveness were, first, non-inverse weight adjusted and, second, inverse weight adjusted to account for censoring of participants due to loss to follow up, and adjusted for baseline covariates (appendix).

Statistical analysis

We did the analysis by intention to treat. Imputation of missing data was by Multivariate Imputation by Chained Equations, and we present raw descriptive data, with imputed estimates of treatment effect.¹⁹ We estimated treatment effects using hierarchical regression adjusted for ethnic origin, grade of whiplash associated disorder at initial attendance, and clustering within emergency departments for Step 1, and using NDI, grade of whiplash associated disorder at initial attendance, and clustering within emergency departments and therapists for Step 2. We analysed work days lost using baseline covariate adjustment for employment status and multiple linear regression with bootstrapping because of highly skewed data. We analysed self-rated benefit using ordinal logistic regression.

In accordance with intention-to-treat principles, estimates of the effectiveness of Step 1 treatments included all participants regardless of whether they participated in Step 2 or not. We tested for potential interactions between Step 1 and Step 2 treatments using formal interaction tests. Data of compensation claims were not imputed and were expressed as a proportion of the number of people providing data. We undertook sensitivity analyses of Step 2 to investigate the mediating role of medication on the effect estimates for physiotherapy. We undertook analyses in STATA 10 (StataCorp) and MLwiN 2.1.²⁰ We undertook random checks of the administrative records of attendance of emergency department against the number of patients approached to participate in the trial to identify whether there was differential recruitment to the trial groups. The study is registered ISRCTN33302125.

Role of the funding source

The sponsor of the study commissioned the trial, approved the design, and appointed an independent trial steering and data monitoring committees to oversee the

study. The sponsor of the study had no role in data analysis, data interpretation, or the decision to submit for publication. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Emergency departments recruited for 12–23 months, and more than 500 clinicians were trained. Recruitment ran from Dec 5, 2005 to Nov 30, 2007. Follow-up was completed on Dec 19, 2008. Imputed analyses did not differ from non-imputed analyses. Four deaths unrelated to treatment occurred, and no other serious adverse events were noted.

For Step 1, six NHS Trusts (seven emergency departments) were randomly assigned to active management, and six NHS Trusts (eight emergency departments) to usual care (figure).

Emergency departments identified 6952 eligible participants, of which 3851 (55%) agreed to provide follow-up data (figure). People who participated were older (mean age 37 years *vs* 32 years) and more likely to be female (2133 [55%] of 3851 *vs* 1435 [42%] 3430) than the patients who did not participate, but not different in whiplash associated disorder grade. During random checks of 1781 records of whiplash attendances at the emergency departments, the proportion of potentially eligible people approached to participate in the trial was 500 (46%) 1087 for the active management group and 340 (49%) of 694 for the usual care group. The number of whiplash books used equalled or exceeded numbers of recruited patients at the active management sites. In Step 1, 2704 (70%) of 3851 of patients provided data at 12 months, with no difference between the trial groups. There were slightly more males among those lost to follow up (47%) than those retained at 12 months (41%), otherwise no important differences were noted. In Step 1, 126 (8%) of 1598 participants in usual care emergency departments provided data by telephone, and 178 (8%) of 2253 in the active management emergency departments, with no difference in baseline characteristics by follow-up method.

Just under 25% of patients (949 of 3851) were considered for Step 2, of which 693 were assessed as potentially eligible and 599 randomly assigned to study groups (figure). The proportions participating from the usual care and active management consultation groups of Step 1 were 45% and 55% respectively (table 1). 55 physiotherapists delivered the treatments, 300 patients were randomised to the physiotherapy package, and 201 (67%) completed the course of treatment as intended, and 80% (239 of 299) the advice session. Most patients (533 of 599, 89%) initiated their follow-up treatment within 28 days of attendance to the emergency department and 479 (80%) of 599 patients completed 12 month follow-up. In Step 2, 28 (9%) of 299 participants in the advice group provided follow-up by telephone, and

29 (10%) of 300 participants in the physiotherapy package, with no difference in baseline characteristics by follow-up method. [See Online for appendix](#)

In Step 1, patients were well matched but the active management group had slightly more people of Pakistani ethnic origin than did the usual care group (table 1). Road

	Usual care (n=1598)	Active management (n=2253)	Difference	p values
Neck disability index (per 100, mean, SD)				
4 months	20.4 (17.2)	21.5 (17.6)	0.5 (-2.1 to 3.0)†	0.7147
8 months	16.0 (16.4)	16.6 (16.5)	0.8 (-1.6 to 3.1)†	0.5174
12 months	14.4 (16.0)	14.4 (15.9)	0.5 (-1.5 to 2.5)†	0.6357
SF12—physical (per 100, mean, SD)				
4 months	46.5 (9.7)	46.0 (9.8)	-0.5 (-2.0 to 1.1)†	0.5496
8 months	48.9 (9.2)	48.5 (9.2)	0.0 (-1.1 to 1.0)†	0.9831
12 months	49.9 (9.0)	49.8 (9.1)	0.0 (-1.5 to 1.5)†	0.9707
SF12—mental (per 100, mean, SD)				
4 months	48.0 (11.6)	47.1 (12.1)	-0.3 (-1.6 to 1.0)†	0.6305
8 months	49.4 (11.3)	48.7 (11.5)	-0.5 (-1.7 to 0.7)†	0.4281
12 months	49.6 (10.9)	49.3 (10.9)	-0.3 (-1.4 to 0.9)†	0.6734
Work days lost (mean, SD)				
4 months	4 (13.1)	4 (13.5)	0 (-1.0 to 1.1)‡	0.8800
8 months	5 (14.5)	5 (15.9)	0 (-1.3 to 1.6)‡	0.8466
12 months	6 (15.8)	6 (17.4)	0 (-2.1 to 1.5)‡	0.8880
Self-rated benefit				
4 months			0.94 (0.77–1.14)§	0.5338
Much better (5)	403 (25%)	517 (23%)		
Better (4)	533 (33%)	745 (33%)		
Same (3)	217 (14%)	317 (14%)		
Worse (2)	57 (4%)	68 (3%)		
Much worse (1)	6 (<1%)	10 (<1%)		
Missing	382 (24%)	596 (27%)		
8 months			1.09 (0.97–1.22)§	0.1367
Much better (5)	328 (21%)	471 (21%)		
Better (4)	413 (26%)	547 (24%)		
Same (3)	335 (21%)	413 (18%)		
Worse (2)	68 (4%)	93 (4%)		
Much worse (1)	5 (<1%)	6 (<1%)		
Missing	449 (28%)	723 (32%)		
12 months			1.28 (1.14–1.45)§	<0.0001
Much better (5)	288 (18%)	468 (21%)		
Better (4)	297 (19%)	479 (21%)		
Same (3)	429 (27%)	491 (22%)		
Worse (2)	73 (5%)	98 (4%)		
Much worse (1)	7 (<1%)	7 (<1%)		
Missing	504 (32%)	710 (32%)		

Data are mean (SD) or n (%) unless otherwise indicated. Descriptive data are raw mean and SD, effect estimates are based on imputed data. SF12=Short Form 12. OR=odds ratio. *Observed intra-cluster correlation coefficients for the primary outcome were 0.0151 at 4 months, 0.0080 at 8 months, and 0.0029 at 12 months. †Mean difference (95% CI). ‡Difference in days (bootstrapped), adjusted for emergency department cluster, WAD grade at baseline, time from attendance to emergency department. §OR, ordinal regression, adjusted for WAD grade at baseline and cluster. SF12 recall period in the previous week. Neck disability index recall period in the past month. Work days lost recalled in the past 4 months. Self-report change in neck symptoms recalled in the past 4 months.

Table 2: Estimates of clinical effectiveness for the comparison of Usual Care Emergency Departments versus Active management/Whiplash Book Emergency Departments*—Step 1

traffic accidents were the usual mechanism of injury. The sample randomised in Step 2 had slightly fewer men than did the sample randomised in Step 1 (table 1), and as expected, a higher prevalence of Grade II and III injuries (table 1). Patients randomly assigned to the physiotherapy package had greater neck disability

(table 1). All analyses of the Step 2 were adjusted for the difference in clinic NDI score.

In Step 2, NDI scores did not differ between active management or usual care consultations at 4 months, 8 months, or 12 months (table 2). A small difference was noted in self-rated change at 12 months in favour of the active management consultations, but no other differences in secondary outcomes (table 2).

By comparison with one session of advice, the physiotherapy package had a modest significant effect at 4 months but not at 8 months or 12 months (table 3). The physiotherapy package decreased the number of work days lost by an average of 4 days at 12 months, equivalent to 40%) and improved self-rated benefit at 4 months (table 3). Secondary outcomes did not differ between the two groups (table 3). The effect estimates for physiotherapy were unchanged in sensitivity analyses adjusting for medication use. Information was available on the treatments provided for 259 (97%) of the 266 patients randomly assigned to the physiotherapy package. The most common treatments were manual therapy with exercise and psychological strategies (211 [81%] of 259), followed by exercise and psychological strategies (45 [17%] of 259). The therapist effects were small, and carry most influence at the timepoints nearest to the delivery of treatment (table 3). General practice consultations, attendance to the emergency department, and medication use was greater for the physiotherapy package (table 4). No evidence of significant interactions between Step 1 and Step 2 treatments was noted (table 3).

The economic evaluation showed that active management consultations were dominated by usual care (Step 1)—ie, they were associated with higher mean NHS costs (£305·37 for active management vs £277·42 for usual care) and lower mean QALYs (0·755 for active management vs 0·758 for usual care) than usual care in the non-inverse weight adjusted analyses. In Step 2, the physiotherapy package was dominated by reinforcement of advice (ie, it was associated with higher mean NHS costs (£414·73 for the physiotherapy package vs £356·37 for advice) and lower mean QALYs (0·691 for the physiotherapy package vs 0·702 for advice) than with advice in the non-inverse weight adjusted analyses. The results of the economic evaluation remained robust to the analytical method and study perspective (appendix).

Data about compensation claims was available for 2617 (68%) of 3851 participants of Step 1 and 465 (78%) of 599 participants of Step 2. In Step 1, the number of people who pursued a claim was 718 (66%) of 1090 for the usual care consultation and 1047 (69%) of 1527 for the active management consultation. In Step 2, 186 (79%) of 234 of people randomly assigned to advice and 187 (81%) of 231 randomly assigned to the physiotherapy package pursued a claim. Treatment assignment had no effect on the number of people pursuing compensation claims at 12 months.

	Advice (n=299)	Physiotherapy package (n=300)	Difference	p value
Neck disability index (per 100, mean, SD)				
4 months	27·8 (17·4)	28·0 (17·9)	-3·7 (-6·1 to -1·3)*	0·0029
8 months	21·5 (16·7)	24·1 (18·4)	-1·0 (-3·6 to 1·6)*	0·4649
12 months	19·5 (17·0)	21·7 (18·4)	-2·0 (-4·6 to 0·6)*	0·1295
SF12—physical (per 100, mean, SD)				
4 months	43·5 (9·7)	42·3 (9·2)	0·2 (-1·4 to 1·8)*	0·7753
8 months	45·8 (9·5)	45·3 (9·8)	0·2 (-1·5 to 2·0)*	0·7921
12 months	47·1 (9·9)	46·5 (10·2)	1·1 (-0·7 to 2·9)*	0·2366
SF12—mental (per 100, mean, SD)				
4 months	45·9 (12·5)	46·3 (12·1)	1·3 (-0·9 to 3·5)*	0·2392
8 months	47·1 (11·4)	46·2 (12·7)	-0·3 (-2·6 to 2·0)*	0·8063
12 months	48·8 (10·6)	47·5 (11·8)	-0·0 (-2·2 to 2·1)*	0·9672
Work days lost (mean, SD)				
4 months	9 (22·9)	6 (14·8)	-4 (-7·9 to -1·1)†	0·0160
8 months	10 (25·3)	8 (17·7)	-4 (-7·7 to -0·5)†	0·0180
12 months	11 (26·2)	9 (18·9)	-4 (-7·5 to -0·02)†	0·0260
Self-rated benefit				
4 months			2·19 (1·54 to 3·11)‡	<0·0001
Much better (5)	45 (15%)	81 (27%)		
Better (4)	127 (42%)	120 (40%)		
Same (3)	53 (18%)	35 (12%)		
Worse (2)	13 (4%)	5 (2%)		
Much worse (1)	5 (2%)	1 (<1%)		
Missing	56 (19%)	58 (19%)		
8 months			0·89 (0·66 to 1·20)‡	0·4308
Much better (5)	62 (21%)	57 (19%)		
Better (4)	98 (33%)	98 (33%)		
Same (3)	63 (21%)	64 (21%)		
Worse (2)	20 (7%)	25 (8%)		
Much worse (1)	1 (<1%)	1 (<1%)		
Missing	55 (18%)	55 (18%)		
12 months			0·98 (0·73 to 1·32)‡	0·9107
Much better (5)	51 (17%)	62 (21%)		
Better (4)	90 (30%)	74 (25%)		
Same (3)	72 (24%)	77 (26%)		
Worse (2)	19 (6%)	25 (8%)		
Much worse (1)	0 (0)	1 (<1%)		
Missing	67 (22%)	61 (20%)		

Data are mean (SD) or n (%) unless otherwise indicated. Descriptive data are raw mean and SD, effect estimates are based on imputed data. SF12=Short Form 12. *Mean difference (95% CI). †Difference in days (bootstrapped), adjusted for therapist cluster, advice at emergency department, baseline neck disability index score, and time from attendance to emergency department. ‡Odds ratio, ordinal regression, adjusted for WAD grade, cluster, and therapist. SF12 recall period in the previous week. Neck disability index recall period in the past month. Work days lost recalled in the past 4 months. Self-report change in neck symptoms recalled in the past 4 months. Therapist effect intraclass correlation coefficients for neck disability index were 0·0544 at 4 months, 0·0009 at 8 months, and 0·0303 at 12 months.

Table 3: Estimates of clinical effectiveness for the comparison of a physiotherapy package versus reinforcement of advice—Step 2

	Step 1				p value	Step 2				p value	Unit cost
	Usual care		Active management			Reinforcement of advice		Physiotherapy package			
	Mean	SD	Mean	SD		Mean	SD	Mean	SD		
NHS consultations											
GP consultations	1.93	3.22	2.03	4.42	0.552	2.18	2.93	2.97	3.96	0.019	36.00*
Nurse consultations	0.12	0.62	0.11	0.74	0.799	0.11	0.63	0.26	1.10	0.079	11.00*
Physiotherapy sessions	2.24	4.27	2.15	4.78	0.663	2.79	5.66	4.15	5.40	0.012	33.90*
Emergency department visits	0.30	0.55	0.33	0.74	0.231	0.28	0.50	0.44	0.72	0.007	148.00†
Outpatient consultations	0.21	0.81	0.19	1.03	0.691	0.26	0.92	0.22	0.63	0.635	116.50†
Psychologist consultations	0.09	0.60	0.21	2.77	0.133	0.10	0.57	0.19	0.91	0.213	72.00*
Orthopaedic consultations	0.13	0.89	0.10	0.78	0.539	0.14	0.89	0.11	0.64	0.691	119.00†
Other consultations	0.10	0.61	0.08	0.73	0.547	0.09	0.73	0.16	0.80	0.325	16.40–84.80†
Diagnostics											
X-ray tests	0.19	0.53	0.19	0.62	0.801	0.19	0.44	0.25	0.57	0.203	30.95†
CT scans	0.01	0.12	0.02	0.20	0.185	0.03	0.17	0.03	0.17	0.980	130.50†
MRI scans	0.04	0.25	0.05	0.33	0.454	0.04	0.25	0.07	0.38	0.464	225.50†
Blood tests	0.14	0.64	0.10	0.48	0.139	0.09	0.36	0.18	0.64	0.083	3.39†
Other tests	0.53	6.99	0.33	5.40	0.476	0.41	5.93	0.01	0.07	0.318	1.00†
Drugs (prescriptions)											
Pain killers	1.39	3.00	1.53	3.41	0.300	1.76	2.79	2.57	4.16	0.020	4.57‡
Anti-inflammatory drugs	0.91	2.07	0.85	1.98	0.508	0.84	1.72	1.42	2.45	0.005	8.22‡
Gels and creams	0.19	1.41	0.18	0.87	0.831	0.15	0.71	0.34	1.03	0.031	5.75‡
Sleeping drugs	0.12	0.60	0.19	1.16	0.064	0.09	0.39	0.42	2.19	0.036	3.66‡
Antidepressants	0.33	1.49	0.27	1.50	0.359	0.29	1.16	0.67	2.76	0.069	5.86‡
Hospital admissions											
Number	0.01	0.09	0.01	0.11	0.320	0.02	0.14	0.01	0.07	0.175	2727.00†
Private health-care consultations											
Physiotherapy consultations	1.81	4.89	1.42	4.12	0.052	1.60	4.03	1.09	4.05	0.191	38.20§
Osteopath consultations	0.39	2.36	0.18	1.48	0.018	0.45	2.93	0.33	2.27	0.629	44.30§
Chiropractor consultations	0.44	2.69	0.48	3.06	0.723	0.29	1.53	0.67	3.51	0.149	35.30§
Outpatient consultations	0.08	0.47	0.11	1.22	0.594	0.09	0.39	0.12	0.59	0.583	182.50§
Psychologist consultations	0.04	0.56	0.09	1.04	0.237	0.05	0.39	0.20	1.49	0.158	70.40§
Other consultations	0.27	1.49	0.28	1.54	0.829	0.45	2.11	0.31	1.24	0.416	24.80–50.00§

GP=general practitioner. References are detailed in appendix. *Curtis LA. *Unit Costs of Health and Social Care 2008*. Canterbury, UK: Personal Social Service Research Unit, University of Kent, 2008. †Department of Health. *NHS Reference Costs 2008*. London, UK: Department of Health, 2008. ‡NHS Information Centre PSU. *Prescribing Analysis and CoST (PACT)*. 2008. §Primary research based on six specialists' private consultation fees.

Table 4: Health service resource use: mean (SD) resource use per patient and unit costs of resource items by type of care (UK£, 2009 prices)

For the **NHS Prescribing Analysis and CoST** see www.ic.nhs.uk/statistics-and-data-collections/primary-care/prescriptions/prescription-cost-analysis-2007

Discussion

Whiplash injuries have a broad effect on society in health, lost productivity, and insurance costs.¹ We provide an interpretation of the trial results in the context of current research (panel). Both the QTF and Bone and Joint Decade Task Force recognised the need for definitive trials of treatments commonly used in whiplash injury.^{2,4} Our findings show that no additional benefit exists to providing active management consultations in the emergency department. A package of physiotherapy has a modest effect on early recovery of persisting symptoms but is not cost effective from a UK NHS perspective.

This trial tested interventions in the context of normal health-care delivery in a range of emergency departments from large university to smaller regional hospitals.

The patient characteristics were consistent with those reported in observational studies,³ and we believe, representative of the population to which the interventions would apply in clinical practice. In common with many pragmatic trials, there was no attention control, and eligibility criteria were broad.

The cluster design was the best option for the assessment of the active management consultations, as the risk of contamination between treatment groups was high. The limitations of cluster designs are well known, and can include differential recruitment into trial groups where allocation is known ahead of patient recruitment.²¹ Working with acute injury precluded the identification of participants before randomising clusters. However, systematic checks done at random intervals showed a

Panel: Research in context**Systematic review**

We searched PubMed and the Cochrane Library for systematic reviews and randomised controlled trials investigating conservative treatments for acute whiplash injuries. We used a combination of text terms and medical subject headings, search dates were January, 1966, to April, 2012, and recognised quality assessment criteria. We identified three systematic reviews,^{4,7,26} encompassing 17 trials of acute whiplash associated disorder of grade 0–III and one additional randomised trial of a nurse home visit at 10 days after injury.²⁷ The quality of the reviews was high but the quality of trials within the reviews was mostly low. Overall, recent reviews conclude health education pamphlets are not effective, and that physiotherapy with exercise and manual therapy might be effective for short-term outcomes.^{4,7,26} We found very few good quality trials with long-term follow-up.

Interpretation

Emergency departments should continue to provide usual care for whiplash injuries. More enhanced forms of advice, in the form of specially trained nurses,²⁷ pamphlets,²⁸ or, as we tested, an active management consultation with the *Whiplash Book*, provide no additional benefit. Our trial confirms physiotherapy packages that include exercise and manual therapy are effective in accelerating recovery of function, reducing pain in the short term,²⁶ and reduce work absence.²⁹ We report no effect on longer term recovery (6–12 months), although this is at odds with a pre-existing study.³⁰ The benefit of a package of physiotherapy is modest by comparison with provision of a single advisory session with the physiotherapist, and, accounting for other sources of provision, is not cost effective from an NHS perspective. Usual consultations in emergency departments and a single follow-up physiotherapy advice session for persisting symptoms are recommended.

similar proportion of eligible patients registered in both trial groups. Additionally, the characteristics of participants were well matched across the groups. Other limitations of this study are that we did not estimate the role of compliance, although this approach is consistent with an intention-to-treat analysis. Because our economic evaluation is from a UK NHS perspective, we did not consider the broader economic implications of cost savings resulting from work days lost.

In Step 2, NDI scores obtained at the eligibility check differed between groups. The risk of allocation subversion is minimum, as we used an independent, quality assured telephone randomisation system. We stratified by site and avoided blocking, minimising the chance that recruitment staff could anticipate allocations. Allocation lists have been checked for date and sequence, and all are normal. The difference is most likely due to chance. It is unlikely that the baseline difference in NDI has influenced the results. We used a robust statistical

technique to achieve the adjustment for the difference, and other measures of injury severity indicated equivalence between the two randomised groups. Although we did not account for therapist effects in the original sample size estimation, the final models of treatment effect were adjusted for these effects.

The level of training provided to emergency departments in Step 1 of the trial was consistent with the best that could be achieved under the constraints of routine UK clinical practice. One explanation for the absence of difference between the usual care and active management groups is that the advice given might have been the same. We did a national survey before this trial,²² and we are confident that the intended active management consultation was substantially different to usual care at the outset of the trial. Usual care consultations represented normative national practice—ie, non-specific advice to exercise, written advice sheets containing inconsistent information, no guidance on expectations for recovery, in some, encouragement to use neck collars and promotional material from injury claim solicitors.²² We were able to measure use of materials and patient records to indicate some aspects of treatment fidelity in the emergency department intervention, but not the verbal content of the clinical consultations owing to the size of the trial. The recovery trajectory in the usual care group was consistent with published rates of recovery from smaller UK cohorts.^{23–25}

A small proportion of people chose to participate in the second randomisation, but they did have worse symptoms at initial presentation suggesting that the approach used identified people at increased risk of poor recovery. We monitored use of health service resources, which confirmed that patients randomly assigned to the physiotherapy package did receive more physiotherapy. That the physiotherapy package had a modest effect was not unsurprising since this was a pragmatic trial and patients were not constrained in the treatments they could seek in the follow-up period. Some patients randomised to the single advice session received additional NHS physiotherapy during the follow-up period. Use of private therapy was substantially low overall, and did not differ in any meaningful way between the trial groups.

The reduction in work days lost attributable to the physiotherapy package was equivalent to about a 40% reduction. Modest improvements in disability could mean that people can return to work more quickly, or alternatively, that return to work is not related to symptoms or disability. Therapists were trained to encourage patients to return to normal activities as soon as possible. Hence the additional contact in the intervention group could encourage earlier return to work.

The participants in the physiotherapy package group used more health-care resources during follow-up, including general practice contacts and medications. One explanation is that the injury severity of patients

randomly assigned to physiotherapy was worse at baseline. The analyses accounted for this possibility by covariate adjustment. For physiotherapists to refer to general practice in complicated cases is not uncommon, or to reinforce the need for adequate analgesia. In sensitivity analyses, the benefits of physiotherapy were not explained by the noted increased use of medication.

The analyses presented do not estimate the role of compliance with the interventions. The single-advice session has the advantage of engendering greater compliance since it necessitated only one visit to the physiotherapist, and had a higher probability of being more cost effective than the physiotherapy package across a range of cost-effectiveness thresholds relevant to decision makers. In conclusion, usual consultations in emergency departments and a single follow-up physiotherapy advice session for persisting symptoms are recommended.

Contributors

SEL participated in the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting of the report, critical revision of the report for important intellectual content, statistical analysis, obtaining funding, administrative, technical, or material support, and supervision (chief investigator); SG participated in acquisition of data, analysis and interpretation of data, drafting of report, critical revision of the report for important intellectual content, administrative, technical, or material support, and supervision. MAW participated in the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting of the report, critical revision of the report for important intellectual content, administrative, technical, or material support. EW participated in the conception and design, acquisition of data, critical revision of the report for important intellectual content, administrative, technical, or material support. SM-I participated in the conception and design, acquisition of data, analysis and interpretation of data, critical revision of the report for important intellectual content, and statistical analysis. EW participated in the acquisition of data, critical revision of the report for important intellectual content, administrative, technical, or material support. EC participated in the analysis and interpretation of data, critical revision of the report for important intellectual content. JS participated in the analysis and interpretation of data, critical revision of the report for important intellectual content. DA participated in the conception and design, analysis and interpretation of data, critical revision of the report for important intellectual content, statistical analysis, obtaining funding, and supervision. MWC participated in the conception and design, analysis and interpretation of data, drafting of the report, obtaining funding, and supervision. SP drafting of economic component of report, analysis and interpretation of data, critical revision of the report for important intellectual content, and supervision. MU participated conception and design, analysis and interpretation of data, critical revision of the report for important intellectual content, obtaining funding, supervision.

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Conflicts of interest

We declare that we have no conflicts of interest.

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