J Occup Rehabil (2006) 16:607–629
DOI 10.1007/s10926-006-9060-1

ORIGINAL PAPER

Incorporating Injured Employee Outcomes into Physical and Occupational Therapists' Practice: A Controlled Trial of the Worker-Based Outcomes Assessment System

Robert H. Ross · Peter W. Callas · Jesse Q. Sargent · Benjamin C. Amick · Ted Rooney

Published online: 18 November 2006

Abstract *Background:* Work related musculoskeletal disorders (WRMSDs) remain costly. The Worker-Based Outcomes Assessment System (WBOAS) is an injury treatment improvement tool. Its purpose is to increase treatment effectiveness and decrease the cost of care delivered in Occupational Health Service clinics. *Methods:* The study used a non-randomized (parallel cohort) control trial design to test the effects on injured employee outcomes of augmenting the standard care delivered by physical and occupational therapists (PT/OTs) with the WBOAS. The WBOAS works by putting *patient-reported* functional health status, pain symptom, and work role performance outcomes data into the hands of PT/OTs and their patients. Test clinic therapists were trained to incorporate WBOAS trends data into standard practice. Control clinic therapists delivered standard care alone. *Results:* WBOAS-augmented PT/OT care *did improve* ($p \leq .05$) physical functioning and new injury/re-injury avoidance and, on these same dimensions, cost-adjusted outcome. It *did not improve* ($p > .05$) mental health or pain symptoms or return-to-work or stay-at-work success nor, on these same dimensions, cost-adjusted outcome. *Conclusion:* Training PT/OTs to incorporate patient-reported health status, pain symptom, and work role performance outcomes trends data into standard practice does appear to improve

R. H. Ross (✉)
Department of Medical Laboratory and Radiation Sciences, College of Nursing and Health Sciences, University of Vermont, 302 Rowell Building, 106 Carrigan Drive, Burlington, VT 05405, USA
e-mail: rhross@uvm.edu

P. W. Callas
Department of Medical Biostatistics, University of Vermont, Burlington, VT 05405, USA

J. Q. Sargent
Department of Psychology, George Washington University, Washington, DC 20052, USA

B. C. Amick
Behavioral Sciences and Epidemiology, School of Public Health, University of Texas Health Science Center, Houston, TX 77401, USA

T. Rooney
Health and Work Outcomes, Brunswick, ME 04011, USA

treatment effectiveness and cost on some (e.g. physical functioning) but not other (e.g. mental health, pain symptoms) outcomes.

Keywords Work related musculoskeletal disorders (WRMSD) · Outcomes assessment · Injury management · Occupational health services · Physical therapy · Occupational therapy

Introduction

Work related musculoskeletal disorders (WRMSDs) remain costly. Since 1994, when U.S. employers reported 6.3 million work injuries costing an estimated $121 billion in lost wages, lost productivity, administrative expenses, health care, and related costs [1], prevalence and cost have only risen [2]. Interest in WRMSD treatment and cost effectiveness has grown accordingly. And the "injury management" approach—variously featuring provider/patient, provider/provider, and provider/employer collaboration—has emerged to augment standard care with "multidisciplinary" care, e.g. physical conditioning, work conditioning, work-related pain and stress reduction, ergonomic consultation, and vocational counseling/placement [3–5]. An early test of the injury management approach reported "74% of the treatment group returned to work or were involved in state-supported vocational training in contrast to 40% of the control group ($P < .05$) ... 91% of the treatment group were working full-time in contrast to 50% of the control group ($P < .05$)" [4]. A later test reported "occupational management resulted in lower injury claim incidence, duration, and costs than standard care" [6]. "Successful interventions," it is now widely accepted, "require attention to individual, organizational, and job characteristics" [7–8]. The injury management approach, mediated by demographics including age and gender, does improve treatment outcomes [9–15]. In one version of the management approach, R.N. case managers not only coordinate care, but also assess health and work domains affecting injury recovery, develop case management plans, teach return-to-work problem solving, identify and reduce workstation risk factors, and reduce exposures leading to re-injury [14–15]. On the treatment side, R.N. case managers work directly with the physical and occupational therapists (PT/OTs) who now provide the better part of case-managed WRMSD treatment. To gauge treatment effectiveness, PT/OTs may complement therapist-reported (clinical) with patient-reported (functional health status) outcomes measures. With early evidence suggesting that care does improve when the latter measures are directly incorporated into treatment [16–18], the study reported here asked, Do treatment and cost outcomes improve if patient-reported outcomes are systematically employed to guide treatment?

Methods

Effects on treatment outcomes were tested for augmenting the standard care delivered by PT/OTs with the Worker-Based Outcomes Assessment System (WBOAS). The WBOAS works by putting same-session *patient-reported* functional health status, pain symptom, and work role performance outcomes data into the hands of PT/OTs and their patients. Specifically, it avails PT/OTs and their patients in-treatment of (a) *outcomes trends graphics* to set and re-set injury recovery and return-to-work goals and (b) *trends-based referral guidelines* to initiate auxiliary worksite evaluation/redesign and behavioral health care.

Design

The study used a non-randomized (parallel cohort) control trial design—the strongest possible design when the provider is integral to the intervention and study subjects may not be randomized same-site to test and control arms—to test the effects on injured employee outcomes of augmenting standard PT/OT care with the WBOAS. Test clinic PT/OTs were trained to incorporate patient-reported health status, pain symptom, and work role performance outcomes trends data into standard practice. Control clinic PT/OTs delivered standard care alone. The study phase commenced with a *pre-intervention period* during which study variables were measured at both test and control sites in order to capture any pre-intervention differences in treatment effectiveness. In the *intervention period*, study variables were measured at baseline (pre-treatment), discharge (1 month post-treatment follow-up), and 3 and 6 month post-treatment follow-up.

Subjects and sites

Fletcher Allen Health Care (FAHC, Burlington VT) is the University of Vermont's academic medical center hospital. Eligible subjects were FAHC employees (regular full-time, regular part-time, temporary part-time) with any WRMSD—upper or lower extremity, upper or lower back, typically strain or sprain, tendonitis and carpal tunnel syndrome—who, for that injury, were subsequently scheduled for PT/OT at one of three FAHC-managed geographically separate OHS clinics. The Sports and Orthopaedic Rehabilitation Center (Clinic 1) served as Test site, the Work Enhancement and Rehabilitation Center (Clinic 2) and the Hand, Upper Extremity, and Microsurgery Center (Clinic 3) served as Control sites. Altogether, the three clinics accounted for 95% of total FAHC WRMSDs referred to PT/OT. All eligible employees were invited to join the study, conditional upon their subsequent referral to PT/OT, by FAHC Employee Health (EH), where all WRMSDs are first seen by an R.N. Case Manager (RNCM) (Table 1).

During the study period, FAHC charged RNCMs a) to provide initial injury assessment and care and b) according to injury severity and patient preference to refer for medical treatment to a FAHC or other medical care provider (M.D., P.A., N.P.). The RNCM then served as manager-communicator among patients, medical care providers and PT/OTs, work supervisors and insurers, and study personnel. FAHC charged medical care providers in turn a) to treat injured employees and b) to refer them as needed for PT/OT to a FAHC-managed or other PT/OT site.

Table 1 Study subject referral, accrual

EH-to-Medical Care. RNCMs refer injured employees variously to:

- Emergency Room: patients seen by an ER physician, resident, nurse, or physician assistant.
- Walk In Clinic: sub-emergency patients with high pain level seen by a physician who can then refer back to EH for follow-up PT/OT.
- Occupational Health: patients are seen by a MD, PA, or NP.
- Primary care physician: patients who prefer are seen by their primary care provider and staff.

Medical Care-to-PT/OT. Medical care providers refer injured employees directly or indirectly (via EH) to PT/OT at:

- Clinic 1: Sports and Orthopaedic Rehabilitation Center
- Clinic 2: Work Enhancement and Rehabilitation Center
- Clinic 3: The Hand, Upper Extremity, Microsurgery Center

Of 362 injured employees thus invited to participate in the study, 302 gave permission and were "pre-consented." Of 302 pre-consented employees, 223 became eligible to join the study by being referred for PT/OT to one of the three study clinics. Of these, 179 (80%) gave permission and were consented, then asked to complete a baseline survey before the first PT/OT treatment visit. Of 179 consented subjects, 158 completed the study through discharge (1 month post-treatment follow-up) (88%), 151 through 3 month post-treatment follow-up (84%), and 138 through 6 month post-treatment follow-up (77%) (Table 2). Because of these high rates, information on subjects lost to follow-up was not collected.

Subject characteristics

Little variation was found in subject characteristics at baseline (pre-treatment): in patient-reported demographics, injury severity, co-morbidities, treatment variation, psychosocial factors, physical and mental health status (Table 3; see following sub-sections "Intervention and Instrument" and "Measures" for specification of named measures indicated by acronyms). Comparing the Test site in the Intervention period (Clinic 1) and all Non-intervention sites (Clinic 1 in the Pre-intervention period plus Clinics 2 and 3 in the Intervention period), significant differences were found only on injury severity (SF-36 PF-10 Physical functioning, $p < 0.01$, to the detriment of Test site subjects) and just four of sixty-four measured co-morbid states (tingling/burning feet, rapid heart beat past 4 weeks, seasonal allergy past 4 weeks, blood pressure medication). In addition to the reported items, there were no significant differences between Test and Control site subjects for marital status, number of persons in household, income, or alcohol consumption.'

The 134 subjects (75% of total, all sites) who reported job titles at baseline were distributed across four categories: records management, patient care, facilities/patient management, and lab management (Table 4).

By WRMSD type, 116 subjects (65% of total) reported an upper extremity injury, 88 (49%) an upper or lower back injury, and 27 (15%) a lower extremity injury (these add to greater than 100% because some subjects were seen for a multi-type injury). Test and control site subjects differed significantly by injury type (Table 5) because, while all three study clinics incorporated standard physical and/or occupational therapy, historically each had a somewhat different clinical focus.

Site effectiveness

Little variation was found in pre-intervention period treatment effectiveness among sites: in injury recovery or re-injury avoidance, return to work or stay at work success, evaluated provider performance or overall satisfaction, or referrals to worksite evaluation/redesign or behavioral health care (Table 6; see following sub-sections "Intervention and Instrument" and "Measures" for specification of named measures indicated by acronyms). Comparing pre-intervention period study sites (Clinics 1 and 2, which together saw $>90\%$ of study subjects), significant differences were found only for the mental health dimension of patient-reported injury recovery (SF-36 MH-5 Mental health, $p = 0.03$ for difference in improvement at discharge) and provider-reported worksite redesign requests ($p = 0.05$ for difference in worksite redesign requests), each in favor of subjects treated at Clinic 1, which was to become the intervention period test site. Considering that a large number of pre-intervention measures were compared (43 items), two findings with $p \leq 0.05$ are not unexpected.

Table 2 Study subject accrual, retention (numbers and rates)

(1) Invited by EH	(2) Pre-Consented by EH	(3) Made eligible by Referral for PT/OT	(4) Eligibles Consented-Baseline (pre-treatment) Interview	(5) 1 mo. (post-treatment) follow-up Interview	(6) 3 mo. (post-treatment) follow-up Interview	(7) 6 mo. (post-treatment) follow-up Interview	(a) Accrual Rate (4)/(3)	(b) Retention Rate (7)/(4)
362	302	223	179	158	151	138	0.80	0.77

Table 3 Study subject characteristics at baseline (pre-treatment)

Intervention period test site vs all Non-intervention sites	Test Clinic 1 ($n = 83$)	Control Clinics 1, 2, & 3 ($n = 95$)	
Age	No. (%)	No. (%)	p value
< 35	29 (35%)	27 (29%)	0.72
35–39	11 (13%)	13 (14%)	
40–44	10 (12%)	19 (20%)	
45–49	11 (13%)	10 (11%)	
50–54	16 (19%)	15 (16%)	
55–59	5 (6%)	6 (6%)	
60–64	1 (1%)	3 (3%)	
Sex (female)	61 (73%)	79 (84%)	0.10
Race (white)	76 (92%)	90 (97%)	0.59
Smoking habits			
Never	33 (40%)	40 (43%)	0.56
Former	29 (35%)	32 (34%)	
< 1 pack/day	11 (13%)	16 (17%)	
1 to < 2 packs/day	10 (12%)	6 (6%)	
$2+$ packs/day	0 (0%)	0 (0%)	
	Mean (SD)	Mean (SD)	
Highest grade completed	13.7 (1.8)	13.5 (1.7)	0.47
Years employed at FAHC	5.8 (6.1)	5.4 (6.1)	0.63
Injury severity			
SF-36 physical functioning	59 (29)	70 (21)	< 0.01
SF-36 bodily pain	41 (22)	41 (22)	0.72
TOPS pain symptoms	56 (18)	57 (18)	0.49
Co-morbidities	No. (%)	No. (%)	
WRMSD in 6 mo prior to "study" injury	7 (8%)	10 (11%)	0.80
TIBI: No significant differences across 64 TIBI items but for:			
Tingling/burning feet (none of time)	65 (79%)	82 (87%)	0.03
Rapid heart beat past 4 wks, none of time	61 (74%)	80 (85%)	0.02
Seasonal allergy past 4 wks, none of time	42 (51%)	67 (71%)	0.04
Blood pressure medication, yes	14 (17%)	6 (6%)	0.03
Physical/mental health status	Mean (SD)	Mean (SD)	
SF-12 physical health	37 (9)	38 (9)	0.57
SF-12 mental health	52 (11)	53 (9)	0.36
Work limitations			
WLQ physical	43 (30)	41 (25)	0.67
WLQ schedule	32 (31)	34 (29)	0.79
WLQ psychosocial	21 (25)	23 (26)	0.56
WLQ output	31 (29)	38 (30)	0.12

Intervention and instrument

Test site subjects received WBOAS-augmented PT/OT care. The intervention employed an instrument that included parts or all of three widely-used patient-reported functional health status measures.

- The SF-36 Health Survey [19] is a condition-generic measure composed of eight multi-item sub-scales, two of which, the ten-item PF-10 (Physical functioning) and the five-item MH-5

Table 4 Study subjects by job category (no/%)

	No. (%)
Records management, e.g. medical secretaries and receptionists, film librarians, transcriptionists, billing and accounts specialists	50 (37%)
Patient care, e.g. nursing staff, respiratory therapists, OR staff, pharmacists and pharmacy technicians	43 (32%)
Facilities, patient management, e.g. housekeepers, waste disposers, materials handlers, security officers, patient attendants and lift support	33 (25%)
Lab management, e.g. laboratory technicians and specialists	8 (6%)
Total	134 (100%)

(Mental health), were incorporated into the study instrument. The PF-10 sub-scale, which has been used in a range of outcome studies for work-related low back injuries [20], measures ability to perform ten lower limb and back ADLs ($r = 0.85$, alpha $= 0.90$) [19]: 1. vigorous activities, such as running, lifting heavy objects, participating in strenuous sports; 2. moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf; 3. lifting or carrying groceries; 4. climbing several flights of stairs; 5. climbing one flight of stairs; 6. bending, kneeling, or stooping; 7. walking more than a mile; 8. walking several blocks; 9. walking one block; 10. bathing or dressing yourself. The SF-36 MH-5, which Katz found was a strong predictor of return to work success [21], measures anxiety, depression, loss of control, and positive well-being. A score of 52 points or less on the SF-36 MH-5 is a cutoff for clinical depression [22].

- The Treatment Outcomes in Pain Survey (TOPS) [23–25] is a condition-specific measure composed of fourteen sub-scales, one of which, Pain Symptoms, was incorporated. The Pain symptoms sub-scale contains five items developed across a sample of 437 chronic pain patients (alpha $= 0.91$, scaling success 100%) and validated by comparison to chart reviews for physician documentation of the patient's best, worst, and average pain ratings 0–10 ($r = 0.81$ with Pain symptoms scale, 0.93 when completed same day patients reported pain ratings to physicians). In responsiveness tests the pain scale changed an average 7 points between the initial and 5-week (post-treatment) follow-up visit in response to treatment ($p < .001$).
- The Work Limitations Questionnaire (WLQ) [26–29] is a condition-specific measure of work performance composed of four sub-scales (time management, physical demands, mental/interpersonal demands, output demands), each of which was incorporated. The WLQ measures the degree to which health problems interfere with the ability to perform job roles. Results of repeated psychometric tests indicate excellent reliability, validity, and precision when applied, for example, to heart disease, low back pain, and occupational injury populations. In the current 25-item version, scaling tests produced Chronbach alphas of .89 (time), .89 (physical), .91 (mental), and .88 (output) with 100% scaling success across all four sub-scales. The positive relationship of WLQ scores to objectively measured productivity in a population

Table 5 Study subjects by injury type

	Test (No. / %)	Control (No. / %)	p value
Upper extremity	39 (48%)	77 (82%)	< 0.001
Upper and lower back	48 (58%)	40 (43%)	0.05
Lower extremity	20 (24%)	7 (8%)	0.003

Table 6 Study site effectiveness (pre-intervention period)

	Test site	Control site	
Injury recovery: Provider-rated, baseline (pre-treatment) to discharge (1 mo post-treatment follow-up)	Clinic 1 (No. = 12) Mean (SD)	Clinic 2 (No. = 20) Mean (SD)	*p* value
Continuous measure	2.1 (0.7)	2.1 (1.1)	0.92
Injury recovery: Patient-reported, baseline (pre-treatment) to discharge (1 mo post-treatment follow-up)	Clinic 1 (No. = 11) Mean (SD)	Clinic 2 (No. = 19) Mean (SD)	
SF-36 physical functioning	6 (23)	14 (22)	0.37
SF-36 mental health	14 (14)	4 (11)	0.03
TOPS pain symptoms	− 20 (20)	− 27 (23)	0.37
Re-injury avoidance: Provider-rated	Clinic 1 (No. = 12) No. (%)	Clinic 2 (No. = 20) No. (%)	
New injury/re-injury baseline (pre-treatment) through 6 mo post-treatment follow-up	4 (33%)	2 (10%)	0.17
New injury during 6 mo post-treatment follow-up	3 (25%)	1 (5%)	0.14
Re-injury avoidance: Patient-reported, baseline (pre-treatment) to 6 mo post-treatment follow-up	Clinic 1 (No. = 11) Mean (SD)	Clinic 2 (No. = 19) Mean (SD)	
SF-36 physical functioning	14 (11)	19 (18)	0.37
SF-36 mental health	12 (18)	4 (15)	0.19
TOPS pain symptoms	− 28 (27)	− 33 (28)	0.65
Return to work success: Provider-rated, baseline (pre-treatment) to 6mo post-treatment follow-up	Clinic 1 (No. = 11) Mean (SD)	Clinic 2 (No. = 19) Mean (SD)	
Continuous measure	0.8 (1.1)	1.7 (0.9)	0.72
Return to work success: Patient-reported, baseline (pre-treatment) to discharge (1 mo post-treatment follow-up)	Clinic 1 (No. = 11) Mean (SD)	Clinic 2 (No. = 19) Mean (SD)	
WLQ physical	− 17 (29)	− 28 (27)	0.31
WLQ schedule	− 10 (39)	− 13 (48)	0.88
WLQ psychosocial	− 23 (19)	− 14 (39)	0.41
WLQ output	− 17 (32)	− 16 (42)	0.96
Stay at work success: Provider-rated	Clinic 1 (No. = 11) No. (%)	Clinic 2 (No. = 20) No. (%)	
Work restriction during treatment (absence, reduced hours, modified work)	2 (18%)	8 (40%)	0.26
Work restriction during 6 mo post-treatment follow-up (absence, reduced hours, modified work)	3 (27%)	5 (25%)	1.00
Stay at work success: Patient-reported, baseline (pre-treatment) to 6 mo post-treatment follow-up	Clinic 1 (No. = 11) Mean (SD)	Clinic 2 (No. = 19) Mean (SD)	
WLQ physical	− 27 (21)	− 33 (26)	0.50
WLQ schedule	− 9 (39)	− 31 (40)	0.14
WLQ psychosocial	− 20 (20)	− 25 (28)	0.63
WLQ output	− 10 (39)	− 32 (33)	0.11
Provider performance: Patient-reported at 1mo post-treatment follow-up	Clinic 1 (No. = 12) Mean (SD)	Clinic 2 (No. = 20) Mean (SD)	
Longitudinal continuity, 1 question	68 (24)	56 (24)	0.21

Table 6 Continued

	Test site	Control site	
Visit-based continuity, 1 question	92 (10)	86 (17)	0.28
Knowledge of patient, 4 questions	73 (12)	69 (19)	0.51
Integration of care, 6 questions	79 (13)	70 (0)	0.56
Physical exam, 1 question	82 (20)	78 (19)	0.59
Interpersonal treatment 5 questions	87 (11)	82 (17)	0.44
Communication, 6 questions	88 (10)	79 (19)	0.09
Trust 8, questions	79 (11)	80 (17)	0.86
Overall satisfaction 1 = best, 7 = worst	1.7 (0.5)	1.9 (1.1)	0.53
PT/OT-initiated auxiliary care	No. (%)	No. (%)	
Provider-reported	Clinic 1 ($n = 12$)	Clinic 2 ($n = 20$)	
Mental health referral	2 (17%)	1 (5%)	0.54
Other referral	3 (25%)	3 (15%)	0.65
Worksite evaluation requested	4 (33%)	3 (15%)	0.38
Worksite evaluation implemented	3 (25%)	3 (15%)	0.65
Worksite redesign requested	4 (33%)	1 (5%)	0.05
Worksite redesign implemented	1 (8%)	1 (5%)	1.00
Worksite restriction requested	5 (42%)	8 (40%)	1.00
Worksite restriction implemented	5 (42%)	3 (15%)	0.12
Patient-reported	Clinic 1 ($n = 10$)	Clinic 2 ($n = 18$)	
Mental health referral	1 (10%)	1 (6%)	1.00
Other referral	2 (20%)	1 (6%)	0.28
Worksite redesign referral	2 (20%)	3 (17%)	1.00
Worksite equipment purchase	1 (10%)	3 (17%)	1.00

of 919 regular employees of a large firm that monitors employee productivity has likewise been demonstrated.

The intervention itself had information and action components. For the *information component*, at in-take and then at 10–14 day intervals throughout treatment, test site subjects (pre-treatment) used a touch-screen monitor to report current physical function and mental health (SF-36 PF-10 and MH-5), pain symptoms (TOPS), and work limitations (WLQ). This took 5–8 minutes. Input was instantly analyzed and printed out on one page of bar graphs. By the second and third visits, respectively, graphs contrasted initial-to-current visit and initial-to-previous-to-current visit trends. For the *action component*, test site PT/OTs employed (a) *outcomes trends graphics* to set and re-set injury recovery and return-to-work goals and (b) *trends-based referral guidelines* to initiate auxiliary worksite evaluation/redesign and behavioral health care. PT/OTs were comprehensively trained by the study team on both components of the intervention, regularly updated by e-mail on various aspects of protocol, and at 4–6 month intervals re-trained on both components by the study team.

Worksite evaluations were conducted by OHS PT/OT evaluators who, by FAHC protocol, were a) trained to conduct both ergonomic and work organization assays and b) authorized to introduce worksite modifications. Evaluators' recommendations, including those for new or modified equipment, were reviewed by the subject's RNCM, medical care provider, and supervisor before being implemented. Behavioral health care was likewise, by FAHC protocol, delivered by the OHS staff psychologist, an OHS-trained PhD-level therapist. Trends-based referral guidelines were based on published population norms [19, 22–24, 28, 29]. Guidelines encouraged PT/OTs to refer subjects

- to worksite evaluation and redesign when the SF-36 PF-10 Physical functioning fell below 50%, when TOPS Pain symptoms rose above 50%, or when WLQ time management, physical demands, or output demands rose above 50% and
- to behavioral health care when the SF-36 MH-5 Mental health fell below 50% or when WLQ mental/interpersonal demands rose above 50%.

Within 25% of these cut-offs, PT/OTs were asked to consider such referrals. Control site subjects received standard PT/OT care whereby treatment and referral decisions were based solely on the individual therapist's professional impression of a patient's presentation.

Measures

Study outcomes included 1. (*clinical*) treatment period injury recovery and post-treatment period re-injury avoidance; 2. (*functional*) treatment period return-to-work success and post-treatment period stay-at-work success; 3. (*process*) post-treatment evaluation of provider performance and overall satisfaction with care; 4. (*cost*) treatment and post-treatment cost-adjusted outcome; 5. (*auxiliary care/worksite*) treatment period referral to worksite evaluation and redesign; and 6. (*auxiliary care/mental*) treatment period referral to behavioral health care. These were measured as follows:

- (*clinical*) *Injury recovery* by (a) appraisal of a provider panel of four OHS PT/OT and M.D. raters[1] and (b) change in patient-reported symptom severity (SF-36 PF-10, SF-36 MH-5, TOPS Pain symptoms) from baseline to discharge; *Re-injury avoidance* by (a) OHS R.N. Case Manager reports of patients' re-injury incidence within six months of discharge and (b) change in patient-reported symptom severity at discharge and 3 and 6 month follow-up.
- (*functional*) *Return to work success* by (a) appraisal of a provider panel of three OHS R.N. Case Manager raters[2] and (b) change in patient-reported work limitations (WLQ time management, physical demands, mental/interpersonal demands, output demands) from baseline to discharge; *Stay at work success* by (a) OHS R.N. Case Manager reports of patients' work restriction incidence within six months of discharge and (b) change in patient-reported work limitations (WLQ) at discharge and 3 and 6 month follow-up.

[1] Subjects were scored 1 to 4, a score produced by averaging raters across four components of injury recovery at discharge relative to pre-injury—Pain status, Return to work, Functionality/ADLs, and Strength/range of motion at discharge–each component itself scored 1 to 4 (complete recovery, near complete recovery, partial recovery, little or no recovery). For Pain status, for example, ratings were 1. Complete recovery = Pain resolved, 2. Near complete recovery = Pain not interfering with ADLs or work tasks, 3. Partial recovery = Pain partially interfering with ADLs or work tasks, 4. Little or no recovery = Pain severely interfering with ADLs or work tasks.

[2] Subjects were scored 1 to 4, a score produced by averaging raters across four components of return-to-work success at discharge relative to pre-injury–Work status, Maximum medical improvement/impairment status, Injury treatment post-discharge, and patient's Subjective health status–each component itself scored 1 to 4 (complete success, near complete success, partial success, little or no success). For work status, for example, ratings were 1. Complete success = patient at pre-injury work status: full duty (same or equivalent job, unrestricted), 2. Near complete success = patient at near pre-injury work status: modified duty (same or equivalent job, restricted, ex. lower performance requirements and/or hours worked), 3. Partial success = patient is discharged with improvement but measurably short of pre-injury work status: modified duty (lesser job, i.e. lower performance requirements and/or hours worked), 4. Little or no RTW success = patient is discharged with little or no improvement and far short of pre-injury work status: total disability (out of work, injury related).

- (*process*) *Provider performance* by the Primary Care Assessment Survey (PCAS)[3] [30–32] and *Overall satisfaction with care* by a single item satisfaction measure.
- (*cost*) *Cost-adjusted outcome* by test site subjects' *incremental* treatment outcome adjusted for *incremental* treatment cost.
- (*auxiliary care/worksite*) *Worksite evaluation and redesign* referrals.
- (*auxiliary care/mental*) *Behavioral health care* referrals.

Control variables included patient-reported *demographics* age, sex, ethnicity, number of people in household, marital status, education, occupation, household income, time on the job, behaviors such as drinking and smoking, the latter shown by Frymoyer et al. [33] related to back pain, as well as

- Overall health status (SF-12) [34].
- Injury severity (SF-36 PF-10 Physical Functioning and BP-2 Bodily Pain, TOPS Pain symptoms, WLQ).
- Co-morbidities (Total Illness Burden Inventory [TIBI]) [35].
- treatment variation (check-lists of treatment period medications and non-FAHC provider visits).
- Psychosocial factors (SF-36 MH-5).
- Work conditions (Job Content Questionnaire [JCQ] including a supervisor/co-worker support measure [36].

Hypotheses

It was predicted that test site subjects would exhibit significantly higher rates of

- H.1 *(clinical outcome):* treatment period injury recovery and post-treatment period re-injury avoidance.
- H.2 *(functional outcome):* treatment period return to work success and post-treatment period stay at work success.
- H.3 *(process outcome):* post-treatment period evaluated provider performance and overall satisfaction with care.
- H.4 *(cost outcome):* treatment period cost-adjusted outcome.
- H.5 *(auxiliary care/worksite):* treatment period referral to worksite evaluation and to worksite redesign.
- H.6 *(auxiliary care/mental):* treatment period referral to behavioral health care.

Analysis

Data were first examined to detect any unusual values or anomalies. Baseline characteristics of test and control site subjects were compared using two-sample *t*-tests for continuous variables and Fisher's exact test for categorical variables. For age and income, Pearson's chi-square test was used. Pre-intervention period test and control sites and intervention period test and control

[3] The PCAS is a validated, patient-reported provider performance evaluation instrument composed of eleven sub-scales pertaining to care—accessibility (organizational, financial), continuity (longitudinal, visit-based), comprehensiveness (knowledge of patient, preventive counseling), integration of care, clinical interaction (clinician-patient communication, thoroughness of physical examinations), interpersonal treatment, and trust—which taken altogether comprehend the entire clinician-patient primary care relationship. Because study PT/OTs had no responsibility for accessibility, preventive counseling, or integration of care, the measure was modified for use in the study to include only the remaining eight scales.

sites were compared on the aforementioned outcomes and controls. Comparison of test and control site subjects for provider-rated injury recovery and return to work (scored 1–4) used two-sample *t*-tests and nonparametric Wilcoxon rank-sum tests. Outcomes from baseline to discharge and discharge to 3 and 6 month post-treatment follow-up were compared using two-sample *t*-tests and Wilcoxon rank-sum tests on change scores. For examining trends across time, repeated-measures mixed-model analysis of variance was used to assess durability of effects through 6 months of follow-up. Potential confounding and interaction were assessed using stratified analysis and linear or logistic regression for continuous and dichotomous outcomes, respectively. The Breslow-Day test for homogeneity was used to test for interaction in the stratified analysis and the Wald statistic for the interaction term was used in regression analyses. Confounding was evaluated by examining consistency of stratified results with the un-stratified findings and by examining changes in parameter estimates in regression. Because the study had a non-randomized control, baseline group equivalence was carefully assessed. Adjustments were not made for multiple comparisons, since such adjustments increase the likelihood of type II errors for true associations. For pilot studies, avoiding type II errors is generally considered to be more important than reducing type I errors. By describing all comparisons that were made, the overall likelihood of type I errors can be assessed in context [37–38].

Results for H.4 (cost outcome) were derived by assembling data on costs a) of conducting the study, b) of the standard care afforded test and control site subjects alike, and c) of the intervention (WBOAS) component afforded test site subjects alone. Cost estimates were used for equipment and supplies that were donated, in place already, or had uses besides that of study. Prevailing market values were used to calculate rents (for space), project-related percentage use of an item (for equipment), and the wage value of time spent with the protocol (for personnel).

Results

Hypotheses were tested making two comparisons, the intervention period test site (Clinic 1) a) versus all non-intervention sites (including Clinic 1 in the pre-intervention period) and b) versus the two intervention period control sites only (Clinics 2 and 3, excluding Clinic 1 in the pre-intervention period). Except where otherwise noted, results were similar for both comparisons, thus only the former are presented. Where the intervention does not appear to have significantly affected an outcome, data are not reported but may be obtained from the corresponding author.

H.1. Clinical outcomes

Injury recovery

Provider-rated, the intervention does not appear to have affected baseline-to-discharge injury recovery (Table 7). Test site *men*, however, do exhibit significantly higher injury recovery than control site men (mean 2.0 vs 2.6 [$n = 22, 15$] $p = 0.05$). The test of whether the intervention effect was different for men and women is likewise significant ($p = 0.03$). The observed effect on men does not change when controlling for baseline physical functioning or for demographics. Race had a distribution too skewed for stratified analysis.

Patient-reported, the intervention does appear to have significantly affected baseline-to-discharge injury recovery as assessed by the SF-36 PF-10 Physical functioning though not as assessed by the SF-36 MH-5 Mental health or TOPS Pain symptoms sub-scale (Table 7).

That test site subjects exhibited lower baseline physical functioning (SF-36 PF-10) than control site subjects does raise the possibility that their greater improvement post-treatment may

Table 7 Injury recovery: Baseline to discharge

	Provider-rated		
	Test Mean (SD) (No. = 83)	Control Mean (SD) (No. = 92)	*t*-test *p* value
Continuous score (1–4)	2.1 (0.8)	2.1 (0.9)	0.86
	Patient-reported[a]		
	Test Mean (SD) (No. = 75)	Control Mean (SD) (No. = 83)	*t*-test *p* value
Physical functioning (SF-36 PF-10)	22 (27)	11 (20)	0.01
Mental health (SF-36 MH-5)	3 (16)	3 (15)	0.95
Pain symptoms (TOPS)	−22 (25)	−24 (23)	0.47

[a]Means are (X month) − (baseline), where X = 1 mo post-treatment follow-up.

have been due to that lower starting point and not to the intervention. In fact, across all study sites, subjects with baseline SF-36 PF-10 scores below 70 were observed to improve more than those with baseline scores of 70 or above (mean improvement of 29 vs 6 at discharge, 32 vs 8 at 3 month and 33 vs 9 at 6 month follow-up, all $p < 0.0001$). Yet multiple linear regression reveals a significant *interaction* between study site and SF-36 PF-10 score improvement from baseline to discharge and to 3 and 6 month follow-up (interaction p values $= 0.08, 0.05, 0.01$ respectively). The interaction model (Table 8) shows that, while for all subjects the intervention appears more effective for those with lower than with higher baseline physical functioning, test site subjects improved more than control site subjects across all baseline physical functioning scores. And *the lower the level of baseline physical functioning the greater the difference in improvement*. The effect is somewhat stronger for men than women, though the difference is not statistically significant. The effect does not change controlling for subject demographics.

Re-injury avoidance

Provider-rated, the intervention does appear to have significantly affected post-treatment follow-up re-injury avoidance assessed by new injury and re-injury incidence baseline through 6 month follow-up and by new injury incidence during 6 month follow-up (Table 9). No such differences were found in these subjects' WRMSD incidence in the 6 month prior to their "study" WRMSD. Stratified analysis and logistic regression were used to investigate whether higher test site re-injury avoidance might be due to differences in baseline physical functioning, sex, pre-study WRMSD, or work restrictions, where differences between groups, albeit non-significant,

Table 8 Mean values SF-36 PF-10 physical functioning: Discharge — baseline values

Pre-treatment SF-36 PF-10 score	Test site subjects at discharge	Control site subjects at discharge	Improvement difference
25	44	31	13
50	28	20	8
75	12	9	3

Table 9 Re-injury avoidance: Baseline through 6 month follow-up, during 6 month follow-up

	Provider-rated		
	Test No (%) (No. = 83)	Control No (%) (No. = 95)	Fisher's *p* value
New injury/re-injury baseline through 6 month post-treatment follow-up	4 (5%)	14 (15%)	0.04
New injury during 6 mo post-treatment follow-up	3 (4%)	11 (12%)	0.06
	Patient-reported[a]		
	Test Mean (SD) (No. 3 mo = 71/ No. 6 mo = 68)	Control mean (SD) (No. 3 mo = 80/ No. 6 mo = 70)	
Physical functioning (SF-36 PF-10) 3 mo/6 mo	23 (26)/24 (28)	15 (20)/16 (20)	0.05/0.07
Mental health (Sf-36 MH-5) 3 mo/6 mo	6 (20)/5 (21)	3 (14)/5 (16)	0.22/0.97
Pain symptoms (TOPS) 3 mo/6 mo	− 29 (24)/ − 29 (24)	− 30 (26)/ − 32 (27)	0.74/0.49

[a] Means are (X month) − (baseline), where X = 3 or 6 month post-treatment follow-up.

were observed. The intervention effect actually became stronger controlling for these variables ($p = 0.01$ for new injury/re-injury baseline through 6 month follow-up, $p = 0.02$ for new injury during the 6 month follow-up period). And, though across sites men were found more likely than women to be injured/re-injured from baseline through 6 month follow-up, between sites male and female test site subjects alike were injured/re-injured less than male and female control site subjects. Neither effect appears to be a time period artifact. In the pre-intervention period, though numbers are small, the test site does not have a lower re-injury rate than the control site.

Patient-reported, the intervention does appear to have significantly or near significantly affected follow-up re-injury avoidance as assessed by the SF-36 PF-10 Physical functioning though not as assessed by the SF-36 MH-5 Mental health or TOPS Pain symptoms sub-scale (Table 9). The effect is somewhat stronger for men than women, though the difference is not statistically significant. The effect for SF-36 PF-10 was stable across time. Using repeated-measures mixed-model analysis of covariance with baseline SF-36 PF-10 score as a covariate and subject within group as a random effect, there was no change in the significant relationship between intervention and SF-36 PF-10 score across discharge, 3 month, and 6 month follow-up (group by time interaction $p = 0.87$). Consistent with the bivariate finding, there was a baseline by-group interaction, with more of an intervention effect among subjects with lower baseline SF-36 PF-10 than among subjects with higher baseline SF-36 PF-10 ($p = 0.02$). This did not change across time ($p = 0.71$).

H.2. Functional outcomes

Return to work success

Provider-rated, the intervention does not appear to have significantly affected baseline-to-discharge return to work success (Table 10). The observed lack of effect does not change controlling either for baseline physical functioning or for demographics. *Patient-reported*, the intervention does not appear to have significantly affected baseline-to-discharge return to work success as assessed by the WLQ time management, physical demands, mental/interpersonal

Table 10 Return to work and stay at work success, provider-rated

Return to work success: Baseline to discharge			
Continuous score (1–4)	Test site Mean (SD) (No. = 78)	Control site Mean (SD) (No. = 90)	*t*-test *p* value
	1.8 (1.0)	1.6 (0.8)	0.16
Stay at work success: During treatment, during 6 mo follow-up			
	Test site no (%) (No. = 83)	Control site no (%) (No. = 95)	Fisher's *p* value
Any work restriction[a] during 6 mo follow-up	43 (60%)	42 (48%)	0.16
Any work restriction[a] during treatment	59 (74%)	51 (57%)	0.02

[a] Absence, reduced hours, or modified work.

demands, and output demands sub-scales, with no significant differences or consistent non-significant trends.

Stay at work success

Provider-rated, the intervention does not appear to have significantly affected follow-up stay at work success as assessed by incidence of any work restriction (absence, reduced hours, work modification) during 6 month follow-up (Table 10). In fact a trend was found in the 6 month follow-up period to the detriment of test site subjects ($n = 43/60\%$ vs $42/48\%$ $p = 0.16$). The negative effect appears to be a time period artifact, however. Making the "intervention period test site versus control site clinics only" comparison, which leaves out pre-intervention period test site subjects, the difference disappears (Table 11), evidently because there were proportionately more work restrictions during the intervention than during the pre-intervention period for both the test and control sites. Indeed the pre-intervention to intervention period increase in work restrictions from 27% to 60% for the test site is marginally significant ($p = 0.06$) and that from 25% to 61% for the control site is significant ($p = 0.01$). A similar trend is seen for work restrictions during treatment.

Patient-reported, the intervention does not appear to have significantly affected follow-up stay at work success as assessed by the WLQ time management, physical demands, mental/interpersonal demands, and output demands sub-scales, with no significant differences or consistent non-significant trends.

Table 11 Number and percent of work restrictions by study site: Pre-intervention and intervention periods

	Test site No (%)	Control site No (%)	Fisher's *p* value
Pre-intervention period	(No. = 11)	(No. = 20)	
Any work restriction due to injury[a] during 6 mo post-treatment follow-up	3 (27%)	5 (25%)	1.00
Intervention period (Test site versus Control site Clinics only comparison)	(No. = 72)	(No. = 56)	
Any work restriction due to injury[a] during 6 mo post-treatment follow-up	43 (60%)	34 (61%)	1.00

[a] Absence from work, reduced hours, or modified work.

H.3. Process outcomes

Evaluated provider performance

Patient-reported, the intervention does appear to have affected evaluated provider performance at discharge as assessed by the PCAS. All observed differences but one (longitudinal continuity, 44 vs 52 $p = 0.05$) favored test site subjects, significantly so for physical exam (87 vs 81 $p = 0.05$), not significantly so for knowledge of patient, visit-based continuity, integration of care, interpersonal treatment, clinician-patient communication or trust (Table 12). For *men*, significant or near significant differences were found not only on physical exam but also on knowledge of patient (80 vs 59 $p = 0.01$), interpersonal treatment (90 vs 80 $p = 0.10$), and communication (90 vs 78 $p = 0.10$). Neither effect, for all subjects and for men alone, appears to be a time period artifact.

Overall satisfaction with care

Patient-reported, the intervention does not appear to have affected overall satisfaction with care at discharge as assessed by the single-item satisfaction-with-care question. No significant differences were found, though the trend was in the predicted direction.

H.4. Cost outcome

Patient-reported physical functioning (SF-36 PF-10) and provider-rated new injury/re-injury incidence warrant attention. The significant differences reported on Tables 7 and 9 show that test site subjects appear a) to have improved 100% ($0.22 : 0.11 = 2.00$) and 53% ($0.23 : 0.15 = 1.53$) more than control site subjects on physical functioning, respectively, at discharge and at 3 month follow-up and b) to have avoided new injuries and re-injuries from baseline through 6 month follow-up 12% (79/83 : 81/95 [test:control site un-injured plus un-re-injured to total] = 1.12) more than control site subjects.

Conducting the study cost $190,095.99—the sum of the total cash grant ($187,548.00) and the estimated value of donated items ($2,547.99)—or $1062 per subject ($n = 179$). The cost of standard care alone came to $1918.33 per subject, which is the weighted average of the principal test and control sites, Clinics 1 and 2. The reported average was based on the fact that 47% of subjects visited the site with a per-patient standard treatment cost of $1711.86 per patient (Clinic 1) while 53% of them visited the site with a per-patient standard treatment cost of $2101.44

Table 12 Evaluated provider performance at discharge

	Test site Mean (SD) (No. = 82)	Control site Mean (SD) (No. = 93)	*t*-test *p* value
Longitudinal continuity	44 (23)	52 (27)	0.05
Visit-based continuity	85 (27)	84 (28)	0.85
Knowledge of patient	72 (18)	68 (19)	0.17
Integration of care	78 (19)	76 (21)	0.80
Physical exam	87 (18)	81 (22)	0.05
Interpersonal treatment	89 (13)	85 (15)	0.13
Communication	86 (18)	82 (19)	0.26
Trust	81 (15)	78 (17)	0.29

(Clinic 2). The cost of the intervention (WBOAS) component added to standard care of test site subjects came to $189.87 per subject. It was calculated using the dollar value of PT/OT, staff, study coordinator, and subjects' time plus the same session use-in-treatment touch-screen instrumentation associated with this added component. WBOAS-augmented care thus cost 10% more ($2108.20 : $1918.33 = 1.10) than standard care alone.

Since WBOAS-augmented care cost 10% more than standard care alone but improved patient-reported physical functioning 2.00 or 100% more at discharge and 1.53 or 53% more at 3 month follow-up, respectively, then cost-adjusted (2.00 : 1.10 = 1.82 and 1.53 : 1.10 = 1.39) that augmented care can be considered 1.82 or 82% and 1.39 or 39% more effective, respectively, on these outcomes for these subjects. And since WBOAS-augmented care produced a new injury/re-injury avoidance rate (baseline through 6 month follow-up) 12% more (79/83 : 81/95 = 1.12) than that of standard care alone, then cost-adjusted (1.12/1.10 = 1.018) that augmented care can likewise be considered 1.8% again more effective on this outcome for these subjects.

H.5 & H.6. Auxiliary care

Provider- and *patient-reported*, the intervention does not appear to have affected PT/OT-initiated referral to either worksite evaluation or worksite redesign. Indeed significant differences ($p \leq 0.02$) were found to the detriment of test site subjects in provider-reported worksite evaluations requested and implemented and work restrictions requested and implemented (though not in worksite referrals requested and implemented). Patient-reported worksite referrals and worksite equipment purchases followed the same pattern. *Provider*-and *patient-reported*, the intervention does not appear to have affected PT/OT-initiated referral to behavioral health care auxiliary to treatment.

Discussion

Clinical outcomes

The intervention appears to have affected *injury recovery* and *re-injury avoidance* in one important respect (Table 13): with prediction, test site subjects exhibited significantly higher rates of a) treatment period injury recovery and post-treatment period re-injury avoidance on patient-reported *physical functioning* (but not on *mental health* or *pain symptoms*) and b) re-injury avoidance measured by provider-rated *new injury/re-injury incidence* from baseline through 6 month follow-up.

- That significant differences were found on patient-reported physical functioning at discharge and 3 month (and near significant at 6 month, $p = 0.07$) follow-up but *not* on mental health suggests that the intervention's "information" component (same-session outcomes trends graphics incorporated into treatment) was more effective than the behavioral health care dimension of the "action" component (trends-based referral guidelines). It is also possible that the information component was more *effectively implemented* than the action component, but since PT/OT fidelity-to-training was not measured in the intervention phase (a weakness in the study) this cannot be determined.
- That a significant difference was found in treatment period work restriction rates to the detriment of test site subjects suggests in turn that a price was paid for the higher injury recovery rates observed in their favor. Test site PT/OTs may have been induced by referral guidelines to effectively lower new injury/re-injury by raising work restriction rates.

Table 13 Summary of study findings[a]

	Sites comparable on balance for	Sites not comparable for	
Site effectiveness	IR,RA,RTW,SAW,PP,OS	SF-36 MH-5 (IR), WSR requests	
Subject characteristics	IR,RA,RTW,SAW,PP,OS	SF-36 PF-10 (IR)	
	With prediction ($p \leq 0.05$)	No difference ($p > 0.05$)	Against prediction ($p \leq 0.05$)
H.1 Clinical outcome			
IR provider-rated	Men IR status	Women	No
IR patient-reported	All subjects SF-36 PF-10	SF-36: MH-5; TOPS PS	No
RA provider-rated	All subjects New injury/re-injury incidence (baseline through 6 month follow-up)	No	No
RA patient-reported	All subjects SF-36 PF-10 (at 3 mo follow-up)	SF-36: MH-5; TOPS PS	No
H.2 Functional outcome			
RTW provider-rated	No	Yes	No
RTW patient-reported	No	WLQ: SD, PHD, PSD, OD	No
SAW provider-rated	No	Yes	No
SAW patient-reported	No	WLQ: SD, PHD, PSD, OD	No
H.3 Process outcome			
PP patient-reported	All subjects PCAS PE; Men PCAS KP	PCAS VBC, IC, CPC, IP, TR	Women PCAS LoC
GS patient-reported	No	Yes	No
H.4 Cost outcome			
Test subjects CaO ≥ Control subjects CaO	All subjects SF-36 PF-10: CaO = 1.82 or 82% again more effective at discharge; CaO = 1.39 or 39% again more effective at 3 mo follow-up All subjects New injury/re-injury avoidance through 6 mo follow-up: CaO = 1.018 or 1.8% more effective	NA	NA

Table 13 Continued

	With prediction ($p \leq 0.05$)	No difference ($p > 0.05$)	Against prediction ($p \leq 0.05$)
H.5 & H.6 Referrals			
PT/OT-initiated referral to WSE or WSR, therapist- or patient-reported	No	No	WSE requested, implemented WSR requested, implemented
PT/OT-initiated referral to BHC, therapist- or patient-reported	No	Yes	No

[a]IR: Injury recovery, RA: Re-injury avoidance, RTW: Return to work success, SAW: Stay at work success, PP: evaluated Provider performance, OS: Overall satisfaction with care, CaO: Outcome-adjusted Outcome, WSE: Worksite evaluation, WSR: Worksite redesign, BHC: Behavioral health care, SF-36: PF-10 physical functioning, MH-5 mental health, BP bodily pain, TOPS: PS pain symptoms, WLQ: SD scheduling demands, PHD: physical demands, PSD: psychosocial demands, OD: output demands, PCAS LoC: longitudinal continuity, VBC: visit-based continuity, KP: knowledge of patient, IC: integration of care, CPC: clinician-patient communication, PE: thoroughness of physical examinations, IP: interpersonal treatment, TR: trust.

Functional outcomes

The intervention appears not to have affected *return to work* or *stay at work success* at all. Against prediction, test site subjects exhibited no significantly higher rates of patient-reported or provider-rated treatment period return to work or post-treatment period stay at work success. That neither *return to work* nor *stay at work* success was observed to co-vary with *injury recovery* and *re-injury avoidance*—sufficient to produce comparably higher rates, for example, on any of the four dimensions of patient-reported *work limitations*—may indicate that return to work and stay at work success have less to do with *physical functioning* (SF-36 PF-10) and more to do with *mental health* (SF-36 MH-5) and/or *pain symptoms* (TOPS). Though there is no suggestion of this contrast found in those articles centered on return to work [39–44] in a recent issue of the *Journal of Occupational Rehabilitation* dedicated to the subject of work disability, the relative importance of these three clinical outcomes of WRMSD treatment for return to and stay at work success might well be explored more deliberately.

Process outcomes

The intervention appears to have affected *evaluated provider performance* in several respects. With prediction, test site subjects exhibited significantly higher rates of evaluated provider performance on the *physical exam* dimension; male test site subjects as well on the *knowledge of patient* dimension and nearly so on interpersonal treatment and communication dimensions. It is possible that the intervention's "information" component (same-session outcomes trends graphics) bolstered subjects' confidence in the acuity of the physical exam per se and that the men may have been temperamentally more inclined to that component's graphic or "high tech" dimension than the women, hence more likely to have felt that it added significantly to the knowledge, interpersonal, and communicative dimensions of their treatment.

Cost outcomes

The intervention appears to have affected *cost-adjusted outcome* in several respects. With prediction, test sites subjects exhibited considerably higher rates of cost-adjusted outcome on two dimensions of injury recovery and re-injury avoidance: patient-reported *physical functioning* (cost-adjusted outcome 82% higher at discharge, cost-adjusted outcome 39% higher at 3 month follow-up) and provider-rated *new injury/re-injury avoidance* baseline through 6 month follow-up (cost-adjusted outcome 1.8% higher at 6 month follow-up). Considering the actual cost-saving represented by these higher rates, an employer may consider WBOAS-augmented care a sound investment in WRMSD treatment improvement.

Auxilliary care

The intervention appears not to have affected referrals to *worksite evaluation* and to *worksite redesign* or to *behavioral health care* in the direction anticipated. Against prediction, control (not test) site subjects exhibited significantly higher rates of provider-reported *worksite evaluations* and *work restrictions* requested and implemented and of patient-reported *worksite redesign referrals* and *equipment purchases*. Likewise, test site subjects exhibited no significantly higher rates of provider- or patient-reported referral to *behavioral health care*.

- That control site out-did test site providers on both worksite evaluations and work restrictions (a finding that cannot be attributed to baseline difference in site effectiveness because the

baseline trend actually favors the test site) may have resulted from a contamination effect whereby these PT/OTs, aware they were "just" the standard care site, increased requests. A study involving even geographically separated test and control clinics situated in a single organization setting can produce such an effect. But since no post-intervention interviews were conducted PT/OTs (a weakness in the study), this cannot be determined.

- That behavioral health referrals were not affected by trends-based guidelines suggests ineffectiveness of the intervention's "action" component, which in turn could be attributable to the lesser effectiveness of training received in this (compared to the "information") component of the intervention. It cannot be explained by differences in test and control site subjects' baseline mental health status because there were none. But since test site PT/OT fidelity-to-training was not measured (a weakness in the study), no such attribution can be made.

Could the significant differences in injury type reported by test and control subjects (Table 5) have confounded study findings? The possibility is reduced by the fact that the same injury type differences were present as well among pre-intervention period subjects even as these subjects' measured outcomes did not meaningfully differ between test and control sites (Table 6). In any case, to examine intervention effectiveness separately for upper extremity, upper and lower back, and lower extremity injuries encounters two obstacles: a) diminished numbers, especially for lower extremity injuries, and b) overlapping types, i.e. that some subjects were seen for a multi-type injury.

In sum, despite study limitations associated with a) the design requirement that a non-randomized (parallel cohort) trial be conducted and b) the absence of process measures capable of verifying uniform test site implementation of the intervention, indications are that test site subjects *did recover* from their injuries and *did avoid* re-injury at significantly higher rates than control site subjects, *did not* do so because of their lower baseline physical functioning (see Table 8) but *did do so* because of the WBOAS-augmented PT/OT care, notably in its "information" component, that they received.

On the treatment side of the injury management approach, therefore, there is reason to believe that when PT/OTs are trained to incorporate patient-reported treatment outcomes contrasting initial, previous, and current visits into standard WRMSD practice,

- employees will achieve significantly higher rates of injury recovery and re-injury avoidance and
- employers will benefit, cost-adjusted, from the modest investments they make in that training and in the touch-screen technology required for bringing these outcomes same-session into standard practice.

Acknowledgements The authors gratefully acknowledge Diane Aja, M.S., Richard A. Galbraith, M.D., Ph.D., Thomas J. Zweber, M.D., Ashley K. Hardesty, A.S., Krystal Jenness, P.T., Jill Zhou, P.T., and Laura Murphy, R.N. for their contributions. Grant sponsor, number: US DHHS, CDC NIOSH, grant R21 OH07339.

References

1. National Institute for Occupational Safety and Health. National occupational research agenda. U.S. Department of Health and Human Services, 1996.
2. Institute of Medicine, Panel on Musculoskeletal Disorders and the Workplace. Musculoskeletal disorders and the workplace: Low back and upper extremities. Washington, DC: National Academy Press, 2001.
3. Haig AJ, Linton P, McIntosh M, Moneta L, Mead PB. Aggressive early medical management by a specialist in physical medicine and rehabilitation: effect on lost time due to injuries in hospital employees. J Occup Med 1990;32(10):966.

4. Feuerstein M, Callan-Harris S, Hickey P, Dyer D, Armbruster W, Carosella AM. Multidisciplinary rehabilitation of chronic work-related upper extremity disorders. Long-term effects. J Occup Med 1993;35(4):396–403.
5. Carosella AM, Lackner JM, Feuerstein M. Factors associated with early discharge from a multidisciplinary work rehabilitation program for chronic low back pain. Pain 1994;57(1):69–76.
6. Lemstra M, Olszynski WP. The effectiveness of standard care, early intervention, and occupational management in worker's compensation claims. Spine 2003;28(3):299–304.
7. National Academy of Sciences, Steering Committee for the Workshop on Work Related Musculoskeletal Injuries. The research base. Work-related musculoskeletal disorders: Report, workshop summary, workshop papers. Washington, DC: National Academy Press; 1999.
8. Karsh B, Moro FBP, Smith MJ. The efficacy of workplace ergonomic interventions to control musculoskeletal disorders: a critical examination of the peer-reviewed literature. Theoret Issues Ergonomic Sci 2001;2:23–96.
9. McGeary DD, Mayer TG, Gatchel RJ, Anagnostis C, Proctor TJ. Gender-related differences in treatment outcomes for patients with musculoskeletal disorders. Spine J 2003;3(3):197–203.
10. Mayer T, Gatchel RJ, Evans T. Effect of age on outcomes of tertiary rehabilitation for chronic disabling spinal disorders. Spine 2001;26(12):1309–12.
11. Shaw WS, Feuerstein M, Miller VI, Wood PM. Identifying barriers to recovery from work related upper extremity disorders: use of a collaborative problem solving technique. AAOHN J 2003;51(8):337–46.
12. Feuerstein M, Huang GD, Ortiz JM, Shaw WS, Miller VI, Wood PM. Integrated case management for work-related upper-extremity disorders: impact of patient satisfaction on health and work status. J Occup Environ Med 2003;45(8):803–12.
13. Rudolph L, Deitchman S, Dervin K. Integrating occupational health services and occupational prevention services. Am J Ind Med 2001;40:307–18.
14. Shaw WS, Feuerstein M, Lincoln AE, Miller VI, Wood PM. Case management services for work related upper extremity disorders. AAOHN J 2001;49(8):378–89.
15. Shaw WS, Feuerstein M, Miller VI, Wood PM. Identifying barriers to recovery from work related upper extremity disorders: use of a collaborative problem solving technique. AAOHN J 2003;51(8):337–46.
16. Rubenstein LV, Calkins DR, Young RT, Cleary PD, Fink A, Kosecoff J, Jette AM, Davies AR, Delbanco TL, Brook RH. Improving patient function: a randomized trial of functional disability screening. Ann Intern Med 1989;111:836–42.
17. Calkins DR, Rubenstein LV, Cleary PD, Davies AR, Jette AM, Fink A, Kosecoff J, Young RT, Brook RH, Delbanco TL. Functional disability screening of ambulatory patients: a randomized controlled trial in a hospital-based group practice. J Gen Intern Med 1994;9:590–92.
18. Rubenstein LV, McCoy JM, Cope DW, Barrett PA, Hirsch SH, Messer KS, Young RT. Improving patient quality of life with feedback to physicians about functional status. J Gen Intern Med 1995;10:607–14.
19. Ware JE, Snow KK, Kosinski M, Gandek BG. SF-36 Health Survey: Manual and interpretation guide. Lincoln, RI: QualityMetric Incorporated; 2000.
20. Atlas SJ, Deyo RA, Keller RB, et al. The Maine Lumbar Spine study, Part II. 1-year outcomes of surgical and non-surgical management of sciatica. Spine 1996;21:1777–86.
21. Katz JN, Lew RA, Bessette L, Punnett L, Fossel AH, Mooney N, Keller RB. Prevalence and predictors of long-term work disability due to carpal tunnel syndrome. Am J Ind Med 1998;33:543–50.
22. Wells KB, Stewart A, Hays RD, Burnam MA, Rogers W, Daniels M, Berry S, Greenfield S, Ware J. The functioning and well-being of depressed patients. Results from the medical outcomes study. JAMA 1989;262:914–19.
23. Rogers WH, Wittink HM, Ashburn MA, Cynn D, Carr DB. Using the "TOPS," an outcomes instrument for multidisciplinary outpatient pain treatment. Pain Med 2000;1:55–67.
24. Rogers WH, Wittink H, Wagner A, Cynn D, Carr DB. Assessing individual outcomes during outpatient multidisciplinary chronic pain treatment by means of an augmented SF-36. Pain Med 2000;1:44–54.
25. Ho MJ, LaFleur J. The treatment outcomes of pain survey (TOPS): a clinical monitoring and outcomes instrument for chronic pain practice and research. J Pain Palliat Care Pharmacother 2004;18(2):49–59.
26. Amick BC, Lerner D, Rogers WH, Rooney T, Katz JN. A review of health-related work outcome measures and their uses, and recommended measures. Spine 2000;25:3152–60.
27. Lerner DJ, Amick BC, Rogers WH, Malspeis S, Bungay K. The work limitations questionnaire: a self-administered instrument for assessing on-the-job work disability. Med Care 2001;39:72–85.
28. Lerner D, Reed JI, Massarotti E, Wester LM, Burke TA. The work limitations questionnaire's validity and reliability among patients with osteoarthritis. J Clin Epidemiol 2002;55(2):197–208.
29. Lerner D, Amick BC, Lee JC, Rooney T, Rogers WC, Chang H, Berndt ER. Relationship of employee-reported work limitations to work productivity. Med Care 2003;41:649–59.
30. Institute of Medicine, Committee on the Future of Primary Care. Primary care: America's health in a new era. Washington, DC: National Academy Press; 1996.

31. Safran DG, Kosinski M, Tarlov AR, Rogers WH, Taira DH, Lieberman N, Ware JA. The primary care assessment survey: tests of data quality and measurement performance. Med Care 1998;35:728–39.
32. Safran DG, Taira DA, Rogers WH, Kosinksi M, Ware JE, Tarlov AR. Linking primary care performance to outcomes of care. J Fam Pract 1998;47:213–220.
33. Frymoyer JW, Pope MH, Clements JH, Wilder DG, MacPherson B, Ashikaga T. Risk factors in low-back pain: an epidemiological survey. J Bone Joint Surg Am 1983;65:213–18.
34. Ware J Jr, Kosinski M, Keller SD. A 12 item short-form health survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996;34:220–33.
35. Stier DM, Greenfield S, Lubeck DP, Dukes KA, Flanders SC, Henning JM, Weir J, Kaplan SH. Quantifying comorbidity in a disease-specific cohort: adaptation of the total illness burden index to prostate cancer. Urology 1999;154:424–29.
36. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The job content questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol 1998;3:322–55.
37. Rothman KJ. No adjustments are needed for multiple comparisons. Epidemiology 1990;1:43–6.
38. Savitz DA, Olshan AF. Multiple comparisons and related issues in the interpretation of epidemiologic data. Am J Epidemiol 1995;142:904–08.
39. Pransky G, Gatchel R, Linton S, Loisel, P. Improving return to work research. J Occup Rehabil 2005;15(4):453–7.
40. Staal JB, Rainville J, Fritz J, van Mechelen W, Pransky G. Physical exercise interventions to improve disability and return to work in low back pain: current insights and opportunities for improvement. J Occup Rehabil 2005;15(4):491–505.
41. Franche RL, Baril R, Shaw W, Nicholas M, Loisel P. Workplace-based return-to-work interventions: optimizing the role of stakeholders in implementation and research. J Occup Rehabil 2005;15(4):525–42.
42. Young AE, Wasiak R, Roessler RT, McPherson KM, Anema JR, van Poppel MN. Return-to-work outcomes following work disability: stakeholder motivations, interests and concerns. J Occup Rehabil 2005;15(4):543–56.
43. Young AE, Roessler RT, Wasiak R, McPherson KM, van Poppel MN, Anema JR. A developmental conceptualization of return to work. J Occup Rehabil 2005;15(4):557–68.
44. Franche RL, Cullen K, Clarke J, Irvin E, Sinclair S, Frank J. Workplace-based RTW intervention literature review research team. Workplace-based return-to-work interventions: a systematic review of the quantitative literature. J Occup Rehabil 2005;15(4):607–31.