Use of Job-Specific Functional Capacity Evaluation to Predict the Return to Work of Patients With a Distal Radius Fracture

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OBJECTIVE. We examined the predictive validity of a job-specific functional capacity evaluation (FCE) in relation to the return to work of patients with a distal radius fracture.

METHOD. Return-to-work recommendations for 194 participants with a distal radius fracture were based on FCE performance. Three months after the evaluation, participants were contacted to ascertain their employment status to examine the predictive validity of each FCE-based rating.

RESULTS. The recommendation return to previous job (94.83%) was correct more often than the recommendations do not work at the moment (60.47%), change job (52.63%), and return to previous job with modifications (9.38%). A longer period from injury to FCE and compensable injury reduces the predictive ability of job-specific FCE.

CONCLUSION. Job-specific FCE shows a better predictive validity in relation to the return to work of patients with a specific injury, such as a distal radius fracture, than of patients with a nonspecific injury.


In day-to-day clinical practice, occupational therapists are intensively involved in managing upper-extremity injuries. Such injuries are common. In a territorywide survey conducted from 2004 to 2006 among all the occupational therapy work rehabilitation centers in Hong Kong, the average number of patients referred to occupational therapy for work assessment and rehabilitation was 3,031 per year. Musculoskeletal back injuries constituted the most prevalent diagnosis (33%), followed by upper-limb injuries (23.4%), multiple musculoskeletal injuries (15.2%), lower-limb injuries (14.6%), and others (Occupational Therapy Coordinating Committee [OTCoC], 2009). Of the different types of upper-limb injury, distal radius fracture was the main injury, accounting for 53.4% of upper-limb injuries.

Upper-extremity injuries negatively influence the functional use of the hand and may result in long periods of sick leave (Kasdan & June, 1993; Rusch, Dzwierzynski, Sanger, Pruitt, & Siewert, 2003; Skov, Jeune, Lauritsen, & Barfred, 1999). In general, as the duration of sick leave increases, the chances of returning to work decrease (Post, Krol, & Groothoff, 2005). Determining whether a worker is ready or safely able to return to work after injury remains a major challenge for clinicians and claims adjudicators (Gross & Battie, 2006).

One clinical tool used internationally to predict whether a worker is safely able to return to work after upper-extremity injury is functional capacity evaluation (FCE; Lechner, Roth, & Straaton, 1991). FCE provides an objective measurement system that matches physical abilities with essential and critical job demands; targets short- and long-term treatment goals to justify work-hardening therapy; identifies job modifications to enhance worker safety; and...
delineates functional capacities in case of litigation, impairment, or disability (Isernhagen, 1988). It has become widely used in occupational, insurance, and rehabilitation medicine to evaluate work ability and to guide return-to-work recommendations (Gross, Battie, & Cassidy 2004; Soer, van der Schans, Groothoff, Geertzen, & Reneman, 2008). Occupational therapists have long been proponents of functionally oriented assessments of capacity for work (Holmes, 1985). Thus, occupational therapists have become one of the major providers of FCE (Gibson & Strong, 2003).

Earlier studies have reported that the predictive validity of FCEs is poor (Gross et al., 2004; Gross & Battie, 2006; Lechner, Page, & Sheffield, 2008). The relatively low predictive validity of FCE may be caused by the problem of inconsistent terminology (Soer et al., 2008); that is, users may not fully understand the operational definitions of the different types of FCE. Indeed, at least three types of FCE exist; they are distinguished by their degree of evaluation and specificity of focus (Hart, Isernhagen, & Matheson, 1993). Baseline capacity evaluation is used to quantify worker traits in dealing with the common physical work demands listed in the Dictionary of Occupational Titles (U.S. Department of Labor [DOL], 1991a), such as sitting, standing, walking, balancing, climbing, kneeling, stooping, crouching, reaching, lifting, carrying, pushing, and pulling, when there is no specific job to which the worker will return. However, if the specific job to which the worker is to return is known and a job analysis has already been conducted to identify the critical job demands, the worker should be tested using job capacity evaluation. The result of this evaluation should include a specific match of the physical abilities of the worker to the demands of a specific job. Work capacity evaluation is used to determine the worker’s potential to be able to withstand the basic demands of competitive employment, particularly full-day workplace tolerance and daily attendance (Matheson, 1988). Evaluation usually requires the worker to perform work simulations over a significant time period to determine the worker’s capabilities and the demands of competitive employment (Hart et al., 1993).

FCEs can therefore be classified as either generic or job specific. Relying solely on the use of standardized global test batteries under a generic FCE method, however, is not an efficient approach to predicting the ability of an injured worker to deal with specific job demands. Pransky and Dempsey (2004) pointed out that validity of FCE results is optimal with accurate job simulation and detailed, intensive assessments of specific work activities. When test criteria are unrelated to job performance, the validity of results is questionable. In addition, because of the dynamic and complex nature of most job demands, FCE is necessarily dynamic (Pransky & Dempsey, 2004). The evaluator should be flexible in selecting tests and should be able to modify the test battery as required. The predictive validity of FCE should be associated with the ability of the evaluator to identify the critical demands of a specific job.

We previously examined the predictive validity of a job-specific FCE in relation to the employment status of patients with nonspecific low back pain. The results of the study showed that for this condition, for which a cause cannot be definitively identified and a precise pathoanatomical diagnosis cannot be given, job-specific FCE had a high correct prediction rate in relation to recommendations to return to the previous job or change jobs (Cheng & Cheng, 2010). Whether these results can be generalized to other conditions, such as those related to specific upper-extremity injuries, is unknown.

We therefore undertook this study to examine the predictive validity of a job-specific FCE in relation to the return to work of patients with a distal radius fracture. We hypothesized that job-specific FCE would have better predictive validity in relation to the employment status of patients with a specific injury than it would for patients with a nonspecific injury.

**Method**

**Design**

This study used a retrospective cohort design. Data on variables of interest were extracted from the clinical databases of all designated occupational therapy work rehabilitation centers in Hong Kong. Since 2004, it has been standard practice among the centers to administer only job-specific FCEs. A unified reporting format was developed and implemented by the OTCoC of the Hospital Authority of Hong Kong. In addition, 3 mo after an evaluation, a follow-up telephone interview is conducted with each patient to survey his or her employment status as a quality measure. Occupational therapists working at the designated work rehabilitation centers have received formal training in job analysis and FCE. This study design was reviewed and approved by the OTCoC.

**Participants**

The participants were selected on the basis of the following inclusion criteria:

- Received a medical diagnosis of distal radius fracture from a physician
• Referred for FCE by a physician
• Received FCE in designated occupational therapy work rehabilitation centers of the Hospital Authority of Hong Kong during the period March 2004–April 2007
• Willing to cooperate by reporting personal particulars
• Willing to be interviewed by telephone 3 mo after the FCE.

The exclusion criteria were as follows:
• Could not be contacted after discharge
• Refused to report current employment status.

Job-Specific FCE

Before the FCE, a hierarchical task analysis guided by the modified Dictionary of Occupational Titles Physical Demand Questionnaire (Jacobs & Wyrick, 1989; DOL, 1991b) was used to discuss physical work demands with the participants. Their comments were compared with the local job bank, which was developed by local occupational therapists from previous interviews with patients with similar job titles and a formal work site evaluation. With this job information, we quantified the physical work demands in terms of the duration, frequency, and intensity of tasks and activities. Moreover, this information was used to form the criteria by which the return-to-work recommendations were made.

Next, the therapists formulated an FCE protocol, which contained a battery of tests to determine the ability of the participants to deal with physical work demands. In this study, the FCE protocol to determine the work ability of participants with a distal radius fracture included a handgrip strength test, a dynamic bilateral lifting test at three levels (floor to knuckle, knuckle to shoulder, and floor to shoulder), a bilateral and unilateral carrying test, a bilateral and unilateral pulling test, and a bilateral and unilateral pushing test. We adopted a psychophysical testing approach during the entire process of evaluation; therefore, each test was stopped when a participant believed that his or her maximum level of functioning had been reached within an acceptable pain level (Khalil et al., 1987). The standardized FCE method used was the Baltimore Therapeutic Equipment (BTE) work simulator (BTE Technologies, Hanover, MD). This system has 22 different attachments and operates in both static and dynamic modes to replicate >300 different job tasks. Several studies have indicated that the BTE work simulator has high test–retest, intrarater, and interrater reliability (Cetinok, Renfro, & Coleman, 1995; Dunipace, 1995; Fess, 1993; Innes & Straker, 1999a; Kennedy & Bambhani, 1991; Shechtman, Davenport, Malcolm, & Nabavi, 2003) and moderate to good construct and criterion-related validity when used to simulate actual work demands (Beaton, O’Driscoll, & Richards, 1995; Harvey & Gench, 1993; Innes & Straker, 1999b; Kennedy & Bambhani, 1991).

Measures

FCE-Based Ratings. After completing the test, each participant was given a rating that was based on his or her performance in the FCE. A pass rating was given to those participants who passed all the FCE tasks. A fail rating B was given to those who failed all the tasks, and a fail rating A was given to participants who fulfilled some of the criteria of the tasks. With reference to these ratings, each participant was given one of the following four return-to-work recommendations: (1) return to previous job, (2) return to previous job with modifications, (3) change job, or (4) do not work at the moment. Basically, a recommendation to return to the previous job was given to those who passed all of FCE tasks. Participants who obtained a fail rating A were recommended either to return to their previous jobs with modifications or to consider changing jobs. Finally, for those participants who failed all the FCE tasks and thus obtained a fail rating B, the therapists recommended that they should either change jobs or not work at the moment.

Potential Confounding Variables. We selected variables from the administrative databases that have been reported to be predictive of recovery in previously published studies of people with upper-extremity injuries. The variables considered included age, gender, number of days from injury to FCE, being the breadwinner, education level, compensability, occupational category, and level of physical work demands (Bernard, 1997; Bruyns et al., 2003; Feuerstein, Shaw, Lincoln, Miller, & Wood, 2003; Filan, 1996; Gross & Battie, 2006; Himmelstein et al., 1995; Leclerc et al., 2001; Post et al., 2005).

Outcome

All the participants were contacted for a telephone interview 3 mo after the FCE. At least three attempts were made to contact each patient. During the telephone interview, they were asked questions related to their current employment status. Three months was judged to be a suitable follow-up time because events occurring after this period were considered unlikely to be related to the FCE testing. In addition, in our experience, this time period is the optimal follow-up time for ensuring a satisfactory response rate.

Data Analysis

Descriptive statistics were used to describe the demographic characteristics of the participants. k coefficients were
calculated to evaluate the strength of agreement, and the McNemar–Bowker test (Portney & Watkins, 2009) was used to test the symmetry between the return-to-work recommendations made by the therapists and employment status 3 mo after the FCE as reported by the participants. The percentage of correct predictions (hit rate) of each return-to-work recommendation was measured. The relative percentage difference (i.e., deviation; Csuros, 1994) was used to evaluate the precision of the return-to-work recommendations with respect to each FCE-based rating.

To estimate the predictive validity of job-specific FCE, we created a dichotomous variable for whether FCE testing successfully predicted the return-to-work outcomes of the participants (yes for an accurate prediction and no for an inaccurate prediction). Univariate logistic regressions were performed to examine the effect of each extracted confounding variable on the predictive validity of job-specific FCE. The confounding variables that had $p > 5\%$ were eliminated. The remaining variables were entered into a multivariate backward stepwise logistic regression to discover their contribution to the overall predictive validity of job-specific FCE. Finally, these significant confounding variables were put into a multivariate backward stepwise logistic regression to build up a regression model for each FCE-based rating based on the correct prediction of participants’ employment status. This modeling approach allowed for the control of those variables that were most likely to have a confounding influence on each FCE-based rating. All the statistical analyses were performed using SPSS Version 17.0 (SPSS, Inc., Chicago); the significance level was set at $p < .05$.

**Results**

A total of 229 patients with a distal radius fracture received job-specific FCE in designated work rehabilitation centers from March 2004 to April 2007. Of these patients, 194 (84.7\%) were reached for a follow-up telephone interview and became the participants for this study.

Table 1 shows the characteristics of the participants in detail. After the FCEs, 63.9\% achieved a pass rating and 36.1\% a fail rating. Moderate agreement (Landis & Koch, 1977) was found between the return-to-work recommendations made by the therapists and the employment status reported by the participants at follow-up ($\kappa = .449$). A statistically significant difference ($p < .0001$) was obtained from the McNemar–Bowker test, thus confirming that there was more disagreement over some categories of return-to-work outcomes than others. A higher percentage of correct predictions was observed for the recommendations return to previous job (94.83\%) than for the recommendations do not work at the moment (60.47\%), change job (52.63\%), and return to previous job with modifications (9.38\%; Table 2).

Table 3 summarizes the precision of the return-to-work recommendations made according to each FCE-based rating. Participants who passed the FCE testing were able to return to their previous job, whereas it was likely that those who failed the test either had to change their job or refrain from work at the moment. The results of the univariate logistic regressions on the confounding variables showed that only two variables, number of days from injury to FCE (crude odds ratio [OR] = 0.561, 95\% confidence interval [CI] = 0.312–0.971) and compensability (crude OR = 0.683, 95\% CI = 0.347–0.819), had a statistically significant effect on the predictive validity of job-specific FCE. In the multivariate logistic regression analysis, the following two variables continued to play a significant role on the predictive validity of job-specific

<table>
<thead>
<tr>
<th>Variable</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>43.6 (10.11)</td>
</tr>
<tr>
<td>Sex, %</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>64.9</td>
</tr>
<tr>
<td>Female</td>
<td>35.1</td>
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<tr>
<td>Mean days from injury to FCE (SD)</td>
<td>221.47 (235.78)</td>
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<td>Compensable work injury, %</td>
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<td>61.3</td>
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<tr>
<td>No</td>
<td>38.7</td>
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<tr>
<td>Occupation categories, %</td>
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<tr>
<td>Agriculture, fishery, and forestry</td>
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<tr>
<td>Bench work</td>
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<tr>
<td>Clerical and sales</td>
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<tr>
<td>Machine trades</td>
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<tr>
<td>Processing</td>
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<tr>
<td>Professional, technical, and managerial</td>
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<td>Service</td>
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<tr>
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<tr>
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<td>Education level, %</td>
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<td>University</td>
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</tr>
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</table>

Note. SD = standard deviation; FCE = functional capacity evaluation.
FCE: (1) number of days from injury to FCE (adjusted OR = 0.498, 95% CI = 0.263–0.819) and (2) compensability (adjusted OR = 0.549, 95% CI = 0.398–0.912). As a result, a 1-day increase in the number of days from injury to FCE reduced the predictive validity of job-specific FCE by 49.8%, and a compensable injury reduced it by 54.9%.

Table 4 shows the regression models for each FCE rating in terms of correct prediction of employment status after controlling for significant confounding variables. The percentages of correct predictions were as follows: 85.9% ($R^2 = 20.15$, sensitivity = 87.9%, specificity = 75.3%) among the participants who obtained a pass rating, at a best classification cutoff of 0.5; 62.8% ($R^2 = 14.72$, sensitivity = 64.3%, specificity = 69.8%) among the participants who obtained a fail rating A because they did not meet all the criteria of the FCE tasks, at a best classification cutoff of 0.4; and 78.5% ($R^2 = 19.24$, sensitivity = 85.3%, specificity = 72.9%) among the participants who obtained a fail rating B because they failed all of the FCE tasks, at a best classification cutoff of 0.4.

Discussion

The results of our study support our premise that job-specific FCE can have better predictive validity for the employment status of patients with a specific injury than for that of patients with a nonspecific injury. Compared with nonspecific injuries, such as in our previous study on nonspecific low back pain (Cheng & Cheng, 2010), the accuracy of the recommendation return to previous job in the current study reached 94.83%, which is 6.47% higher than the corresponding figures for patients with nonspecific low back pain in our previous study. Similarly, the accuracy of the recommendation do not work at the moment was 60.47%, which is 22.97% higher than in our previous study (Cheng & Cheng, 2010).

For participants who passed our job-specific FCE, a clear and distinct decision could be made to recommend that they return to their previous jobs. If the participants failed the test, regardless of whether it was a fail rating A or B, three options were open to the therapists: (1) return to previous job with modifications, (2) change job, or (3) do not work at the moment. In our study, the return-to-work recommendation for which job-specific FCE had the least predictive ability was return to previous work with modifications. The lack of available modified duties had a significant influence on the ability of the participants to follow the recommendation made by the therapists. This situation was similar to that found in Lechner et al. (2008). If modified duties had been available...
for the participants, the percentage of correct predictions and, hence, the \( \kappa \) coefficients may have been significantly improved.

The importance of providing suitable duties is well known (Brooker, Cole, Hogg-Johnson, Smith, & Frank, 2001; Shaw & Feuerstein, 2004; van Duijn, Lötters, & Burdorf, 2005; van Duijn, Miedema, Elders, & Burdorf, 2004) and is supported by this finding. Nowadays, the provision of modified work programs is a critical administrative measure or organizational policy in workplace disability management (Shrey, 1996; Shrey & Hursh, 1999; Williams & Westmorland, 2002). Different terms are used for these modified work programs, although most of the programs are similar in nature. The most frequently used terms include light duty, limited duty work, and transitional work.

*Light duty* refers to any temporary or permanent activity that is less than regular or full duty and that enables a disabled worker to perform a job according to a set of conditions prescribed by a health care provider. Light duty positions are paid work and are performed in a competitive work environment. They range from adaptations of a worker’s preinjury job to working in an entirely different job at the same or a different company; such measures can be either preexisting or specially created for the disabled worker (Krause, Dasinger, & Neuhauser, 1998). *Limited duty work* is appropriate to an injured worker’s skills, interests, and capabilities. *New jobs* are designed for workers who cannot return to their original work area. They may be either temporary (i.e., for a specified time, such as a few weeks or months) or permanent (when the worker will not be able to return to his or her original job; Randolph & Dalton, 1989).

*Transitional work* is any combination of tasks, functions, or jobs that a worker who has functional restrictions can perform safely for pay and without the risk of injury to self or other workers. Transitional work options include designated jobs or job tasks that are modified, over time, to accommodate the injured worker during the physical recovery process (Shrey & Hursh, 1999).

Most employers, particularly small organizations (<20 employees), experience difficulties in providing suitable duties for injured workers (Kenny, 1999), either because they do not know how to modify jobs or because they lack the flexibility to provide alternative placements. Therefore, when occupational therapists recommend that a worker return to his or her previous job with modifications, they should not take it for granted that all employers can provide such facilitation. Occupational therapists are cognizant of job analysis and workplace modifications and can help employers to identify suitable duties for injured workers. Nevertheless, because of workload and personnel constraints in Hong Kong, it is uncommon for Hong Kong occupational therapists to make on-site evaluations to determine whether a work site needs to be modified to enable an injured worker to perform the essential functions of his or her job. In this regard, there is room for future improvement.

In our study, the job-specific FCE protocol was developed in such a way that it consisted of the upper-limb functions essential for different work requirements. Given that all the participants were suffering from a distal radius fracture, for which a definitively identified and pathoanatomical diagnosis was given, the FCE testing could focus on how their physical limitations and functional impairments became barriers that impeded them from performing regular work duties (rather than the primarily pain-mediated disabilities associated with nonspecific conditions). Nevertheless, we adopted a psychophysical testing approach in our job-specific FCE. The assessment results took perceived pain or pain-related fear into account. *Pain-related fear* is increasingly recognized as an important contributor to disability among people, particularly those with chronic pain, because it can lead to an avoidance of activities or situations that are expected to produce pain (Vowles & Gross, 2003).

The results of our study contrast with the finding of Gross and Battie (2006) that the predictive ability of FCE was not clearly better in participants with a distinct pathology, such as a fracture. This discrepancy may be because of the FCE methods and the different testing approaches used in the two studies. In addition, although we had a set of standard testing items in our FCE protocol, the position of the assessment tools and the duration set for testing could be varied from one participant to another. This variation embodied our hypothesis that FCE should be job specific to increase its predictive ability. The predictive validity of an FCE should be reflected in the correct classification of an evaluatee’s prospective employment status according to the assessment results. Within the sample used in this study, a job-specific FCE could be considered a valid tool for predicting the return to previous jobs of participants with a distal radius fracture. This predictive ability, however, will be compounded by some concurrent factors. Our results are consistent with our previous finding that a longer period from injury to FCE and compensable injury reduces the predictive ability of FCE (Cheng & Cheng, 2010). Compensation benefits and delayed management remain the major determinants of work disability (Cheng & Hung, 2007).

The limitations of this study include its reliance on existing administrative databases in which information on

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all the potentially confounding factors was not available. This missing information influenced our selection of potential prognostic factors and outcomes. In addition, all the participants reported their employment status 3 mo after their FCE, but no further follow-up was made. Consequently, it is not known whether their return to work was sustained. Future prospective research design using longitudinal methodology to investigate any change of employment status after evaluation, job sustainability and, particularly, the reason patients did not accept or follow the return-to-work recommendations is highly recommended. Last, the results of this study are generalizable only to settings that use a BTE work simulator as the FCE method, because our testing procedure was job specific and based on a detailed job analysis with each patient.

Conclusion

On the basis of standard testing items in a given FCE protocol, it is possible to develop a job-specific FCE. The results of this study lead to the conclusion that job-specific FCE could have better predictive validity in relation to the employment status of patients with a specific injury than of patients with a nonspecific injury, particularly in terms of determining whether an evaluatee can return to his or her previous job.

Acknowledgments

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