Evaluation and Management of Occupational Low Back Disorders

Eckardt Johanning, MD, MSc

This clinical practice review of occupational low back disorders describes work-related risk factors, occupational history, physical evaluation, clinical tests, diagnosis, care, and prevention. It is part of a quality assurance (QA) and quality improvement (QI) effort to establish exemplary occupational practice standards. It emphasizes the involvement of occupational medicine physicians in exposure assessment, care of injured workers, and disease prevention. Important occupational risk factors such as lifting, awkward body posture and vibration, in addition to psychosocial, socio-economic and other factors are summarized. The focus is on mechanical back disorders. Return-to-work, rehabilitation and prevention strategies are discussed as part of integrated disability management involving the injured worker, the primary care provider, employers and other relevant parties. Am. J. Ind. Med. 37:94–111, 2000. © 2000 Wiley-Liss, Inc

KEY WORDS: low back disorders; occupational medicine; risk factors; lifting; posture; vibration; prevention; quality assurance; quality improvement

INTRODUCTION

Musculoskeletal disorders of the back (LBD) (i.e., low back pain (LBP)) are among the leading causes of occupational injury and disability in industrialized countries. According to the Bureau of Labor Statistics (BLS), disorders related to trauma from repetitive work movements accounted for about 40% of all reported occupational illnesses in US private industry in the late 1980s. More than one million workers suffer from back injuries on the job. In 1993, back disorders accounted for 27% of all nonfatal occupational injuries and illnesses involving sick leave time. About one hundred million work days are lost each year due to back disabilities. LBP disables 5.4 million Americans per year and it is the most frequent reason for filing a workers’ compensation claim. The annual incidence rate is estimated to be around 1–2% [Hashemi et al., 1997].

In 1986, the total compensable cost for LBP in the United States was estimated to be $11.1 billion. The average cost of a worker’s compensation claim for LBP was $8,300, about twice the average cost for all other claims combined. Medical costs account for about 1/3 of the total costs; with the remaining expenditures going to wage and related costs [Webster and Snook, 1994]. In 1993, the cost for the compensation coverage in the US was reported to be approximately $57 billion with about 60% going for wage-replacement alone [Schmulowitz, 1995]. The costliest LBP claims (10%) at a large insurance company in 1992, were responsible for a large percentage of the total costs (86%). Seven percent of the claims with a greater than one year length of disability accounted for 75% of the costs and 84.2% of total disability days [Hashemi et al., 1997]. Episodes of LBP are common. About 85% of the general population develops LBP at least once in their lifetime [Von Korff et al., 1988]. About one third of American workers are employed in jobs that may significantly increase their risk of developing or aggravating back disorders and disabilities. Since 1989, the National Institute for Occupational Safety and Health (NIOSH) has listed musculoskeletal diseases as a leading priority for research and disease prevention efforts in the US. It called particular attention to the need for instituting treatment and preventive research programs.
related to “traumatogen workplace hazards” [NIOSH, 1996].

The Bureau of Labor Statistics (BLS Internet home page: http.bls.gov.oshhome.htm) trend data for 1992–1995 indicate a general decline in injuries and illnesses requiring days away from work. For example, the incidence rate of overexertion (lifting) declined from 52.1 per 10,000 workers in 1992 to 41.1 in 1995. According to NIOSH, there may be several reasons for these declines, including secular trends in reporting injury, socio-economic trends or improvements due to effective prevention and intervention programs [NIOSH, 1997].

Of 127 million active workers, 22.4 million (17.6%) reported ‘back pain for a week or more’ in the 12 months preceding the National Health Interview Survey (NHIS) in 1988. Work-related back pain, caused by injury or repeated activities, accounted for approximately 53% of self-reported causes [Park et al., 1997]. Recent reviews of epidemiology data and workplace factors, including a comprehensive review of musculoskeletal disorders by an expert panel convened by NIOSH, conclude that “strong evidence” exists for the following occupational risk factors: lifting, forceful movement and whole body vibration, and to a lesser degree for heavy physical work and awkward posture [NIOSH, 1997; Burdorf and Sorock, 1997]. Etiologic research has concentrated on identifying and quantitating several personal and work-related factors, as often the exact anatomical cause of LBP cannot be identified [Frymoyer and Gordon, 1989; Riihimäki, 1991]. The prevalence is highest between the ages of 35 and 55 years and there are no significant gender differences. In addition to the above mentioned specific occupational risk factors for back problems, non-work-related risk factors such as smoking, sedentary lifestyles, education and some psychosocial factors are important [Pope et al., 1991; Erdil and Dickerson, 1997]. Gender, height, weight, exercise and marital status, however, appear not to be important factors associated with back disorders in occupational population [Burdorf and Sorock, 1997].

Certain occupations are associated with a high risk of LBD (Table I). Female nurses and nurses’ aides (prevalence = 19%) and maids (15%) were about 2.5 times more likely than other female workers to develop LBD. Male construction workers (23%), carpenters (22%), truck and tractor operators (22%) compared to other male workers were nearly two times more likely to suffer a LBD [Guo et al., 1995; Hales and Bernard, 1996]. The epidemiology, costs to business and identification of high risk jobs or industries have been recently compiled by a Washington State agency. The highest composite incidence rates for work related musculoskeletal injuries (including lower backs) were ‘wallboard installation’ and ‘temporary help’ (24/100 full time workers), followed by roofing (20), moving company (18), garbage collection (15), nursing homes (14) and beer distributors (13) [Washington State Summary, 1996].

The focus of this review is on occupational risk factors, pathogenesis, and assessment of work-related spinal conditions and injuries. It is complementary to the growing numbers of other, more clinically oriented guidelines issued by other professional organizations: Agency for Health Care Policy and Research (AHCPR) [Bigos et al., 1994]; American College of Occupational and Environmental Medicine (ACOEM) [Harris et al., 1997]; Royal College of General Practitioners (RCGP) [Waddell et al., 1996]; National Association of Spine Surgeons (NASS); and American Academy of Orthopedic Surgeons (AAOS) [AAOS, 1991]. The goal is to provide a review of the best practices in the diagnosis, treatment, management, and prevention of occupational low back disorders caused or aggravated by ergonomic stressors and specific work-related risks. This review does not claim to be one of the “generic, all-encompassing guidelines”, which have been recently criticized [Owens, 1998]. Strong emphasis is given to the identification of workplace risk factors for LBD, particularly return to work decision, rehabilitation and prevention strategies. The goal is to optimize the quality of care by developing a model of care which integrates medical care with preventive efforts. Non-occupational back disorders that are part of an infectious process, inflammatory systemic disease, bone cancer, rheumatologic or metabolic disorders or other non-mechanical disorders will not be included in this discussion. The reader interested in these issues should consult more general texts on this topic [for example, Borenstein and Wiesel, 1989; Klippel, 1997]. A further description of these potentially serious “red flag conditions” can be found in the ACOEM Occupational Medicine Guidelines [Harris et al., 1997] or the Royal College of General Practitioners’ LBP review [Waddell et al., 1996].

Primary psychiatric disorders presenting with somatic complaints of LBP among others, are also not the focus of

<table>
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<tr>
<th>TABLE I. Examples of Occupations with a High Risk of Low Back Disorders</th>
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<td>Vehicle operators</td>
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<td>Construction trade</td>
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<td>Service workers</td>
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<td>Agriculture, fishing industry, forestry</td>
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this paper. This guideline should be used by physicians as a guide and does not substitute for individualized case assessment and good medical judgment.

A short summary description of the pathogenesis and the most important workplace factors that are associated with occupational low back disorders will be discussed. The reader should keep in mind that the development of a low back disorder is often of multi-factorial origin and the result of combined or cumulative effects of the factors listed separately (Table II).

### PATHOGENESIS AND OCCUPATIONAL ETIOLOGY OF BACK DISORDERS

The natural history and pathogenesis of LBP and degenerative spinal changes are still not fully understood. Among experts the consensus is that in the majority of cases there is no conclusive knowledge about the exact etiology of LBP. In particular, the correlation among symptoms, clinical findings, and morphological imaging findings is not always consistent. A multitude of symptoms may result from degenerative disease of the spine. Inter-individual variations of subjective and objective findings between patients and observers have been described. However, careful characterization of clinical findings and neurological examination of sensory changes and muscular weakness can aid in localization of a possible morphological/anatomical lesion and assist in the differential diagnosis and treatment. Various work-related and individual causes and mechanisms have been discussed. Genetic predisposition and family history of low back disorders appear to be important predictors. The understanding of the biochemical and biomechanical properties of the vertebra, disc, and ligaments has been broadened with more refined research methods. Many disciplines including bioengineers, basic science researchers, clinicians, and epidemiologists are now involved in the analysis of LBP [Nachemson, 1976; Kelsey and Hochberg, 1988; Pope et al., 1991; Haldeman, 1990; NIOSH, 1997a]. Modern epidemiological research principles have been proposed to improve LBP research methods and clinical tests [Anonymous, 1991; Dempsey et al., 1997], although there are implicit methodological limitations [Park et al., 1997]. Nevertheless, there is growing evidence and consensus among experts that the current knowledge of workplace factors is sufficient to recognize certain occupational back hazards and develop focused prevention strategies.

The causes of LBP may be variably related to the muscular, ligamentous, and skeletal structures of the spine. Degenerative bony growth, disc changes and herniation may lead to spinal cord or nerve root compression, resulting in sciatica or other neurological complications. Pain can arise from an inflammatory or infectious process, or from a tumor, trauma or fracture. There are several rheumatologic conditions, collagen vascular diseases, postural deformities, and, genetic skeletal defects that can affect the structure, function, and symptomatology of the spine. In about half of the cases, the exact etiology of the pain remains unknown [Frymoyer, 1988]. For many patients, physiologic ageing of the spinal elements—the vertebra, discs, and ligaments—is a potential source of back problems. However, this "natural" degenerative process can be accelerated and influenced by external factors in the work environment [Kellgren, 1977; Junghanns, 1979; Borenstein and Wiesel, 1989; Riihimäki, 1991; Boden, 1991; Luoma et al., 1998].

The understanding of the exact relationships between disc metabolism and degeneration and exogenous stress factors is still limited, however, a few hypotheses have been developed about the etiology of "discogenic pain". A cross-sectional study of construction workers reported that progressive degenerative spinal changes were associated with an increased risk of sciatic pain [Riihimäki et al., 1989a, b]. Contributing effects and risk factors of work on degenerative back disease and low back pain syndrome have been described [Luoma et al., 1998]. Spinal degenerative radiological changes can be seen up to ten years prematurely in subjects with risk factors [Wickström, 1978].

### Risk Factor: Lifting and Forceful Movements

In many jobs (construction, nursing homes, hospitals, package and mail handling) heavy or frequent lifting, forceful movements, and carrying of heavy loads complicated by awkward body posture are daily elements of required tasks. If the load is too heavy or the frequency of lifting exceeds the tolerance, acute or chronic injuries (initially, mostly micro-traumata) to the lumbar spine can be the consequence. However, there are no simple and solid

<table>
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<th>Occupational Risk Factors</th>
<th>Other Risk Factors</th>
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<tr>
<td>Heavy lifting and forceful movements</td>
<td>Psychological health (depression and anxiety)</td>
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<tr>
<td>Whole body vibration</td>
<td>Psycho-social status and support (family, friends and work)</td>
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<tr>
<td>Awkward body posture</td>
<td>Socio-economic status and support (income and benefits)</td>
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<td>Job control and satisfaction</td>
<td>Genetics and family history</td>
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<td>Motivation</td>
<td>Attitudes and beliefs about LBP</td>
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<td>Monotonous workload</td>
<td>Age</td>
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**TABLE II. Risk Factors for Low Back Disorders and Pain**
guidelines of how much weight is “too heavy” or how many lifts per hour are “too many”.

The occupational history should focus on these questions: What was the weight of the load? Was there forceful movement of heavy objects? How frequent was the lifting? What was the required (spinal) posture? Was there asymmetrical lifting present? Was the coupling between the object and the worker’s hands sufficient? Were there adequate rest periods? Was the worker physically fit? Were special climatic challenges (cold temperature) present? Were lifting devices or tables available and utilized? Did the worker have any pre-existing back conditions or other diseases limiting the lifting capacity? Prior to the lifting task, was the worker (driver) exposed for longer time periods to vibration and shocks in a vehicle? Was a “back belt” used, which may have given the worker a false sense of safety?

The risk of lifting-related LBP increases as the demands (force and frequency) of the lifting task increase. The evaluating physician should consider biomechanical, physiological and psychophysical limiting factors of lifting [Herrin et al., 1986; NIOSH, 1994a]. A job may be considered hazardous if the imposed loads (forces) exceed the individual’s strength and endurance/tolerance, i.e., lifting of heavy loads may only be tolerated for very short time or frequent lifting may only be tolerated for light loads. (Fatigue effects may follow the Miner–Palmgreen’s rule.) [Miner, 1945].

A lifting formula (equation), a multiplicative model with six task variables has been proposed by NIOSH to protect “healthy workers”, although it is noted that many scientific uncertainties remain. The earlier NIOSH lifting equation from 1981 is based on a static biomechanical model assuming compressive forces (measured in Newtons) on soft tissue structures (disc) caused by lifting tasks at the disc level of L5/S1. The revised 1993 lifting equation, using an integrated assessment (assuming dynamic lifting model), provides methods for the evaluation of asymmetrical lifting tasks, lifting of objects with other than optimal hand-container coupling, and longer work duration, and lifting frequencies than the 1981 equation [Waters et al., 1993; NIOSH, 1994a]. Personal, environmental, and job-related risk factors for manual material handling injuries have been summarized [Simonton, 1996; Waters and Putz-Anderson, 1997]. Table III lists important risk factors associated with manual material handling injuries. The NIOSH 1993 lifting equation provides a basis for the identification of hazardous lifting jobs with the ‘lifting index’ [Waters et al., 1993]. An updated guidance on design of safe lifting has been recently published by NIOSH (www.cdc.gov/niosh/lifting1.html). NIOSH/CDC now has more than 80 documents about “lifting” ergonomic studies, programs, facts and prevention information on their web-site (www.search.cdc.gov enter search term: “lifting”). A variety of other assessment tools have been used in ergonomic research, such as computerized ergonomic lifting evaluation programs or video monitoring of lifting movements. However, these tools are not widely utilized in industry. A list of software sources has also been published by NIOSH on the Internet (www.cdc.gov/niosh/lifting1.html). Some of these computer models are rather complex, although more detailed biomechanical data can be obtained; i.e., the model for three-dimensional biomechanical data and electromyographic data from back muscles to estimate the internal loading of the spine [Marras and Sommerich, 1991]. For further information on the assessment of lifting demands and material handling, the respective literature should be reviewed [Eastman Kodak Company, 1986; Ayoub and Mital, 1989]. Specific weight limit lifting numbers and tables cannot be listed here in this context and the interested

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<th>TABLE III. Risk Factors Associated with Manual Material Handling Injuries</th>
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<td><strong>Individual—social factors</strong></td>
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<td>Gender</td>
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<td>Age</td>
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<td>Genetics/family history</td>
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<td>Body weight/height</td>
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<td>Fitness/fatigue</td>
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<td>Medical problems</td>
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<td>Smoking, lifestyle</td>
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<td>Psycho-social</td>
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<td>Socio-economic status</td>
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<td>Benefits/contractual arrangements</td>
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| Sagittal lifting angle |

| Bad coupling (contact/distance of object from workers’ hands) | | |

| Good coupling (contact/distance of object to workers’ hands) | | |

| High coupling (contact/distance of object outside workers’ hands) | | |
Risk Factor: Awkward Body Posture

Repetitive or static awkward body posture resulting from excessive bending (forward and lateral) and twisting (trunk rotation or torsion) will increase the spinal stress and disproportionate loading of spinal structures. Work in forced, extreme body posture can lead to temporary or chronic spinal postural defects and neurological compression syndromes. Back stress from lifting tasks can be complicated and vibration effects can be aggravated if the spine is in an awkward posture. Risk is likely to be increased with the speed of the trunk motion and the deviation from the normal (neutral) spinal posture as well as the intensity and duration of the exposure. Rapid twisting can generate shear or rotational forces on the lower back resulting in the normal (neutral) spinal posture as well as the intensity and duration of the exposure. Risk is likely to be increased with the speed of the trunk motion and the deviation from the normal (neutral) spinal posture as well as the intensity and duration of the exposure. Rapid twisting can generate shear or rotational forces on the lower back resulting in

Risk Factor: Vibration

Whole-body vibration (WBV) is an important risk factor for occupational lower back disorders and has been recently recognized by a NIOSH expert panel to have strong epidemiologic evidence [NIOSH, 1997a]. It will be discussed in more detail here, because it has not been adequately described in many standard text books. Back problems related to WBV were first reported in 1939 in a German medical journal; the paper compared seated and standing vehicle operators [Müller, 1939]. Since that time many studies looked at the relationship of acute vs. prolonged WBV and back responses (primarily in the vertical direction). In the United States, the published medical research in this area commenced in the 1970s. To date there have been no specific vibration standards or threshold limit regulations in the US, except for a general recommendation to lower vibration if possible. There is agreement among international investigators that long-term WBV stemming from engines and vehicles is an important mechanical stressor contributing to early and accelerated degenerative spine diseases, leading to back pain and prolapsed discs [Heide, 1977; Dupuis and Zerlett, 1986, 1987; Hulshof and van Zanten, 1987; Kelsey and Hardy, 1975; Wilder et al., 1982; Seidel and Heide, 1986; Griffin, 1990; Boshuizen et al., 1990, 1991; Bovenzi and Hulshof, 1998]. Poor body posture, inadequate seat support and muscle fatigue have been described as cofactors in the pathogenesis of musculoskeletal disorders of the spine in operators/drivers [Troup, 1978; Sandover, 1981; Griffin, 1990; Dupuis and Zerlett, 1986]. High prevalence of back pain, early degenerative changes of the spine and herniated lumbar disc problems have been consistently reported among vibration-exposed occupational groups, i.e. tractor drivers, truckers and interstate bus drivers, crane or earth moving equipment operators and helicopter pilots. The rate of back complaints and degenerative spinal changes seen on plain film is very high (50–80%) [Spear et al., 1976; Gruber and Ziperman, 1974; Gruber, 1977; Heliovaara et al., 1987a; Heliovaara, 1987b; Dupuis and Zerlett, 1986, 1987; Griffin, 1990; IVSS, 1989; Miyashita et al., 1992; Bovenzi, 1996]. Also among operators of rail-vehicles (railroad and subway trains) with relatively low vertical but high lateral vibration, the prevalence of back disorders is high [Haas et al., 1989; Hanunkari et al., 1977, 1978; Netterstrom et al., 1983; Arnautova-Bulat, 1979; Johanning, 1991a; Johanning et al., 1991b]. The highest levels of vertical vibration were measured in off-road vehicles and forklifts [Johanning et al., 1997a]. For a comparison of vibration levels see Figure 1.

LBP has been reported by professional drivers long before conventional plain film x-rays were able to detect degenerative changes such as spondylolisthesis, osteo-spondylosis, osteochondrosis, and spondylothesis. This poor correlation has been well documented in pathological examinations of cadaver specimens [Vernon-Roberts and Pirie, 1977; Junghanns 1979; Seidel and Heide, 1986]. A consistent temporal relationship between vibration exposure and back disease has been found, although a clear dose–response relationship often cannot be firmly demonstrated [Dupuis and Zerlett, 1986; Griffin, 1990; Boshuizen et al., 1990; Bovenzi and Hulshof, 1998]. This inability to show a
The dose–response relationship may be due to inadequate technical exposure assessment, insensitive measurement tools and confounding epidemiological risk factors.

Two principal pathological mechanisms of vertebral damage due to vibration loads have been suggested. First, induction of micro-fractures at the end-plates, with callus formation during healing and the altered disc dimension under the load, may reduce the rate of nutrient diffusion. Second, vibration-induced mechanical overload, causing continuous compression and stretching of the spinal structures, may result in tissue fatigue [Sandover, 1981; Dupuis and Zerlett, 1986; Frymoyer and Gordon, 1989].

LBP and back injuries appear to be particularly common among seated vehicle operators. In a seated position the disk pressures are higher and the changes in the spinal motion segments result in a disengagement of the facets. Spinal muscle fatigue caused by prolonged vibration exposure has been described, which can increase the adverse effect of transmitted vibration [Seidel et al., 1988].

WBV exposure measurements of particular vehicles have in the past often not been readily available. Nowadays, the instrumentation for vibration measurement has been simplified with modern computer technology and the experienced industrial hygienist or engineer should be able to provide this information at a reasonable cost. In most cases it will be sufficient for the physician to rely on published exposure data and tables or data banks [Johanning et al., 1997a]. Some of the WBV data are available on the Internet (www.umetech.niwl.se/VibBases). Typically, off-road vehicles, heavy equipment and construction vehicles are producing potentially hazardous high levels of vibrations and shocks (Fig. 1). A total occupational WBV-exposure dose is calculated by the product of vibration exposure level (weighted acceleration for 8 h/working day) times the actual exposure duration (years of employment). Generally, an excessive health risk can be assumed if the ISO (2631-1) 1996 “safe” exposure values are exceeded during more than 10 years of employment [Johanning et al., 1997a].

**FIGURE 1.** Vibration exposure values of road and off-road vehicles. (Please note that the proposed European Communities “action level (AL) is set at $A(8) = 0.5 \text{ ms}^{-2}$ and the “exposure limit value” is established at $A(8) = 0.7 \text{ ms}^{-2}$). (From ISSA/Christ1989, with permission)
Other Factors

There is an increasing body of evidence that several non-work related factors such as age, gender, anthropometric, genetic and psycho-social factors have an influence on the presentation, clinical outcomes of LBDs, and behavioral responses of the injured workers. Several studies have been reviewed in further detail in the recently published NIOSH document [NIOSH, 1997a] and other reviews [Burdorf and Sorock, 1997]. Some authors even propose that individual psychological and motivational factors are more important predictors of disability outcomes or even that overly generous medical leave benefits may adversely affect a rapid and successful reintegration of an injured worker. Although there are significant methodological differences and inconsistencies between studies, the definitions of study outcomes, study population and socio-economical status of workers, the following important “non-physical” factors influencing clinical presentations and illness related behavior have been identified: monotonous work, perception of intensified workloads, limited job control and job satisfaction, low job clarity and low social support.

The psycho-social factors may influence the clinical presentation and development of LBD in four principal ways [Bongers et al., 1993; Sauter and Swanson, 1995]; psycho-social demands may increase muscle tension causing exacerbation of biomechanical strain which would influence awareness leading to reporting or perception of causality. An initial episode of pain caused by a physical condition may trigger a nervous system dysfunction (chronic pain syndrome) because of an underlying psychosomatic interaction. In some work situations, changes in both, the psycho-social and biomechanical demands, may result in effect-modifying changes and changes in causal associations. Several studies have shown a clear relationship of measures of psychological dysfunction and self-reported low back pain. However, since many of these studies are of cross-sectional design, the temporal relationship remains unclear.

In many studies that focus primarily on psychological factors, the workplace ergonomic factors and physical stressors are often not sufficiently assessed to adequately address the interaction. Psycho-social factors may represent generalized risk factors for the development of work-related LBP as well as they do for other diseases. Physical workload and psycho-social factors may be simultaneously and independently associated with LBD. However, in a study of transit workers physical workloads remained the strongest factor associated with LBP after adjustment of organizational and psycho-social factors [Krause et al., 1997a]. Nevertheless, the clinician should routinely investigate possible psycho-social and work-organizational factors that may be influencing the management of the patient.

THE CLINICAL EXAMINATION OF WORKERS WITH LOW BACK COMPLAINTS

A primary goal of the initial evaluation is to distinguish low back pain/strain, which is generally self-limited and is not associated with neurological dysfunction, from disorders of the lower back which are associated with neurological signs and symptoms. This evaluation should include an investigation of signs and symptoms of spinal abnormalities and movement dysfunctions, especially of the lower back, utilizing standardized approaches and tests, i.e., the clinical evaluations further reviewed by NIOSH [1992], Nelson [1991], Borenstein and Wiesel [1989], Erdil and Dickerson [1997] or Viikari-Juntura et al. [1998]. In general, the diagnostic accuracy and reliability of functional assessments and measurements can differ considerably between test methods, examiners, and even between subsequent exams of the same patient [Leclaire et al., 1996; Chen et al., 1997]. However, in a cooperative patient and with an experienced examiner, the following proposed tests are useful to adequately assess and describe spinal deformity, motion restrictions or painful abnormalities in order to establish a diagnosis and clinical treatment decisions. The major diagnostic categories of mechanical spinal disorders are described:

Low Back Pain and Strain (“Simple Low Back Pain”)

Key: Very common muscular–ligamental disorder, soft tissue injury, strain and mechanism, localized symptoms, no neurological deficits, no laboratory or imaging abnormalities.

Disc Herniation

Key: Back pain is very common with more than 90% occurring at the lower three lumbar discs; most frequent is postero-lateral herniation. Peak occurrence is in workers 30–55 years of age. The onset may be acute, subacute or due to chronic microtrauma. Often a single nerve root is involved. Physical findings: positive straight leg raising (AHCPR), muscle weakness, sensory or motor nerve defects, decreased or absent reflexes; imaging tests (MRI, CT-scan) are positive. Less than 1% of patients may present with cauda-equina syndrome, a major, acute compression problem caused by large tumors. Medial disc herniation results in findings of motor and sensory polyradiculopathy. Check for incontinence and decreased anal sphincter tone. An urgent ER/surgical referral may be necessary!
**Spinal Osteoarthritis (Degenerative Joint Disease (DJD))**

Key: In occupational spinal disease, there is a relatively accelerated and increased level of degeneration (especially in workers less than 45–50 years of age), although prevalence normally increases with age. Discs, facet joints, and vertebrae are affected. Osteophytes on plain x-ray. May result in spinal stenosis. Symptoms vary among patients.

**Spinal Stenosis**

Key: Any form of spinal canal narrowing except that caused by tumors, complete disc herniation or spondylitis. Pain with standing and walking.

**Facet Syndrome**

Key: Facet joint with nerve innervation resulting in localized pain, pain triggered in hyperlordosis and relieved with forward bending, working above shoulder level.

**Spondylosis and Spondylolisthesis**

Key: Forward subluxation of L5 vertebra, present in about 5% of asymptomatic patients, the symptoms depend on the degree of spinal malalignment; pain is increased with activity. It is a risk factor for other back injuries; x-ray is diagnostic. Most common at level L5/S1.

These conditions need to be distinguished from “systemic diseases” affecting the spine, such as cancer, infections, vascular disease, hip disorders, endocrinologic and inflammatory rheumatologic diseases or visceral disorders (urologic, gynecologic, or intestinal). Depression and other primary psychiatric disorders may also present with back complaints. Serious types of back problems (So-called “red flag conditions”) that need to be rapidly recognized for urgent medical intervention that may be necessary, are listed in Table IV.

A complete clinical examination should include the following elements:

**Interview**

Obtain a complete occupational and medical history. A standard format can be useful to collect information on demographics, work history/previous employments and risk factors for back disease, personal habits and behavior (smoking, sports), medication, medical/surgical and family history, psychological history, previous musculoskeletal diseases or developmental deformities. Further, the work status, previous compensation claims and injuries, pending legal actions and benefit arrangements should be ascertained. Special emphasis should be placed on type, characterization, onset/frequency/duration, aggravating/alleviating factors, and location/radiation of reported back pain. Previous response to treatment and work modification should be explored. The subjects may be asked to fill in a standardized questionnaire (i.e., “University of Vermont Low Back Pain Questionnaire” or CORE Network LBP Medical Screening questionnaire) which contain written questions addressing the above topics (NASS, Oswestry, SF-36) [Bowling et al., 1997]. Also useful are pain scales and ‘pain diagrams’, in which the patient indicates on a body chart diagram the area of pain and other abnormalities. This should be reviewed after completion by the examining physician.

Based on the patients’ history, complaints can be defined in three categories as acute (less than two to six weeks’ duration), subacute and chronic (more than three months’ duration) LBP. Subcategories may include: localized lumbar pain, lumbar pain with pain radiating into the thigh, and LBP radiating below the knee (nerve root irritation) [Quebec Task Force on Spinal Disorders, 1987; Atlas et al., 1996].

**Medical Examination**

The physical examination should include assessment of the vital signs, general organ description and examination (skin, head/neck, lymph, lungs, heart, abdomen, extremities, vessels, bone/muscle). The examination (inspection, palpation, percussion and functional assessment) of the spine (neck, upper and lower back) should be performed with the subject in standing, seated, and prone positions. The neurological examination of the spine and extremities should include: tests of reflexes, sensory and motor functions, muscle strength, nerve root inflammation, such as dural tension signs and straight leg raise test or Lasègue test. (This test is positive if reproduction of patient’s radicular symptomatology occurs with a straight leg elevation in the critical range between 30–70°). Functional tests and instruments are described by Nelson, [1991], NIOSH [1992], and Biering-Sørensen [1984]. A series of positive so-called “Waddell signs” should prompt the examiner to investigate psychological problems or psychosomatic disorders. Specifics and illustrations of some of the tests listed below can be found in Borenstein and Wiesel [1989], Nelson, [1991], and Erdil and Dickerson [1997].

**Standing**

Posture (kyphosis, scoliosis, scapula/shoulder and pelvic abnormalities/deformities).

Neck and lower back range of motion (ROM) measurements (flexion, extension and lateral flexion, rotation).

Inspection of lumbar lordosis and position of iliac crest (anterior/posterior).
Schober Test (Expansion measurement of curvature at level S1 from erect to forward flexion: normal >2 inches).

Finger-floor distance in standing/bent-forward position (inches).

Sitting
- Lumbar lordosis (erect and slouched sitting).

Prone
- Hip range of motion, sustained extension in lying (press up symptom change).
- Isometric endurance of the back muscles.

Supine
- Single and double straight leg raising (a nerve root tension/inflammation test) [Boden, 1991], hamstring length.
- Waddell’s Tests

Evaluation of non-organic pain behavior (test is “positive” if three out of five screening tests are “positive”: non-organic tenderness, axial loading and lumbar rotation simulation, distraction tests, regional disturbance, overreaction).

**Instrumentation**
- Measuring tape, some flexible rulers, goniometer, iliac crest level testers.

**Diagnostic Tests**

**Laboratory Tests**

The measurement of the erythrocyte sedimentation rate (ESR) is an economical, quick, and sensitive method to screen for inflammatory, infectious, and malignant back
problems (ESR elevated) and can assist in the differential diagnosis of degenerative (spondylosis) back disorders or musculo-ligamentous strain/sprain conditions (ESR normal) in most cases. A variety of other specific rheumatologic laboratory tests (i.e., rheumatoid factor, C-reactive protein, uric acid, alkaline phosphatase (AP) or antibody titers) may be indicated by the patient’s history and findings in the examination [Klippel et al., 1997; Borenstein and Wiesel, 1989; Dearborn and Jergesen, 1996; Callegari and Williams, 1995]. Laboratory tests should be used primarily as supplementary information for as in most cases, the diagnosis is a clinical one.

**Radiographic evaluation**

Plain film x-rays are not sufficiently sensitive and specific to detect occupational back disorders of interest, particularly in the early phases of soft-tissue or bony degenerative changes. X-rays should not be used for a “routine” initial work-up, unless a “red flag condition” (Table IV) is suspected (fracture, infection, tumor) and possibly in combination with a CBC and ESR. LBP is often present even in the absence of changes recognized on conventional plain x-ray films, and some changes may be demonstrable with more sensitive imaging techniques in persons without pain. The associated radiation exposure with x-ray, particularly in the pelvic region, is not justified. Plain x-ray films may be helpful to study clinically significant malalignment of the spine (scoliosis, spondyloolisthesis).

Imaging techniques with higher resolution and superior sensitivity or specificity such as magnetic resonance imaging (MRI) or computed tomography (CT) are indicated in individuals with a possible disc herniation or spinal stenosis. These tests may also be indicated if the examiner is considering the need for surgery or if the initial conservative treatment (approximately six weeks) has failed. CT or MRI is not necessary for patients with uncomplicated acute LBP. Modern MRI is thought to be superior or equivalent to other conventional techniques in showing changes in soft-tissue structures, particularly of the discs and its surrounding structure [Eyre, 1989; Kricun, 1988; Stoller and Genant, 1990; Boden et al., 1990; Boden and Wiesel, 1990; Modic et al., 1989; Maravilla and Cohen, 1991]. MR signal intensity seems to correlate well with biochemical changes of the ageing disc [Pearce et al., 1991], especially in younger age groups with minimal age-related degeneration [Tettii et al., 1991]. MRI is non-invasive, it does not involve radiation risk, intrathecal or allergenic contrast material and no significant safety risk for the patient have been detected [Kanal et al., 1990]. Indeed, MR imaging is considered by many as the method of choice in the detection of lumbar disc herniation, with a sensitivity of 89% and specificity of 82% [Masaryk et al., 1988].

In a recent study, 20–36% of a limited number of studied subjects without any subjective back problems were found to have “significant HNP”. It remained unclear, however, why some disc herniations were asymptomatic; morphological spinal changes (narrowing of the spinal canal) may be relevant [Boden et al., 1990]. CT appears to better identify bony structural abnormalities associated with LBP. Either CT or MR imaging is indicated if urgent conditions such as cauda equina, tumor, infections or a fracture is clinically suspected.

**Electrophysiologic Evaluation**

If the patient’s history (leg symptoms regardless of LBP) and neurological exam suggest signs of significant nerve-compression (radiculopathy) or if nerve root dysfunction lasts more than three to four weeks, nerve-conduction velocity/electromyography study (NCS/EMG), H-reflex or sensory evoked potentials (SEPs) may be useful to study the degree or location of the involved nerve-root, disc protrusion, spinal stenosis (cord problem) or muscle involvement. Preferably both legs should be studied for comparison. In the early phase, negative results are possible. Some examiners consider electrophysiologic tests unnecessary to confirm the presence of clinically present radiculopathy. The methodological limitations of these methods have been discussed elsewhere in more detail [Andersson et al., 1996]. However, in some situations the requirements for workers’ compensation documentation may make these tests necessary.

**Other Tests**

Discography and myelography are neither recommended nor necessary in most ambulatory cases of LBP [Bigos et al., 1994]. Thermography is not generally used, because its clinical reliability is not acceptable. Bone scan may be useful if spinal tumors, infections, or fractures are suspected. Radiological tests are generally contraindicated during pregnancy.

**TREATMENT OF OCCUPATIONAL BACK DISORDERS**

In many cases, the clinical care of patients with acute and simple low back problems seen by the occupational health physician should follow current medical consensus guidelines, such as the *Acute Low Back Problems in Adults* published by the Agency for Health Care Policy and the Royal College of General Practitioners (RCGP) [Bigos et al., 1994; Harris, 1997a; Waddell et al., 1996]. Clinical treatment and management of adult patients with acute or chronic occupationally related low back disorders may include any or a combination of the following modalities,
depending on the patient’s history, the clinical findings and the physician’s training and experience:

- Health education (symptoms, findings, prognosis, psychological–behavioral aspects).
- Analgesics, i.e., acetaminophen, acetaminophen with codeine, non-steroidal anti-inflammatory drugs (consider: adverse drug reactions and significant side effects; may interfere with safe machine operation and vehicle control).
- Muscle relaxation medications effectively reduce LBP (cyclobenzaprine, limited use of diazepam (note of caution: dependency (i.e., more than one week)); adverse drug reactions and significant side effects: may interfere with safe machine operation and vehicle control).
- Back pain with sciatica may respond to epidural steroid injections.
- Short periods of rest (up to four days), if early mobilization and light or normal activity is not tolerated; schedule re-examination after seven days for return-to-work (RTW) or “release to normal activity” determination. Prolonged bed rest is generally not recommended for acute and recurrent LBP, disc prolapse, or nerve root pain.
- Early and minimal regular physical activity as per MD instruction.
- Physical therapy [Bowling et al., 1997] for pain control, strength, endurance, and ROM.
- Spinal manipulation (not for nerve root pain) and hydrotherapy.
- Conditioning exercises (i.e., hydrotherapy with swimming) and ‘back school’ [Deyo, 1987, White, 1992, Waddell et al., 1996], McKenzie exercise (for acute LBP) [Simonsen, 1998], start exercise programs before six weeks.
- Activity modification (avoidance of lifting, prolonged sitting, postural stress, vibration); if lifting, keep close to body, do not exceed 10–15 lbs. until symptoms resolve.
- Work place modification (lifting devices, tables, transporters, suspension-ergonomic seats with good lumbar support, frequent changes of body position, avoid prolonged sitting and alternate with standing position and work on an elevated table, i.e., “old teacher’s podium”).
- Lumbar corsets and support belts appear not effective for acute LBP treatment.

Psychosocial factors and socio-economic factors are important risk factors for chronicity and treatment response. Psychological support and expedited case management will positively influence medical symptoms and signs. Issues such as treatment with physical therapy, manipulation, exercise, and functional capacity evaluations as well as impairment ratings are discussed in a recent “Occupational Medicine—State of the Art Review” [Malanga, 1998].

The RCGP concludes that there is evidence against the following treatments: benzodiazepines and narcotics for more than two weeks; colchicine; systemic steroids; bed rest with traction; manipulation under general anesthesia; and plaster jacket [Waddell et al., 1996]. In cases of serious and complicated neurologic–orthopedic injuries and red flag conditions such as cauda equina, a specialty consultation should be considered and urgent follow up by orthopedic, neurology, and/or neurosurgery specialists should be coordinated.

The Quebec Task Force classification system was reported to be strongly associated with the severity of symptoms and the probability of subsequent surgical treatment [Atlas et al., 1996]. A consensus summary on the diagnosis and treatment of lumbar disc herniation has recently been published. Combining the results of history and physical findings increases the predictive value of diagnostic tests. Confirmatory tests are needed for definite diagnosis and treatment outcome assessment [Andersson et al., 1996]. Factors such as the patients’ age, general health, significant co-morbidity and co-exposures (ergonomic stress, chemicals or physical agents) need to be considered. In any case, certainly smoking should be discouraged. The principles of the American with Disabilities Act (ADA) need to be considered by the physician in the treatment and return-to-work plans [Blanck, 1995].

Comprehensive care of injured workers includes the coordination of care with the primary physician, the referral specialists, and insurance or health plans. In addition, potential disability-related psycho-social or economic problems may need the attention of a social worker and paper documentation. The occupational health physician should aid the patient in obtaining entitled benefits, complete claim forms and assist the patients’ legal representatives by providing the medical evidence and commenting on the causal relationship as required by the respective compensation boards.

**PREVENTION**

The prevention of back injuries and identification of risk factors is an important task, if not duty, for the occupational health physician. Control of exposure and risk can include administrative, organizational, and ergonomic changes. It may be necessary and beneficial to alternate work duties, limit daily exposure, request a complete medical removal. Medical monitoring of workers with a pre-existing history of back problems (high predictor value) is prudent. The use of a pre-employment plain x-ray is not a useful predictor of future back problems [Himmelstein and Andersson, 1988]. The patient should be educated about the
previously described occupational risk factors for back injuries. A workplace ergonomic evaluation and, if necessary, intervention should be attempted by the occupational health specialist in cooperation with the employer, their health and safety specialists, and preferably the union safety representative. Participatory approaches involving employees and employer representatives appear to be successful and foster compliance and acceptance [Johanning et al., 1996; Johanning, 1998; Krause et al., 1997b].

Industrial uses of ‘back belts’ have not been sufficiently validated to be appropriate and effective in preventing or treating occupational back disorders and are not recommended by independent public health groups [NIOSH, 1994b, 1997b]. Risk reduction guidelines and examples for better lifting techniques have been published for use by workers and health and safety specialists [Simonton, 1996]. In a controlled trial, no long-term benefits associated with an educational lifting and handling program and training in a large governmental agency (US Postal Service) was found [Daltroy et al., 1997]. Focused exercise programs and training of injured workers before return to work (RTW) may be more beneficial, because the motivation and awareness of workers with LBP may be different. Also, behavioral programs without improvement of work conditions and technical back risk control appear not sufficient in the prevention of occupational low back disorders.

Example: Prevention of Whole Body Vibration Hazards and Low Back Disorders

Patients with back disorders should be fully educated about the hazards and prevention approaches of intense whole body vibration (WBV) and other possibly harmful activities (such as prolonged unsupported sitting, heavy lifting, back twisting or bending, competitive or motorized sports). WBV exposure can effectively be attenuated through better vehicle and operator seat design. Modern suspension seats are commercially available for many applications (consult author). Updated WBV exposure assessment guidelines have been published by the International Organization of Standardization in ISO/DIS 2631-1.2 [ISO, 1996]. Medical surveillance of vibration exposed workers and intervention will be necessary in addition to improved engineering of vehicles [Johanning et al., 1997a; Johanning and Christ, 1997b; Johanning, 1997c]. Elements and benefits of such a comprehensive approach in one large metropolitan transportation service agency has been recently described [Johanning, 1998].

Every employee with occupational WBV exposure above the proposed action limit (AL) of $A(8) = 0.5 \text{ m/s}^2$ (see Figure 1) should have pre-placement and periodic follow-up physical examinations, with special emphasis on back problems. The medical evaluation should be conducted by a qualified occupational physician. Possible contraindications and risk factors for high and prolonged WBV exposure are: accelerated degenerative spinal pathology, progressive herniated disc disorder, active inflammatory spinal disease, history of pre-existing chronic LBP, certain congenital or acquired spinal deformity and malalignment, spinal surgery and vertebra fracture, chronic gastritis, peptic ulcer disease, and pregnancy. Workers need to be educated about WBV risks, the signs and symptoms of vibration related disease, and ways to lessen exposure, such as technical measures to reduce vibration at the source or reduce transmission by well adjusted (i.e., weight adjusted) suspension seats.

Another important factor—often overlooked—is the operator’s machine control behavior or vehicle driving proficiencies (speed and “driving style”). Reduced work schedules, avoidance of heavy and forceful lifting after prolonged vehicle operations (because the back will be fatigued and weakened) as well as avoidance of awkward body postures are helpful for protection from vibration. Engineering controls, administrative measures and medical surveillance can be successful to eliminate or if not, at least reduce vibration hazards to workers. “Occupational work-hardening” for WBV exposed workers is not protective and should not be employed [Wasserman et al., 1997; Johanning, 1997c]. Vibration exposure data should be reported by all vehicles or machine manufacturers using vibration safety data sheets (VSDS), similar to material safety data sheets. Health warnings should be issued, if the seat exposure levels are in excess of $a_{eq} > 0.5 \text{ m/s}^2$. This provision is currently implemented in the European Union based on the Machine Directive [EEC, 1989; EEC, 1991; EU, 1993]. With respect to WBV, an eight hour exposure limit (EL) of 0.7 m/s² has been proposed by the European Commission, which may be used as a guideline in the US [EU 1993].

RETURN TO WORK

One of the important treatment goals should be the carefully guided return-to-work (RTW) of the patient with a low back disorder. RTW is the goal only under conditions where re-injury will not likely occur. Often, it will require the cooperation and coordination of many non-medical parties and the health care-providers. Many factors have been identified that have a strong influence on the success rate of RTW outcome and the chronicity of LBP (Table V). A recent review of the studies about accelerated RTW and modified work programs showed positive effects in most cases in the reduction of long-term disability. However, many RTW studies had methodological weaknesses and comprehensive epidemiological data is lacking [Krause et al., 1997b]. Some companies offer “modified” or so-called “light-duty work programs” to their employees, which can expedite a RTW process. A well-planned RTW
decision for an injured worker should incorporate a risk assessment and a control of hazardous job tasks or conditions to prevent re-injury and continued harm. Work restrictions or modifications (“light duty requests”) should be written as specifically as possible to facilitate compliance and reduce misinterpretation. Employers with so-called “light duty programs” may be better able to accept or accommodate workers with specific work-duty restriction or workers who have not fully recuperated. Under the Americans with Disabilities Act (ADA, 42 U.S.C.A. 12101 et seq., 1990) the employer has some legal responsibility to accommodate a worker with a disability (i.e., chronic back injury related physical impairment); for a more detailed discussion on this, see Noonan [1997].

Some form of guided light “aerobic” exercise and especially hydrotherapy are generally beneficial for improved pain control and early conditioning. (The patient should be given specific written instructions). Various treatment modalities and the success of RTW as a “hard endpoint” of outcomes have been reviewed and the results are mixed. Additional controlled prospective studies have been called for to assess effectiveness, benefits and functional restoration following modern epidemiologic methods [Teasell and Harth, 1996; Scheer et al., 1995, 1996, 1997; Krause et al., 1997b]. Functional restoration is a recognized rehabilitation approach that has been successfully applied to a variety of neurological spinal diseases. However, for chronic LBP, the significance of long-term improvement as measured by the RTW success remains controversial. Formal, repeated quantification of physical status and training improvement, psycho-social and socio-economic behavior assessment, physical conditioning and interdisciplinary, medically-directed team approach are all important elements of the functional restoration (FR) program [Teasell and Harth, 1996]. In a review of four thousand English articles published between 1975–1993 concerning randomized controlled trials in industrial LBP, the authors concluded that only 35 met their stringent review criteria (Part 1: Acute Intervention. Part 2: Discogenic low back pain. Parts: Subacute/Chronic Pain Intervention) [Scheer et al., 1996, 1997].

Although RTW is influenced by a combination of social, socio-economic and job-related decisions, physical symptom severity will probably be the most important factor in the actual decision of RTW. Therefore, the medical treatment options and success will be crucial in order to shorten the sick leave time (disability) and improve the probability of RTW. For the “non-neurological” LBP patient, short bed-rest (1–3 days) and generalized aerobic and flexibility approaches for long-term prevention of acute episodes appear to be warranted. Data for back-school programs, simple back exercises and “spinal manipulation” appear insufficient to show efficacy [Scheer et al., 1996]. Non-surgical intervention for subacute and chronic LBP, including multidisciplinary pain clinics, exercise, and cognitive-behavioral strategies appear to have some value, but methodological problems and limitations of the studies make it difficult to assess the long-term effects [Scheer et al., 1997]. Another study found FR to be effective for chronic LBP rehabilitation, but cautioned that other statistical variations may be important factors in the results of the different studies [Bendix et al., 1998]. RTW success in chronic LBP patients may be improved with better pain reduction, improved strength and endurance, and better psychological health and life satisfaction. Keep also in mind that the work capacity changes with gender, age, and for any worker putting in overtime.

An intervention study of public transit workers which was jointly sponsored by the labor and management, showed that the absenteeism and reported prevalence of back disorders could be significantly reduced through a comprehensive approach [Johanning et al., 1996]. The multi-disciplinary intervention included changes of the working conditions and the illness behavior of a vehicle operator, through exposure reduction, ergonomic improvements and a psychological—physical therapy program. The majority of published intervention studies and reviews have not adequately looked at the above described occupational risk factors (lifting, posture, and vibration) for back disorders and their influence on workers’ “job stress”. Often the focus was primarily on the medical intervention. Many of the current medical guidelines are not addressing

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**TABLE V.** Delayed Return-to-Work (RTW) Factors and Risk Factors for LBP Chronicity

<table>
<thead>
<tr>
<th>Factor</th>
<th>Factor</th>
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<tbody>
<tr>
<td>Job demands, control and satisfaction</td>
<td>Previous history of LBP</td>
</tr>
<tr>
<td>Employer/employee motivation/practice</td>
<td>Total work loss in past twelve months (LBP related)</td>
</tr>
<tr>
<td>Employee age</td>
<td>Radiating leg pain, nerve root involvement</td>
</tr>
<tr>
<td>Benefit structure/disability case management</td>
<td>Reduced trunk muscle strength and endurance</td>
</tr>
<tr>
<td>Contractual labor—management arrangement</td>
<td>Poor physical fitness</td>
</tr>
<tr>
<td>Insurance carrier case management problems</td>
<td>Heavy smoking</td>
</tr>
<tr>
<td>Adversarial medico-legal (worker’s compensation) relationship and management</td>
<td>Psychological complications</td>
</tr>
</tbody>
</table>

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the workplace conditions, but rather concentrating on individual patient issues, and managerial and technical/medical approaches. The reintegration of workers having a back injury will depend on many factors, some of which may be controlled by the treating physician, including some behavioral factors [Gillette, 1996]. Others depend on cooperative employers (are “modified” or “light” duty jobs available?), insurers and health plans, existence of health and safety representatives, functioning labor and management communication and “good relationships” among patients, doctors, labor and management representatives.

There now appears to be increased pressure on medical providers by some managed-care programs or industries to send patients with LBDs back to work as quickly as possible. Some companies are using “daily patient call programs” or special back-injury RTW programs utilizing in-house health providers to expedite the RTW. Although rapid and timely RTW is an important treatment goal, the treating occupational physician should make his RTW decision primarily based on the patient’s safety and health interest. Physicians should follow accepted professional and ethical principles of good medical practice and respect peer guidelines [Teichman and Wester, 1994; Brodkin et al., 1996].

**CONCLUSION**

Low back disorders are one of the most common and expensive occupational injuries in highly industrialized economies. For the practicing occupational physician, it frequently poses a challenge to identify a single causal relationship, since many injuries and pain syndromes are of multifactorial pathogenesis and typically are of cumulative nature. Cumulative effects and repetitive loading of the spine can result in accelerated degeneration and fatigue failure of the spine. The now well recognized and accepted risk factors are heavy or repetitive lifting, awkward body posture (static work, bending and twisting) and whole-body vibration. Sudden over-exertion or postural spinal stress can result in ligament strain, fractures, disc herniation or nerve compression syndromes. The occupational history and identification of workplace risk-factors are cornerstones in the correct medical assessment and establishment of the causal work-relatedness. Although, the treatment and management of occupational low back disorders can in most cases follow standard ambulatory care principles, the occupational physician needs to be aware of “red flag” symptoms or conditions that require specialty consultation and possibly urgent surgical intervention. Return to work decisions and the management of injured workers should be based on a thorough understanding of the workplace conditions, evaluation, and control of identifiable risk factors to prevent further injury. Because of these complex factors, physicians trained in occupational medicine appear to be highly qualified and well positioned to be directly involved in the ambulatory care of workers with low back disorders. Psycho-social factors, work-organizational structures, and compensation benefits will play an important part in the successful rehabilitation and reintegration of the injured workers into the workforce.

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