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Electrician's Job Demands Literature Review – Overhead Work

An electrician's job is physical in nature, and the physical demands of the job are affected by postures employed and environmental factors. Overhead work, or work at or above shoulder level, is an essential component of electrical work and is a risk factor for developing a shoulder injury. In the United States, shoulder injuries are third most reported cases behind low back and leg injuries (Nussbaum et al., 2001).

During the month of April in 2005, the International Brotherhood of Electrical Workers (IBEW) local 353 commissioned the Toronto Clinic of the Occupational Health Clinics for Ontario Workers (OHCOW) to complete a musculoskeletal discomfort/symptom survey of its membership. OHCOW found that in the last year (at the time of survey), an average of 50.35% of reporting union members experienced work related aches, pain, discomfort or numbness of the shoulder. Of the reporting members, 31.4% had sought a health care professional's advice for shoulder pain. Identifying potential mechanisms of injury within the job tasks of electrical work may prevent or lead to the reduction of work related injuries. OHCOW's findings appear to be in line with Hanna et al.'s (2005) findings about the factors affecting absenteeism in electrical construction; 52% [of electricians] reported they had a work-related injury sometime during their career that caused them to miss work.

Mechanisms of Injury

There are three main injury mechanisms (McGill, 2002). Most individuals can identify the "specific incident" injury mechanism where a load greater than the individual's tissue tolerance is applied, resulting in an injury (Appendix). An injury may also occur from the continuous application of a load resulting in an injury from the reduction in an individual's tissue tolerance over time. The final injury mechanism involves repeated loading, which decreases an individual's tissue tolerance over time until an injury finally occurs (McGill, 2002).

Potential Injuries

Musculoskeletal Disorders of the Shoulder:

The National Institute of Occupational Health and Safety (NIOSH) (1997) defines musculoskeletal disorders (MSDs) as a condition that involves the nerves, tendons, muscles, and supporting structures of the body. An MSD may cause pain, inflammation, reduced mobility as well as other symptoms. NIOSH (1997) states that repeated or sustained shoulder flexion and abduction greater than 60 degrees from neautral is positively associated with shoulder MSDs and shoulder tendonitis. When the shoulder nears its end range of motion in overhead work settings, stretching and compression of tendons and nerves occurs limiting blood flow to the joint and damaging tissues. The longer a fixed or awkward body position is held, the greater the risk of developing MSDs (CCOHS, 2002).

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Shoulder Impingement, Shoulder Tendonitis & Rotator Cuff Injuries:

The rotator cuff is responsible for the internal and external rotation of the shoulder, but the prime function is to hold the head of the humerus in the shoulder socket during movement, increasing joint stability. The rotator cuff is composed of four muscles: subscapularis, supraspinatus, infraspinatus and teres minor (Moore & Dalley, 1999). Shoulder impingement occurs when pressure is placed on the rotator cuff from the shoulder blade as the arm is lifted, which limits joint range of motion (AAOS, 2002).

Pain from a shoulder impingement may be due to an inflamed shoulder bursa or inflammation of the rotator cuff tendons. Shoulder impingement can become a chronic condition and may eventually lead to a torn rotator cuff. The American Academy of Orthopedic Surgeons (AAOS) (2002) lists repetitive lifting and overhead work as the main risk factors for incurring a shoulder impingement.

Shoulder tendonitis is the inflammation of the tendons of the shoulder. Hagberg et al. (1995) wrote that shoulder elevation and external forces acting on the shoulder impair circulation to the rotator cuff causing the tendons to degenerate and inflame. Circulation in the tendons also decreases as greater force is applied to the shoulder joint. Chaffin et al. (1999) confirmed that repeated elevation and sustained elevated shoulder postures can lead to degerative tendonitis in the shoulder.

Risk Factors for Injuries

Shoulder injuries limit a worker's ability to perform daily work activities. Four main risk factors associated with the development of shoulder injuries are static loads, insufficient rest, vibration and lack of non-neutral postures (Nussbaum et al., 2001; Schell, 2000).

Shoulder Composition:

The shoulder joint is the most complicated joint in the body (Kumar, 1999). The head of the humerus sits in a cup formed by the shoulder blade (scapula), collar bone (clavicle) and associated ligaments and muscles (Moore & Dalley, 1999). The cup that the head of the humerus sits in is shallow, giving the joint high mobility but decreased joint stability. Therefore the shoulder joint is highly susceptible to injury (Chaffin et al., 1999). The shoulder, being a ball and socket joint, is capable of moving in three axes and accomplishes these movements using a number of muscles, the best known being the rotator cuff and the deltoids. The rotator cuff, as described above, is responsible for shoulder stability and is composed of the subscapularis, supraspinatus, infraspinatus and teres minor (Moore & Dalley, 1999). The shoulder joint is also surrounded by a capsule filled with fluid called the synovial membrane which lubricates and protects the joint.

Repeated use of the shoulder joint over time wears down the cartilage in the joint. Repetitive motion also warms the fluid in the joint capsule, making the fluid less viscous affecting its ability to lubricate the joint and protect it from compression forces.

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Physical Demands Descriptions (PDDs) for IBEW local 353 were completed during the summer months of 2006. The PDDs revealed that reaching above the shoulder is a required posture that is frequently performed for 25-50% of a task. When working in an overhead position, the muscles involved in shoulder movement are working from an anatomically disadvantageous position affecting the muscles ability to protect the shoulder joint from applied forces (Chengalur et al., 2004). The Canadian Centre for Occupational Health and Safety (CCOHS) (2002) considers work involving shoulder elevation stressful for the shoulder to maintain. The higher a worker has to reach to complete a task, the shorter it takes for the worker to experience pain or fatigue. This is further complicated as a worker ages as endurance limits decrease (Chaffin et al., 1999)

Work posture and the external forces acting on the body are the most important factors in determining the force the shoulder musculature and ligaments must produce to support an external load (Kumar, 1999). The further the work performed by the shoulder is from a neutral position, the greater the forces produced by the shoulder are in order to achieve the given task (Chengalur et al., 2004).

When an arm is raised and unsupported, as in overhead electrical work, gravity pushes down on the extended arm, increasing the shoulder load. The musculature then activates to hold the arm in position. Flexion or abduction of the shoulder above 90 degrees is especially problematic, as stresses on the shoulder tendons, ligaments and other tissues increases greatly (Chaffin et al., 1999). Increasing forces on the shoulder cause increased joint compression, reduced circulation and increased muscular discomfort. As such, the higher a worker must raise their arm and the farther a worker must reach, the lower the weight that can be handled, effecting a worker's ability to handle tools and materials during overhead work (Chengalur et al., 2004).

Kumar (1999) found that forces on the hand and exerted by the hand increase muscle activation in the deltoids, but even more so in the rotator cuff muscles, placing them at risk for injury. When the arm is held in an elevated posture, Chaffin et al. (1999) noted that the shoulder musculature and upper fibres of the trapezius muscle were the first muscles to fatigue. This places the shoulder and cervical spine at risk for injury as the muscles ability to withstand forces is diminished.

It is also important to note that the greater the force required to sustain a posture, the quicker an individual will become fatigued (Hagberg et al., 1995). Therefore, as repetitions of shoulder flexion and extension increase, an individual may become more fatigued increasing the risk of a shoulder injury. Hagberg et al. (1995) also noted that the longer a static posture is held, the greater the need for recovery time between work activities or work shifts.

Nussbaum (2003) commented that localized musculoskeletal stresses can have consequences for the whole body. Although overhead work has a direct and easily identifiable connection with the shoulder and subsequent injuries to the shoulder, overhead work also increases lumbar spine extension and perceived exertion more so than work at chest height (Burton et al, 1994). Nussbaum (2003) also noted that overhead

work decreases postural control and increases postural sway. Therefore overhead work also increases a worker's risk of developing a spinal injury due to a lowered ability to stabilize and protect one's spine from compression and shear forces.

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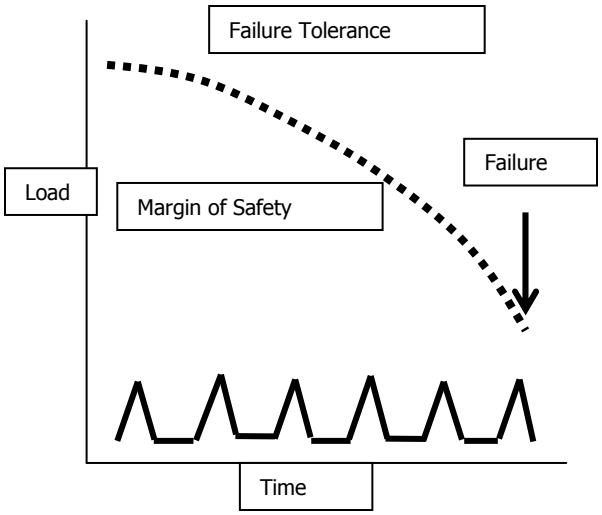
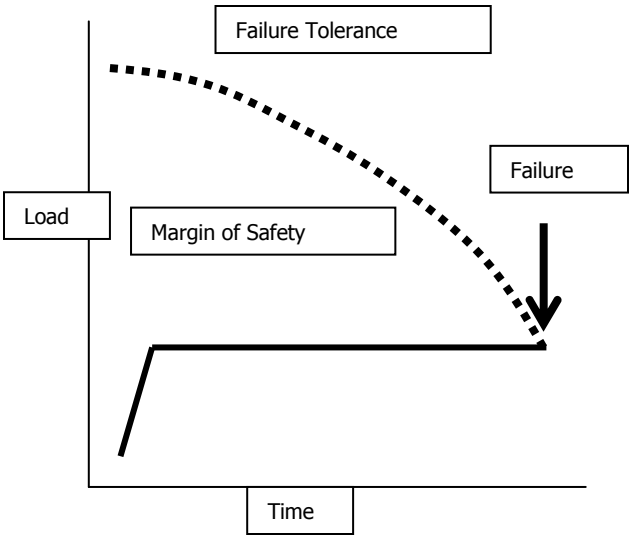
Appendix

Injury Mechanisms (McGill, 2002)





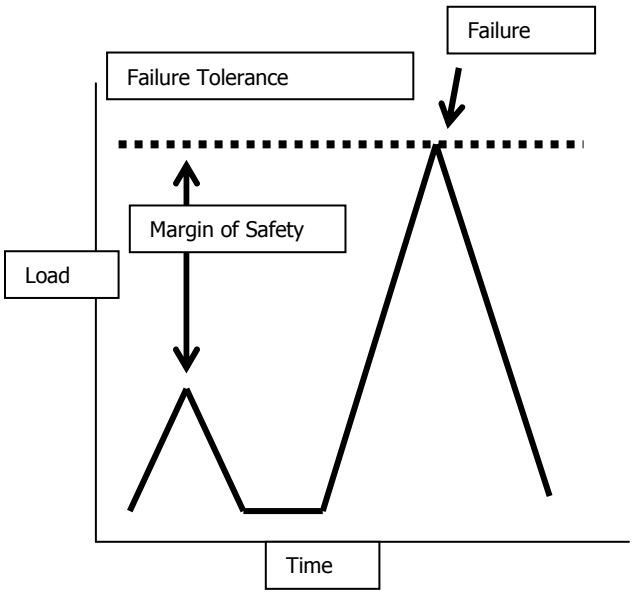


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Table 1. Evidence for causal relationship between physical work factors and MSDs

Body part *Risk factor*	**Strong evidence (+++)**	**Evidence (++)**	**Insufficient evidence (+/0)**	**Evidence of no effect (-)**
Neck and Neck/shoulder				
Repetition		✓		
Force		✓		
Posture	✓			
Vibration			✓	
Shoulder				
Posture		✓		
Force			✓	
Repetition		✓		
Vibration			✓	

Source: NIOSH, 1997

Table 2 (Chengalur et al., 2004)

Primary Job Risk Factors Considered in Major Reviews

Risk Factor	Low Back	Distal Upper Extremities	Neck and Shoulders
Force	Strong	Strong	Strong
Awkward Posture	Strong	Strong	Strong
Static Posture	Good	Good	Good
Repetition	Good	Strong	Strong
Dynamic Factors	Good	Weak	Weak
Compression	Good	Weak	Weak
Vibration	Strong	Strong	Weak
Combined	Good	Strong	Good

Strong = strongly correlated risk factor for MSDs in the low back/distal upper extremities/neck & shoulders
Good = strongly correlated risk factor for MSDs in the low back/distal upper extremities/neck & shoulders
Weak = weakly correlated risk factor for MSDs in the low back/distal upper extremities/neck & shoulders

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Overhead Work Photographs

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