Dynamic Chiropractic

Reducing Back Injuries: The NIOSH Lifting Equation ‚Äì Past, Present and Future

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I attended the Human Factors and Ergonomics Society's 54th Annual Conference in San Francisco this past summer as both a certified professional ergonomist and a diplomate of the American Chiropractic Board of Occupational Health. To my great pleasure, the conference included a session titled "Occupational Safety: The Past, Present and Future," organized by Dr. Thurman Lockhart, that included the "legends" of industrial ergonomics and the creators of the "most used" risk assessment tool for manual materials handling and back injury prevention of all time.[1]

The session agenda focused on contributions about the development, applications and accomplishments of the Revised NIOSH (National Institute for Occupational Safety and Health) Lifting Equation (RNLE), designed for evaluating lift-task characteristics, estimating risk and reducing back injuries in ergonomic practice. Specific agenda items included the "gap between research and practice in the field of industrial ergonomics nowadays; possible usage of novel technologies in work evaluation; and further directions of industrial ergonomics."[1] The stage was set for a dynamic session replete with recollections, opinions, findings and forecasts.

Among those present for the panel discussion were ergonomic legends Dr. Mo Ayoub, physiologist; Dr. Don Chaffin, biomechanist; Dr. Colin Drury, physicist and mathematician; Dr. Arun Garg, physiologist; Dr. Gary Herrin epidemiologist and statistician; Dr. Karl Kroemer, ergonomist and scientist; Dr. Stover Snook, pioneer in psychophysics; and Dr. Thomas Waters, ergonomist, scientist and NIOSH team leader.[1] The illustrious panel provided background and insight regarding the 1981 and 1991 versions of the manual lifting guide, and the methods used for developing, shaping and negotiating the original criteria; as well as the subsequent basis for the later revision. The varied perspectives of team members were melded into this truly interdisciplinary project.

The resulting applications manual of the RNLE is an overwhelmingly popular assessment tool for many health professionals interested in risk assessment of manual materials handling tasks and back injury prevention,1 including the doctor of chiropractic working in occupational health.

The Revised NIOSH Lifting Equation

The RNLE provides a systematic approach to the assessment of lifting tasks by evaluating characteristic features of the human-load interface and task demands. The method assumes that 51 lbs is the maximum load that can be safely managed under ideal conditions and would not pose an increased risk of back injury to the average worker.[2] The equation uses six lift characteristic coefficients to modify the 51 lb load to the conditions that are being evaluated.

The RNLE is performed by health professionals evaluating the manual materials handling tasks and includes the horizontal distance of the load from the body, vertical locations at origin and destination, distance traveled of the load, frequency of lift, hand-load coupling, and asymmetry or twisting of the spine. Lifting duration may be classified into three categories: 1) short duration, 2)

moderate duration or 3) long duration.

Short duration implies lifting for one hour or less followed by rest of 1.2 times the work duration. Moderate duration is lifting more than one hour but less than two hours followed by rest at least 0.3 times the work period. Long-duration lifting implies lift-work between two and eight hours with standard industrial rest periods.[2]

The equation yields a recommended weight limit (RWL) for the given characteristics of the particular lift interfaces and task demands. In most instances, the load is reduced from 51 lbs to a safe level based upon the less-than-ideal conditions. The equation also yields a lifting index (LI) to estimate risk for back injury as the ratio of actual load lifted divided by the RWL. The LI scale, 1-3, may be interpreted as: 1=no increased risk, 2=increased risk, and 3=significant risk, thus allowing the evaluator to classify the lifting task as safe or unsafe.[2]

The RNLE is also used to guide the evaluator in identifying effective, high-impact interventions that would measurably reduce risk through lift redesign.[2] Manipulation of the task design and lift interface to improve psychophysical, biomechanical and/or physiological stresses to workers may be immediately possible. The RNLE approach is measurable, predicable and can provide quantitative evidence that reduction in stresses and risk of back injury is readily achievable. This approach is often used to reassess effectiveness of risk reduction secondary to ergonomic controls.

Occupational health professionals began using the NIOSH Lifting Equation in 1981, even in the absence of a validating study. Like many ergonomic assessment tools, the concepts and theories were well-supported in the literature, but not validated through rigorous scientific inquiry.

The original equation was cumbersome and required greater technical skills to use. The RNLE provided tables and standardized spreadsheets for recording and calculating the RWL and the Lifting Index (LI). The NIOSH provided an Excel spreadsheet with formulas to enhance ease of use available to download from the Internet. The RNLE enjoyed continuing acceptance and wide use by health professionals from many disciplines including doctors of chiropractic specializing in occupational health and applied ergonomics. The equations were ultimately evaluated for validity, sensitivity and specificity two decades after adoption by ergonomists and occupational health professionals.

Evaluating the Lifting Equation

Dr. William Marras and colleagues evaluated the equations and published their results in 2000.[3] Their landmark study used a database of 353 jobs from 48 manufacturing companies throughout the Midwestern U.S. The jobs were followed for six years and all injuries were recorded. Jobs were both evaluated using the NIOSH equations and classified from low to high risk based upon health outcomes data. They also had available, low back disorder risk categories available from health outcomes data derived from over 15 years, 600 jobs and 21 million hours of exposure compiled by the Ohio State University Biodynamics Laboratory.

The dependent variables were the six lift-equation characteristics. They found that the 1981 equation had good specificity, 0.91 or 91 percent accuracy to identify low-risk jobs; but low sensitivity, 0.10 or 10 percent accuracy to identify high-risk jobs. By comparison, the 1993 RNLE had better sensitivity, 0.73 or 73 percent accuracy to identify high-risk jobs; but reduced specificity, 0.55 or 55 percent accuracy to identify low-risk jobs. This study indicated that the different equations have varied strengths and weaknesses and that those using the equation should select the best tool for the job. The equations are valid for use in estimating stresses and risk

associated with manual materials handling (MMH) tasks.[3]

More recently, Boda and colleagues presented and published their finding from a validation study designed to evaluate predictive variables of 258 asymptomatic workers followed over time for the occurrence of low back disorders associated with MMH tasks. They found that peak stresses from lifting tasks were better predictors of incident cases of injury and that the NIOSH Lifting Equation and peak load moment were valid job analysis methods to predict risk for low back injury.[4]

Future Directions in Work Safety

The legendary group comprising the panel discussion at the Human Factors and Ergonomics Society conference all stated that future directions in work evaluation must include greater integration of factors that estimate risk and affect health outcomes of workers. Dr. Chaffin stated that he'd like to see the incorporation of dynamic biomechanical models that predict disc failure better address lifting frequency and the individual differences of workers. He asked the audience, "How do we identify those at risk?"

Dr. Ayoub asked, "Does capacity change over time? If so, how much?" He felt that advances in human performance evaluation offer new methods to measure capacity, and that better and newer approaches should be used in future models.

Dr. Kroemer suggested that scientists should follow up on studies from the 1980s that focused on "individual lifting testing." Dr. Snook asked, "Why do people suffer low back pain?" He felt that greater work is needed in "evaluating spine tolerances" that address the variability resulting from the many influencing factors, and would like to see more research investigating the "characteristics of the spine."

Dr. Drury indicated that he would like to see an "extension of the equation" to address more variables associated with MMH, while Dr. Herrin stated that he wanted to see more use of engineering controls to accomplish MMH. He went on to state that one strategy could be to increase bulk weight that would result in making human MMH impossible and force the use of engineering devices, thus relieving the worker of lifting stresses.

Dr. Garg stated that he would like to see an "index that incorporates more variability" associated with MMH and lifting. There was much discussion about the difficulty of incorporating the psychosocial factors that may be associated with back pain.[1]

Psychosocial factors have been linked to the reporting of physical pain, such as LBP and disability, by several authors.[5-11] It has been found that psychosocial factors can influence the development of neuromusculoskeletal symptoms, including but not limited to stress (work, family and financial), such as poor job satisfaction, poor social support, unhealthy relationships, poor body image, somatization symptoms, and poor ego functioning.[7-8,11-13] Davis and Heaney[14] also found that types of work activities, environments and social networks may be predictive of LBP among working populations.

It is my opinion that future models used to predict risk for low back pain associated with workplace exposures should address all of the major determinants, not just focus on obvious physical stresses. It became clear to me when listening to the panel of experts in ergonomics that they too recognized the need to evolve the RNLE and incorporate new methods and perspectives, as well as broaden the metrics used for future revisions of the equation to better address human variability, psychosocial stresses and individual differences.

Chiropractic has long been the holistic profession intent on addressing the whole person. It appears that mainstream occupational health is embracing this concept. The RNLE is alive and well, valid and available to doctors of chiropractic wishing to provide occupational health and applied ergonomics services. It remains a top-notch method taught in the American Chiropractic Board of Occupational Health diplomate program for doctors of chiropractic interested in developing their knowledge, skills and abilities for injury prevention in the workplace.

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Chiropractors interested in specialized training in occupational health and applied ergonomics are encouraged to contact the continuing-education department at NWHSU at www.nwhealth.edu or the International Academy of Chiropractic Occupational Health Consultants (IACOHC) at 507-455-1025 or iacohc@gmail.com.

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