

WHEN IS IT SAFE TO MANUALLY LIFT A PATIENT?

The Revised NIOSH Lifting Equation provides support for recommended weight limits.

BY THOMAS R. WATERS, PhD

Overview: In 1994 the National Institute for Occupational Safety and Health (NIOSH) released the Revised NIOSH Lifting Equation—an ergonomics assessment tool that can be used to calculate the recommended weight limit for two-handed manual-lifting tasks. However, NIOSH excluded assessment of patient-handling tasks from the uses of the revised equation, arguing that such tasks involve too many variables. The equation in fact can be used to calculate a recommended weight limit for a limited range of patient-handling tasks in which the patient is cooperative and unlikely to move suddenly during the task. In general, the revised equation yields a recommended 35-lb. maximum weight limit for use in patient-handling tasks. When weight to be lifted exceeds this limit, assistive devices should be used.

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Illustration by Jennifer Smith

A nurse is responsible for raising a patient's leg off the bed while preparing the leg for surgery. The patient weighs 250 lbs. Should the nurse manually lift the leg or find another method?

Two nurses are helping a patient to stand from a chair. The patient weighs 180 lbs. and can assist only partially, enough to lift about half of his own weight. Can they perform this task safely?

Four nurses are about to move a fully dependent patient weighing 200 lbs. from a bed to a wheelchair. Can they do so without risking injury to themselves?

Despite the widespread use of manual-lifting techniques, such as the "bear hug" (in which the caregiver places both arms around the patient's waist) and the "hook and toss" (in which the caregiver "hooks" the patient's arm with her or his own arm), health care workers continue to suffer unacceptably high rates of musculoskeletal injuries. And over the course of 30 years, research has suggested that such approaches to lifting are not safe.¹ While many schools of nursing still train students in their use, an overreliance on manual-lifting techniques may well contribute to the high number of nurses who suffer from work-related musculoskeletal disorders. This isn't only because such methods don't work; investing time and money in them may also delay recognition of the need for more comprehensive and proven approaches. According to the U.S. Bureau of Labor Statistics, in 2005 nursing ranked eighth among occupations reporting work-related musculoskeletal disorders involving days away from work, with more than 9,000 cases of such disorders and a median of seven missed days of work per injury, and nurses' aides, orderlies, and attendants ranked second, behind laborers and freight, stock, and material movers.²

Musculoskeletal disorders continue to be one of the leading and most costly occupational health problems in the United States and are often caused by overexertion when lifting excessive loads and, in nurses, by the cumulative effect of repeated patient-handling tasks and high-risk tasks such as lifting, transferring, and repositioning patients.³ Extensive laboratory-based research has documented high levels of biomechanical stress on caregivers' spines, shoulders, hands, and wrists from patient lifting and repositioning.⁴⁻⁷

Many of these injuries are preventable. A strong body of research has demonstrated that mechanical lifting equipment, as part of a program promoting safe patient handling and movement, can significantly reduce musculoskeletal injuries among health care workers.⁷⁻¹²

THE NIOSH LIFTING EQUATION

In 1981 the National Institute for Occupational Safety and Health (NIOSH) first published the

Work Practices Guide for Manual Lifting, which addressed the prevention of musculoskeletal disorders caused by manual lifting.¹³ The guide summarized the literature on manual lifting prior to 1981 and provided a lifting equation to calculate recommended weight limits for specified two-handed manual lifting tasks.

In 1985 NIOSH convened an ad hoc committee of experts who reviewed the literature on lifting and recommended criteria for revising the original equation for defining the lifting capacity of healthy workers. The committee used the criteria to formulate the Revised NIOSH Lifting Equation, which can be used to calculate a weight limit for a given manual-lifting task so that nearly all healthy workers (those who have no conditions that would increase their risk of musculoskeletal injury) could perform that task over a substantial period (for example, up to eight hours) without increasing their risk of developing low back pain.¹⁴ A user's guide, *Applications Manual for the Revised NIOSH Lifting Equation*, was published in 1994.¹⁵ The revised equation involves the multiplication of six factors—such as the frequency of lifting and the horizontal distance between the object and the body of the person lifting—by the "load constant," which is 23 kg (about 51 lbs.) and defined as the maximum weight to be lifted under ideal conditions. (See *Using the Equation*, page 57.)

Not safe for handling patients. In the documentation for the Revised NIOSH Lifting Equation, my colleagues and I, who developed the revised equation, indicated that the equation shouldn't be used for assessing the lifting of patients because it "does not include task factors that account for unpredictable conditions, such as unexpectedly heavy loads, slips, or falls."¹⁴ These limitations are necessary because

- patients can be unpredictable (they might have muscle spasms, be combative, or resist) and are sometimes heavier than they appear.
- a patient's movements during a lift can create loads within the lifter's spine greater than those created by the slow, smooth lifting of a stable object.

When conditions are right. Despite the above-mentioned limitations, the revised equation can be used to calculate a recommended weight limit for many patient-lifting activities when the following conditions are met:

- The patient can follow directions and is not combative.
- The amount of weight the caregiver handles can be estimated.
- The lifting is smooth and slow.
- The "geometry" of the lift—the body and hand positions in relation to the object being lifted—

and the amount of weight lifted are not subject to change.

For most patient-lifting tasks, the maximum recommended weight limit is 35 lbs.—but even less when the task is performed under less than ideal circumstances, such as lifting with extended arms, lifting when near the floor, lifting when sitting or kneeling, lifting with the trunk twisted or the load off to the side of the body, lifting with one hand or in a restricted space, or lifting during a shift lasting longer than eight hours.

In 1999 the Department of Veterans Affairs first funded the Veterans Integrated Service Network 8 (VISN 8) Patient Safety Center of Inquiry in Tampa, Florida, which developed algorithms for assessing patient-handling tasks. The center uses the limit of 35 lbs. derived from use of the Revised NIOSH Lifting Equation in the algorithms to help health care workers differentiate between dependent patients, who require nurses to lift more than 35 lbs. in helping them, and partially weight-bearing patients, who will not force the nurse to lift more than 35 lbs.¹¹ For lifting fully dependent patients, assistive equipment, such as a full-body lift, is recommended. For lifting partially dependent patients, workers may be able to use a sit-to-stand assistive device, or the workers may be able to assist manually with the lift, and equipment may not always be necessary.

In 2004 the vast majority of the more than 2.9 million RNs in the United States were women (94.3%), who in general have less back and upper-extremity strength than men do; the average age of RNs in 2004 was 46.8 years.¹⁶ Since muscle strength and intervertebral disc strength decrease with age, a lower weight limit for lifting would be appropriate for nurses. The choice of 35 lbs. as a maximum recommended weight limit for patient lifting, rather than the recommended 51-lb. weight limit set by the Revised NIOSH Lifting Equation for lifting (which doesn't involve patients and assumes ideal conditions), should protect health care workers from injury. The 35-lb. limit is based on an assumed minimum horizontal distance (the distance between the object being lifted and a point between the ankles of the person lifting it, if measured on the floor) of 14.5 in. for women—longer than the 10-in. distance considered the minimum for manual-lifting tasks not involving patients. This is because when lifting patients, caregivers do not get as close as they do to a box or other stationary object; lifting a patient often requires reaching out and usually entails lowering the patient into a chair or onto a bed, both of which prevent the worker from getting close to the patient.

The implications of a 35-lb. maximum weight limit for patient lifting are that many tasks that

RECENT POLICY AND LEGISLATIVE INITIATIVES

Will 'no manual lifting' policies become a national norm?

In recent years many facilities have initiated "no-lift policies," and some states have passed laws requiring hospitals to establish and implement programs on "safe patient handling." In January 2006 Texas became the first state to enact such legislation; it requires medical facilities to establish protocols "to control risk of injury to patients and nurses associated with the lifting, transferring, repositioning, or movement of a patient."

Also, in 2003 the American Nurses Association launched its Handle with Care campaign, "a profession-wide effort to prevent back and other musculoskeletal injuries" (see www.nursingworld.org/handlewithcare) and released a position statement, *Elimination of Manual Patient Handling to Prevent Work-Related Musculoskeletal Disorders* (see www.nursingworld.org/readroom/position/workplac/pathand.pdf).

And in September 2006 a bill introduced to the U.S. House of Representatives, the Nurse and Patient Safety and Protection Act of 2006 (HR 6182), will, if passed, "amend the Occupational Safety and Health Act of 1970 to reduce injuries to patients, direct-care registered nurses, and other health care providers by establishing a safe patient handling standard."

But the passage of such national legislation could be years away. In the meantime, not all hospitals have implemented no-lift policies, and where they do exist not all workers comply with them.—Joy Jacobson, managing editor

health care workers perform would be unacceptable. Except in pediatrics, few patients weigh less than 35 lbs. While strictly applying such a weight limit may strike some as unreasonable, it might be justified: the rate of injury among workers handling patients shows that current approaches to preventing back injuries resulting from the manual handling of patients—such as training in biomechanics and the use of back belts—are not working. The 35-lb. limit should help in identifying tasks for which the use of assistive lifting equipment would be appropriate.

Estimating weight. How will nurses know when the amount of weight being lifted for a specific task exceeds the limit? Can they quickly judge a task's hazards and determine when to use assistive equipment or lift manually? Because many challenging tasks require two or more caregivers, it may be even harder to estimate the weight being lifted by each worker in one task. Some hope can be found in a recent study of manual laborers' perceptions of

IDLED EXPERTISE

Haste and imperfect ergonomic conditions can cause irreparable harm.

Martha Murphy, BSN, RN, CNOR, is at pains to emphasize that she's grateful. To be working. To have benefits. To have a healthy back and legs. Even so, typing data into a computer, scheduling appointments, filing paperwork, performing menial tasks hour after hour, she sometimes starts to feel trapped. "If I get to give a patient an injection," she says, "it's the highlight of my day."

Murphy worked for 25 years as a nurse in the orthopedic operating room (OR). The work was repetitive, continual, and rapid. She lifted instrument trays, hung 3-liter IV bags, pulled and pushed heavy carts on tracks, held up patients' legs and arms as they were prepared for surgery, and filled out charts on computer screens hung from the ceiling. "I saw myself as a strong individual," says Murphy, who is 55 and a little under 5' 3" tall. "I never shied away from a task. At the time it didn't feel like I was putting excess strain on my body."

So when her right elbow started to hurt from tendonitis, she'd get an occasional injection of dexamethasone (Decadron and others) and lidocaine (Xylocaine) from a physician she knew and head right back to work. "We nurses are pretty stoic. Just give me a little shot and I'll be fine." She persisted like this for many months, until about a year ago it got so bad that if she accidentally tapped her elbow against a hard object she'd be in agony.

Murphy chose surgery—a lateral epicondylectomy with tendon reimplantation—expecting to recover quickly and then return to work. While the surgery reduced her pain, she now knows that her elbow will never be strong enough for most of the tasks she used to perform. Her first assignment upon return to work was as a greeter in the hospital lobby. Now she performs "light-duty" tasks, mostly clerical, and her nursing skills

lie dormant. She has seven years until retirement and sometimes wonders whether the wait is worth it.

In retrospect Murphy sees her job as an OR nurse in orthopedics as "an ergonomics nightmare." Like most nurses she'd been taught to bend at the knees and not to twist from the waist, but the hospital had few other

ergonomics protocols in place. The computer screen used for charting hung from the ceiling without a wrist or hand support. Trays were often weighed to make sure they weren't more than 25 lbs., but the carts on tracks, designed to be easily moved, would pile up 10 at a time and "you'd have to slide all ten out of the way just to get to the one you wanted."

That kind of design just doesn't make any sense, says Murphy. Why, she wonders, aren't nurses consulted by the ergonomics experts? At the same time, she says, having more staff would allow health care professionals to perform tasks more slowly and correctly. "In the OR, it's always about speed. Time is money."

"I got hurt doing what I love," says Murphy. She hopes to someday get another chance to use the specialized skills she acquired in the orthopedic OR. Maybe a position as an educator will open up. For now, her advice to other nurses is this: ask for help, always get a cart to put something heavy on, and "if you think it's too heavy, don't lift it." And her advice to administrators? "Spend a day following a nurse and trying to do what they do."—*Jacob Molyneux, senior editor*



the weight of various loads. Yeung and colleagues investigated the relationship between the actual weight lifted and a series of weight descriptors, such as "light," "moderate," and "heavy."¹⁷ They found that each descriptor was associated with a well-defined range of load weight, with a predominant weight defined for each category. For example, the terms "light," "moderate," and "heavy" were most closely associated with median weights of 11 lbs. (5 kg), 27.5 lbs. (12.5 kg), and 46.2 lbs. (21 kg), respectively. A weight of 35 lbs. would fall somewhere between "moderate" and "heavy." Studies are needed to determine whether these descriptors are appropriate for health care workers to use in estimating the loads involved in patient-lifting tasks.

When the patient can help with the lift and can bear part of her or his own weight, it may be unclear how much assistance the patient will need and what percentage of the patient's weight the caregiver must handle. A patient's weight-bearing ability can also vary, and nurses should use their best judgment in making estimates; if they think that what they're lifting weighs more than 35 lbs., they should not manually lift it.

At the same time, even cooperative patients may sometimes slip, trip, faint, or have a muscle spasm. When that happens to a patient who is usually able to help with movement or transfer, it can greatly increase the caregiver's risk of injury. Such accidents are one of the reasons some institutions have adopted "safe lifting" or "no-lift" policies limiting

or prohibiting the manual lifting of patients. (See *Recent Policy and Legislative Initiatives*, page 55.)

REVISITING THE PROBLEMS

Lifting is complex; no single factor can define a safe lift. For this reason, the Revised NIOSH Lifting Equation is based on information derived from biomechanics, psychophysics, physiology, and epidemiology.¹⁴ The equation's use is more likely to protect healthy workers in performing a wider variety of lifting tasks than would methods that rely on only a single variable. Nurses who are ergonomics coordinators and safety managers and are familiar with ergonomics assessment may find the equation valuable when assessing many basic lifting tasks that must be repeated. For example, the Association of periOperative Registered Nurses (AORN) has used the equation to provide recommendations on the lifting of such objects as linen bags, lead aprons, sterile packs, garbage bags, body positioning devices, fluoroscopy boards, and instrument pans or trays.¹⁸

Under certain conditions, such as when a worker lifts from below her or his knees, it may be necessary to use the equation to determine the recommended weight limit, which may be significantly less than 35 lbs. But health care workers handling patients in their day-to-day work will find that the equation is too complex and time-consuming to allow for efficient, on-the-spot clinical use. In cases such as those presented at the beginning of this article, the recommended maximum weight limit of 35 lbs.—itself a product of the Revised NIOSH Lifting Equation—is reasonable for use in manual lifting when using the equation isn't feasible.

A nurse is responsible for raising a patient's leg off the bed while preparing the leg for surgery. The patient weighs 250 lbs. According to Chaffin and colleagues, a 150-lb. person's leg would weigh about 24 lbs., a 200-lb. person's leg about 31 lbs., a 250-lb. person's leg about 39 lbs., and a 300-lb. person's leg about 47 lbs.—in each case, almost 16% of the total body weight.¹⁹ Therefore, the weight of this patient's leg probably exceeds the recommended 35-lb. maximum limit, and the nurse should use a leg lift or limb positioner.

Two nurses are helping a patient to stand from a chair. The patient weighs 180 lbs. and can assist only partially, enough to lift about half of his own weight, leaving 90 lbs. to be shared between the two nurses. Each nurse would lift 45 lbs., again exceeding the recommended 35-lb. limit. In this case, a lifting device or a sit-to-stand device should be used.

Four nurses are about to move a fully dependent patient weighing 200 lbs. from a bed to a wheelchair. If each caregiver lifts an equal amount of weight, each would lift 50 lbs. This would exceed the recommended maximum 35-lb. weight limit; a lifting-assist device should be used for this task.

USING THE EQUATION

The Revised National Institute for Occupational Health and Safety (NIOSH) Lifting Equation provides a multiplier for each of six variables that are inherent in any task involving lifting, as shown below. These variables, when multiplied, decrease the load constant—the maximum weight to be lifted under ideal conditions, which is 51 lbs. For example, when the distance between the load and the worker (the horizontal multiplier) increases beyond 10 in., the **recommended weight limit** (RWL) for that task is reduced from the ideal starting weight. The RWL is calculated using the following equation:

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM.$$

The variables used in the calculation are the following:

- **LC = load constant:** maximum weight anyone should lift under ideal conditions (51 lbs.)
- **HM = horizontal multiplier:** horizontal distance of the object from a point between the ankles of the person performing the lift, if measured along the floor
- **VM = vertical multiplier:** vertical height of the lift
- **DM = distance multiplier:** distance the object is lifted or lowered vertically
- **AM = asymmetric multiplier:** distance the object is displaced, in degrees from the front of the body
- **FM = frequency multiplier:** how often the lifts are made in a 15-minute period
- **CM = coupling multiplier:** quality of hand-to-object connection (for lifting legs and arms, the coupling would in most cases be rated "good," since you can get your hand around them; for other body parts or for the entire body, however, the coupling would likely be rated "poor")

Once the RWL is calculated, the number can be used to determine the **lifting index** (LI), which denotes an estimate of the physical stress associated with a particular manual lifting task. This estimate is defined by the relationship of the weight of the load lifted and the recommended weight limit. As my colleagues and I wrote in 1993, "it is likely that lifting tasks with an LI greater than 1.0 pose an increased risk of lifting-related low back pain for some fraction of the workforce" and "many workers will be at elevated risk if the lifting index exceeds 3.0."¹ Therefore, the LI can be used to determine whether a lifting task is acceptable or not. It is calculated using the following equation, where load weight (L) = weight of the object lifted (in lbs. or kg):

$$LI = \frac{\text{Load Weight}}{\text{Recommended Weight Limit}} = \frac{L}{RWL}.$$

For a detailed description of how to use the equation, see the *Applications Manual for the Revised NIOSH Lifting Equation*, at www.cdc.gov/niosh/docs/94-110.

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GENERAL PURPOSES: To provide registered professional nurses with an explanation of the Revised National Institute for Occupational Safety and Health (NIOSH) Lifting Equation and a rationale for its use in calculating the recommended maximum weight limits for a limited range of patient-handling tasks.

LEARNING OBJECTIVES: After reading this article and taking the test on the next page, you will be able to

- explain the background information, statistics, and progress related to the issue of patient lifting as a leading cause of caregiver injury.
- describe the Revised NIOSH Lifting Equation and the author's recommended expansion of its application to include certain patient-handling tasks.
- discuss applications of a 35-lb. recommended weight limit derived from the equation to specific patient-care situations.

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