AORN Ergonomic Tool 3: Lifting and Holding the Patient's Legs, Arms, and Head While Prepping

THOMAS WATERS, PhD, CPE; **PATRICE SPERA,** MS, RN, CNOR; **CAROL PETERSEN,** MAOM, BSN, RN, CNOR; **AUDREY NELSON,** PhD, RN, FAAN; **EDWARD HERNANDEZ,** BSN, RN; **SHAWN APPLEGARTH,** AA, MSME

ABSTRACT

Lifting the arms, legs, or head of a patient while prepping these areas for surgery can exert strong forces on the muscles and joints of the shoulders and backs of perioperative team members who perform this task, which may lead to work-related musculoskeletal disorders. AORN Ergonomic Tool 3: Lifting and Holding the Patient's Legs, Arms, and Head While Prepping provides scientifically based determinations of the amount of weight perioperative personnel can safely lift and hold manually for up to one, two, and three minutes using one hand or both. If these weight limits are exceeded, additional staff members or assistive devices are needed to help with the task. *AORN J* 93 (May 2011) 589-592. Published by Elsevier Inc. on behalf of AORN, Inc. doi: 10.1016/j.aorn.2010.08.028

Key words: *musculoskeletal disorders, body segment weights, muscle fatigue, skin prep.*

Editor's note: *This is the third in a series of seven articles based on the "AORN guidance statement: Safe patient handling and movement in the perioperative setting." These articles describe specific ergonomic solutions for high-risk patient handling tasks in the perioperative clinical setting.*

The AORN "Recommended practices for preoperative patient skin antisepsis" states that

The antiseptic agent should be applied to the skin over the surgical site and surrounding area in a manner to minimize contamination, preserve skin integrity, and prevent tissue damage.[1(p370)] *. . . The prepared area of skin should extend to an area large enough to accommodate potential shifting of the drape fenestration, extension of the incision, the potential for additional incisions, and all potential drain sites.*[1(p371)]

doi: 10.1016/j.aorn.2010.08.028
Published by Elsevier Inc. on behalf of AORN, Inc

Figure 1. A limb can be held by a holding device to reduce caregiver strain.

Preparing a limb for surgery generally requires that it be raised and held for circumferential skin preparation. To accomplish this task, a member of the perioperative team may need to lift and hold the extremity so that it can prepared in the required manner. The limb can be held by a person or suspended by a holding device (Figure 1).

When the limb is held manually during the entire skin prep, one person usually does this while a second person performs the prep. In some instances, if the limb is small or only the distal portion needs to be prepped, the person performing the skin prep may hold the limb. If a holding device is used, the limb must be lifted to complete the prep of the area resting on the holder. The person lifting the extremity must hold it away from his or her body to prevent contamination. The size of the body part, length of holding time, posture necessitated by holding the body part, and physical ability of the person doing the holding all contribute to the ability of caregivers to safely perform this task.

Lifting and holding limbs during surgical prepping may be hazardous for caregivers because performing these tasks with the arms extended exerts strong forces on the muscles of the shoulders, arms, and back. When the magnitude of the muscle exertion is low or the task is performed for only a few seconds, the risk of injury is lowest. When the muscle exertion is high or continues for long periods, however, the weight being lifted must be reduced for safety, depending on the magnitude of the forces and the exertion times involved. Scientific studies have shown that when the exertions exceed acceptable levels, the risk of injury is increased significantly, which can result in musculoskeletal disorders.[2,3] Ergonomic Tool 3: Lifting and Holding the Patient's Legs, Arms, and Head While Prepping relies on scientifically published muscle strength and endurance limits to outline lifting and holding guidelines, and the weight limits are designed to meet the strength capabilities of at least 75% of female workers in the United States (Figure 2). Nurses should use their clinical judgment to assess the need for additional staff member assistance or assistive devices to lift or hold a body part for a particular period.

ERGONOMIC TOOL 3

The tool displays the average weight for an adult patient's leg and arm, as a function of whole body mass. Weights are presented in both US units (lb) and metric units (kg) rounded to the nearest whole unit. Maximum weights to be lifted and held for up to two minutes were calculated on the basis of 75th-percentile shoulder flexion strength and endurance capabilities for US adult women, where the maximum weight for a one-handed lift was assumed to be 11.1 lb (5.03 kg) and that for a two-handed lift was assumed to be 22.2 lb (10.1 kg). The shaded areas of the figure indicate whether it would be acceptable for one caregiver to lift or hold particular body parts for up to one, two, or three minutes with one or two hands. Respecting these limits should minimize the risk of muscle fatigue and the potential for musculoskeletal disorders.

Rationale and Calculations

Patient weight is divided into 10 categories, ranging from very light ($\leq$ 40 lb) to very heavy ($>$ 440 lb). Normalized weight for each leg, each

Patient weight lb (kg)	Body part	Body part weight, kg		Lift		Hold		
				1-hand	2-hand	2-hand	2-hand	2-hand
		lb	kg			≤ 1 min	≤ 2 min	≤ 3 min
≤ 40 lb (≤ 18 kg)	Leg	< 6	< 3					
	Arm	< 2	< 1					
	Head	< 3	< 1					
40-90 lb (18-41 kg)	Leg	< 14	< 6					
	Arm	< 5	< 2					
	Head	< 8	< 4					
90-140 lb (41-64 kg)	Leg	< 22	< 10					
	Arm	< 7	< 3					
	Head	< 12	< 6					
140-190 lb (64-86 kg)	Leg	< 30	< 14					
	Arm	< 10	< 4					
	Head	< 16	< 7					
190-240 lb (86-109 kg)	Leg	< 38	< 17					
	Arm	< 12	< 6					
	Head	< 20	< 9					
240-290 lb (109-132 kg)	Leg	< 46	< 21					
	Arm	< 15	< 7					
	Head	< 24	< 11					
290-340 lb (132-155 kg)	Leg	< 53	< 24					
	Arm	< 17	< 8					
	Head	< 29	< 13					
340-390 lb (155-177 kg)	Leg	< 61	< 28					
	Arm	< 20	< 9					
	Head	< 33	< 15					
390-440 lb (177-200 kg)	Leg	< 69	< 31					
	Arm	< 22	< 10					
	Head	< 37	< 17					
> 440 lb (> 200 kg)	Leg	> 69	> 31					
	Arm	> 22	> 10					
	Head	> 37	> 17					

Key:
No shading = okay to lift and hold; use clinical judgment and do not hold longer than noted.
Heavy shading = do not lift alone; use assistive device or more than one caregiver.

***Editor's note:** This ergonomic tool has been updated since the previously published version in* Perioperative Standards and Recommended Practices. *Denver, CO: AORN, Inc; 2011:624.*

Figure 2. AORN Ergonomic Tool 3: Rules for Lifting and Holding of Limbs in the OR.

arm, and the patient's head is calculated as a percentage of total body weight, where each complete lower extremity represents 15.7% of total body mass, each upper extremity (ie, upper arm, forearm, hand) represents 5.1% of total body mass, and the combination of head and neck represents 8.4% of total body mass.[2] To accommodate 75% of the US adult female working population, the maximum load for a one-handed lift is calculated to be 11.1 lb. This is determined by calculating the strength capabilities for a 25th-percentile US adult female maximum shoulder flexion moment of 35 Nm (mean = 40 Nm; standard deviation = 13 Nm) and a 75th-percentile US adult female shoulder-to-grip length (mean = 610 mm; standard deviation = 30 mm).[4] Maximum loads for one person for a two-handed lift (ie, 22.2 lb) are calculated as twice that of a one-handed lift. Muscle strength capabilities diminish as a function of time; therefore, maximum loads

for two-handed holding of body parts are presented for one-, two-, and three-minute durations.[5] Muscle endurance has decreased by 48% after one minute and by 65% after two minutes. After three minutes of continuous holding, strength capability is only 29% of initial lifting strength.[5] If the limits in Ergonomic Tool 3 are exceeded, then additional staff members or assistive limb holders are needed.

Conclusion

The act of prepping the patient's limbs or head often requires that the person performing the prep or an assistant lifts and holds these body parts for prolonged periods. Using these guidelines can help perioperative personnel determine safe limits and times for lifting and holding body parts and whether additional help or assistive devices are needed, thus reducing the risk of injury or disability. AORN

Editor's note: *The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health or the Veterans Health Administration.*

References

1. Recommended practices for preoperative patient skin antisepsis. In: *Perioperative Standards and Recommended Practices*. Denver, CO: AORN, Inc; 2011:361-379.
2. Chaffin DB, Anderson GBJ, Martin BJ. *Occupational Biomechanics.* 3rd ed. New York, NY: John Wiley & Sons; 1999:73.
3. National Research Council and the Institute of Medicine. *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities. Panel on Musculoskeletal Disorders and the Workplace. Commission on Behavioral and Social Sciences and Education*. Washington, DC: National Academy Press; 2001.
4. Pheasant S. *Bodyspace.* London, England: Taylor & Francis, Ltd; 1992:111.
5. Rohmert W. *Maximum Forces of Men Within the Reach Envelope of the Arms and Legs* [in German]. Research Report No. 1616. Northrhine-Westfalia: Westdeutscher Verlag Koeln-Opladen; 1966. Cited in Chaffin DB, Anderson GBJ, Martin BJ. *Occupational Biomechanics.* 3rd ed. New York: John Wiley & Sons; 1999:49, Figure 2.25.

Thomas Waters, PhD, CPE, is a senior research safety engineer at the National Institute for Occupational Safety and Health, Cincinnati, OH. *Dr Waters has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

Patrice Spera, MS, RN, CNOR, is a perioperative RN and case manager at MPM Bardmoor Surgery Center, Seminole, FL. *Ms Spera has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

Carol Petersen, MAOM, BSN, RN, CNOR, is a nurse informaticist at Catholic Health Initiatives national office, Denver, CO. *Ms Petersen hashas no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

Audrey Nelson, PhD, RN, FAAN, is a chief nurse and director of nursing service for research in Health Science Research and Development/Rehabilitation Research and Development at the Center of Excellence and Maximizing Rehabilitation Outcomes at the James A. Haley Veterans Affairs Medical Center, Tampa, FL. *Dr Nelson has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

Edward Hernandez, BSN, RN, is an OR nurse manager at the James A. Haley Veterans Administration Hospital, Tampa, FL. *Mr Hernandez has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

Shawn Applegarth, AA, MSME, is a biomedical engineer at the James A. Haley Veterans Administration Hospital, Tampa, FL. *Mr Applegarth has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*