AORN Ergonomic Tool 4:

Solutions for Prolonged Standing in Perioperative Settings

NANCY L. HUGHES, MS, RN; **AUDREY NELSON,** PhD, RN, FAAN;
MARY W. MATZ, MSPH; **JOHN LLOYD,** PhD, MErgS, CPE

ABSTRACT

Prolonged standing during surgical procedures poses a high risk of causing musculoskeletal disorders, including back, leg, and foot pain, which can be chronic or acute in nature. Ergonomic Tool 4: Solutions for Prolonged Standing in Perioperative Settings provides recommendations for relieving the strain of prolonged standing, including the use of antifatigue mats, supportive footwear, and sit/stand stools, that are based on well-accepted ergonomic safety concepts, current research, and access to new and emerging technology. *AORN J* 93 (June 2011) 767-774. Published by Elsevier Inc. on behalf of AORN, Inc. doi: 10.1016/j.aorn.2010.08.029

Key words: *prolonged standing, perioperative musculoskeletal disorders, fatigue.*

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

Static postures are described as physical exertions wherein the same physical posture is maintained throughout the exertion.[1] Such exertions increase the load and forces on the musculoskeletal system.[1-3] Static work postures such as prolonged standing and trunk and neck flexion have been identified as tasks at high risk for causing acute and chronic musculoskeletal disorders.[4] Perioperative team members are frequently required to maintain static postures during surgical procedures and often must stand in one place for extended periods. These care providers must maintain the integrity of the sterile field and a change in position could result in contamination of the field, so it is often difficult for them to temporarily relieve an uncomfortable position by sitting or significantly shifting their weight. Lack of flexibility in altering body positions is believed to contribute to fatigue[1] and health problems.[5,6] Factors such as OR bed height, environmental layout, demands of the surgical procedure, and human requirements for stretching and relaxing muscles regularly need to be considered in

doi: 10.1016/j.aorn.2010.08.029
Published by Elsevier Inc. on behalf of AORN, Inc

addressing this critical ergonomic problem in the perioperative setting.[7]

HEALTH RISKS ASSOCIATED WITH PROLONGED STANDING

Although the focus of ergonomic interventions is on musculoskeletal outcomes, the ramifications of prolonged standing encompass many physical demands and can cause serious health problems. The risks associated with prolonged standing have been a documented occupational safety and health issue dating back to the 18th century, when Bernardino Ramazzini linked prolonged standing and awkward postures with common disease states.[8] In the 1990s, researchers brought attention to prolonged standing in the nursing profession. Cook et al[9] recognized that standing for long periods was a common factor in groups of workers, including nurses, who experienced high incidences of leg pain. In a study of work postures in the surgical setting, researchers concluded that improvement was needed in the work postures of instrumentation nurses and specified the effects of static work postures as the reason.[10]

In 2001, Beynon and Reilly[6] compared the difference in spinal shrinkage in nurses performing simulated nursing activities with and without a seated break. Although not specific to perioperative nurses, this study suggested that the potential for back problems caused by spinal loading may be decreased if nurses take a seated break during their work shifts. Prolonged standing also has been identified as a problem in the United Kingdom and has resulted in the promulgation of health and safety regulations concerning the provision of seating for workers. Even with regulations to protect workers, this major safety and health issue in the United Kingdom (ie, an estimated one-third to one-half of all workers spending more than four hours per day either standing or walking) goes unenforced, although there has never been a prosecution for a breach of these health and safety regulations.[11]

The hazards associated with prolonged standing in the nursing profession include

- leg pain,[9]
- spinal compression,[6]
- chronic venous insufficiency,[12]
- increased risk of carotid atherosclerosis and thus increased risk of heart attack and stroke,[11] and
- impaired circulation with resultant swelling of the lower extremities.[5,11]

These hazards also can lead to varicose veins,[5,13] decreased oxygenation of and supply of nutrients to affected muscles[1] with resultant fatigue and pain,[5] and adverse birth outcomes.[14-16]

> The earliest and most common symptoms from prolonged standing are discomfort and fatigue in the feet and legs—that is, in the shins, calves, knees, and thighs. Pain and discomfort may also be felt in the hips, neck, and lower back.

When a person is maintaining an upright posture and standing in one position without the relief of walking periodically, circulation of the blood and other body fluids is compromised.[5] The resultant pooling in the lower legs and feet causes swelling[5,11] that may progress to inflammation of the veins and varicose veins.[5,12,13] It is not surprising, then, that the earliest and most common symptoms from prolonged standing are discomfort and fatigue in the feet and legs (ie, shins, calves, knees, thighs), but pain and discomfort may also be felt in the hips, neck, and lower back.[5,11,12,14,17] For women, standing for long periods (ie, four or more hours per day) appears to worsens existing lower back conditions.[12] Researchers have found the highest incidences of lower back pain in workers who stand for more than four hours per day.[14]

As well as musculoskeletal implications, the weight of the body plus any load being carried or held can result in injurious compressive forces on the joints, leading to joint damage and arthritis.[5,11] It is also suggested that the immobilization or locking of the joints in the spine, hips, knees, and feet that can occur during prolonged standing can facilitate degeneration in the tendons and ligaments and even rheumatic diseases.[5] Plantar fasciitis, heel spurs, and other foot problems are also linked to standing for long periods.[14]

In a literature review of 17 studies on health risks associated with prolonged standing,[14] four studies related preterm birth and spontaneous abortions with standing for long periods at work. In a study of occupational risks in the nursing profession and their relation to preterm birth, researchers found that nurses who stood for periods of four to six hours and for more than six hours per shift had a significantly greater risk of giving birth prematurely.[15] Guidelines for new and expectant mothers in the catering industry warn that fatigue from prolonged standing and similar workloads can lead to problems in neonatal development.[14] Low birth weight has also been linked to prolonged occupational standing by other researchers.[15,16] Pregnant workers who stand for long periods also are likely to experience lower back pain as a result of the increase in the curve in the lower back during pregnancy that forces the back muscles to exert more effort to maintain a balanced posture.[18]

Musculoskeletal risks from standing for long periods are of concern for the entire perioperative team, but scrubbed team members are at higher risk because they are often required to stand for much longer periods and are not able to alternate between standing and sitting in a chair that is lower than the sterile field. Consequently, this prevents them from taking breaks from their standing position and results in stressful static loads.[4] When sit/stand stools are used, they are limited to use in situations in which sitting or standing does not compromise the sterile field.

The deleterious effects of prolonged standing have been described as aging a person by 20 years and as equivalent to the damaging cardiovascular effects of smoking, high blood pressure, and high cholesterol level.[11]

ERGONOMIC TOOL 4

The AORN Ergonomic Tool 4: Solutions for Prolonged Standing in Perioperative Settings helps perioperative team members make decisions about how to minimize risks associated with prolonged standing (Figure 1). Evaluation and ergonomic intervention is required if a perioperative care provider is required to stand in the same position

- for two hours or more,
- for more than 30% of the workday, or
- while wearing a lead apron.

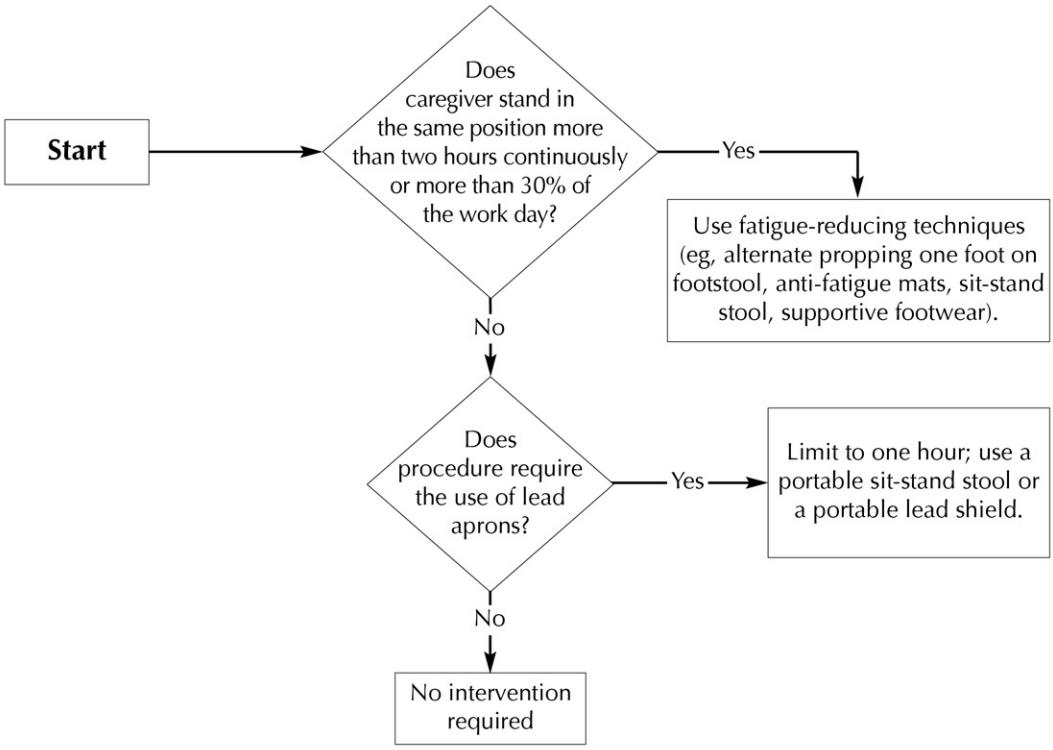
Interventions to minimize risk include measures such as propping alternating feet on foot stools, using antifatigue mats,[4,5] using sit/stand stools,[4,5,17] and limiting standing times.[4,17-19] Flooring and shoe features influence the effects of standing for long periods.[4,5,17] Additionally, regular contraction and relaxation of muscles is beneficial.[4]

Prolonged Standing Limits

To control for the deleterious effects of prolonged standing, some researchers[11,19] recommend standing during no more than 30% of a typical eight-hour workday for any worker; Tapp[18] recommends a three-hour limit for pregnant workers who must continuously stand in the same position. The Occupational Health Centre for Ontario Workers recommends limiting prolonged standing for pregnant workers to two hours, and floor matting should be provided.[17] The AORN guidance statement recommends limiting prolonged standing in the perioperative setting to two hours.[4]

Antifatigue Mats

The foot/floor interface influences body discomfort and fatigue, thus affecting worker performance and productivity.[12] Consequently, flooring materials influence the effects of prolonged



General recommendations

- Caregiver should wear supportive footwear that has the following properties:
  - does not change the shape of the foot;
  - has enough space to move toes;
  - shock-absorbing, cushioned insoles;
  - closed toe; and
  - height of heel in proportion to the shoe.
- Caregivers may benefit from wearing support stockings/socks.
- Anti-fatigue mats should be on the floors.
- Anti-fatigue mats should be placed on standing stools.
- The sit-stand chair should be set to the correct height before setting the sterile field so caregivers will not be changing levels during the procedure.*
- Be aware of infection control issues for nondisposable and anti-fatigue matting.
- Accommodations for pregnancy were considered, but the two-hour limit on prolonged standing covers this condition.
- Scrubbed staff should not work with the neck flexed more than 30 degrees or rotated for more than one minute uninterrupted.
- Two-piece, lightweight lead aprons are recommended.
- During the sit-to-stand break, staff should look straight ahead for a short while.

* Recommended practices for maintaining a sterile field. In *Standards, Recommended Practices, and Guidelines.* Denver, CO: AORN, Inc; 2007:665-672.

Figure 1. Ergonomic Tool 4: Solutions for Prolonged Standing in Perioperative Settings.

standing.[5] Flooring properties of elasticity, stiffness, and thickness influence standing comfort.[12] Generally, when a person stands for long periods, softer floors provide less muscle fatigue and more comfort than hard floors, especially for the lower extremities and lower back.[5,12,20] Floor material that is too soft, however, will affect stability and may increase muscle demands and fatigue. Flexible flooring materials (eg, wood, cork, carpeting, rubber) will provide for safer standing than inflexible ones but are not feasible in a surgical environment because of infection control issues.[5]

Harder flooring materials, often found in surgical suites, can be covered with antifatigue mats[4] to reduce their injurious properties.[4,11] Antifatigue mats are designed to cause a slight postural sway that induces minor activation of the leg muscles, improving blood flow and thus decreasing fatigue and reducing blood pooling. Holes, small bumps on the top of the mat, or a foam bottom will stimulate this movement. A common misperception is that antislip and other regular soft mats also have antifatigue properties; however, they may not. Very soft mats such as thick foam-rubber mats should be avoided because the thick cushioning may increase risks caused by prolonged standing and promote leg and back fatigue. To reduce the possibilities of slipping and tripping, experts recommend choosing mats with tapered edges that do not slide on the underlying floor surface and that have a top antiskid coating.[21] An alternative to using antifatigue mats is wearing shoes that incorporate materials with antifatigue properties in the insoles.[21] If standing stools are used to adjust worker height so the worker can more easily and safely perform tasks, placement of antifatigue matting on the stools will decrease ergonomic risk.[4] Purchasing agents for the facility where the caregiver is employed will most likely select the types of antifatigue mats and flooring material used by the facility. When antifatigue mats are in use, infection control measures must be considered. Mat selections may be made based on infection control factors rather than prolonged standing implications.

Sit/Stand Stools

Alternating sitting and standing allows for flexibility in body positions (Figure 2).[5] Such flexibility increases the number of muscles used during prolonged standing tasks and, in doing so, better distributes the loads on different parts of the body, reducing the strain on individual muscles and joints used to keep the body in a fixed standing position. In addition, the activation of these muscles improves blood flow, thereby decreasing muscle fatigue.[5] In a 2001 study that compared seated breaks with standing breaks in common nursing tasks, Beynon and Reilly[6] found a significant difference in spinal shrinkage between the two types of breaks and proposed that seated breaks during a nursing shift might reduce the potential for injury to the back from spinal loading. Consequently, if at all possible, stools should be provided so staff members can perform their activities either sitting or standing.[4,11] If that is not possible, stools should be available for resting when the procedure allows. The sit/stand stool should be placed at an optimal ergonomic height for the staff member to complete his or her work at the sterile field.[4,5] It is suggested that individuals who must maintain a static posture look straight ahead during sit/stand breaks to provide additional relief to the neck and shoulders from prolonged standing stress.[4]

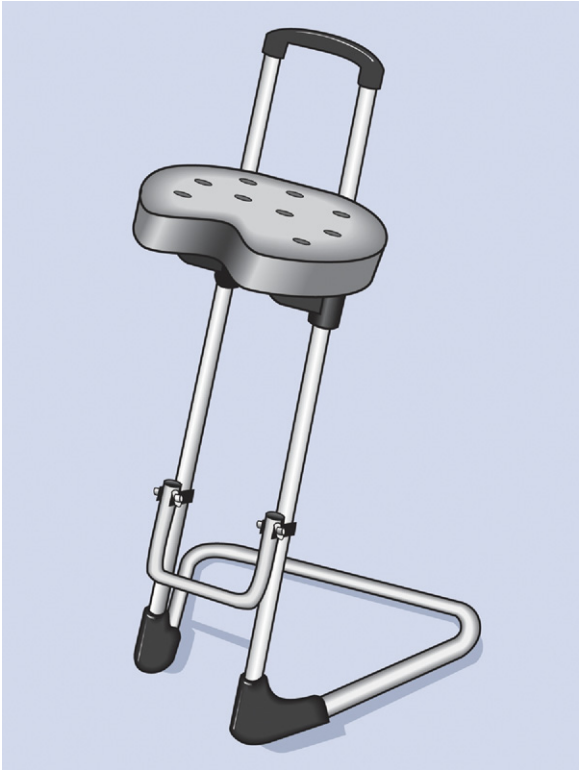


Figure 2. Sit/stand stools allow for flexibility in body position.

Regular contraction and relaxation of muscles is also beneficial.[4]

Footwear

Supportive footwear helps to minimize risk from prolonged standing, so footwear should have the following characteristics:

- firmly grips the wearer's heel to prevent slippage, instability, and discomfort;
- maintains the natural shape of the foot;
- has closed toes with adequate space to move toes[5]; and
- has shock-absorbing, cushioned insoles with arch supports.[4,5]

Use of antifatigue materials as shock absorbers as well as customization of the insole to a worker's desired level of cushioning and support is also suggested.[21] Workers are advised not to wear flat shoes or shoes with heels higher than 2 inches; however, if the heel height is in proportion to the shoe, higher heels are acceptable.[4,5]

Wearing lace-up shoes allows the wearer to adjust the fit of the shoe. It is recommended that the wearer firmly tighten the lace instep to prevent foot slippage inside the footwear. If a person has bone tenderness on top of the foot, padding under the tongue of the shoe will help to relieve this discomfort. When purchasing footwear, individuals should try on the shoes and walk around in them to make sure they fit properly and comfortably.[5] There are many components of Ergonomic Tool 4 that allow perioperative team members to make personal choices. For example, the type of footwear worn and whether the team member chooses to wear support stockings or support socks is left to the individual.

Footrests

Footrests enable staff members to alternate their weight from one foot to another, thus decreasing the effects of static posture (Figure 3).[4,5]

Figure 3. Footrests allow team members to increase their height at the sterile field or to alternate weight from one foot to the other by putting one foot on the stool at a time.

Tapp[18] specifically recommends the use of portable footrests for pregnant workers.

Lead Aprons

Staff members sometimes must wear lead aprons for protection from radiation exposure. When this is necessary, a two-piece lightweight lead apron and a one-hour prolonged standing limit or use of a portable lead shield is advised.

Other Considerations

In the perioperative work environment, ergonomically unfavorable static postures (eg, prolonged standing) and dynamic activities (eg, lifting) may cumulatively increase the ergonomic risk of the work environment.[22] The deleterious effects of prolonged standing can be accentuated by other static loading tasks that are found during surgical procedures, such as trunk and neck flexion as well as lifting for prolonged periods.[4] To decrease the effects of prolonged standing, surgical team members should

- be positioned at the appropriate height for the level of the OR bed,

- be positioned as close as possible to the patient during performance of lifting and moving tasks, and
- take care to avoid awkward postures.[5,7]

During prolonged standing, staff members should face toward the work area when performing tasks and avoid reaching behind their shoulders.[4,5] Scrubbed staff members should not work with their necks flexed more than 30 degrees or rotated for more than one minute uninterrupted. Stretching and relaxing muscles regularly will facilitate reduction of stress and strain from awkward postures and static loading inherent in the perioperative work environment.[7]

Finally, as in any sterile procedure, infection control must be rigorously maintained. Infection control issues for nondisposable materials such as antifatigue matting and sit/stand stools must be addressed.[4]

CONCLUSION

The nature of perioperative work does not allow for elimination of the risks for musculoskeletal disorders; however, Ergonomic Tool 4 offers measures individuals can incorporate into their work to reduce risks of musculoskeletal disorders and other health effects from prolonged standing in the perioperative setting. The risks associated with prolonged standing are a well-documented occupational health and safety issue in the perioperative area. Some of this tool's recommendations are dependent on the purchasing decisions of the health care organization, and some are dependent on individual perioperative team members' choices and awareness of the risks.

Further research specific to perioperative settings is needed to evaluate technologies and strategies to reduce the risks associated with prolonged standing. Researchers should consider conducting studies using objective physiologic measures to validate the time limits identified in the ergonomic tool. It is important for future research to identify barriers and facilitators for implementing this ergonomic tool in clinical settings and to conduct evaluations of the benefits of using sit/stand stools appropriate for the perioperative setting. 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 American Nurses Association or the Veterans Health Administration.*

References

1. Static postures. Iowa State University Department of Environmental Health and Safety. http://www.ehs.iastate.edu/cms/default.asp?action=article&ID=88. Accessed September 23, 2010.
2. Pope MH, Goh KL, Magnusson ML. Annual review of biomedical engineering. *Spine Ergon.* 2002;4:49-68.
3. Low back musculoskeletal disorders: evidence for work-relatedness. In: *Musculoskeletal Disorders and Workplace Factors* [NIOSH Publication Number 97-141]. National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/docs/97-141/ergotxt6.html. Accessed September 23, 2010.
4. AORN guidance statement: Safe patient handling and movement in the perioperative setting. In: *Perioperative Standards and Recommended Practices.* Denver, CO: AORN, Inc; 2011:617-637.
5. Working in a standing position—basic information. Canadian Centre for Occupational Health & Safety (CCOHS). www.ccohs.ca/oshanswers/ergonomics/standing/standing_basic.html. Accessed September 23, 2010.
6. Beynon C, Reilly T. Spinal shrinkage during a seated break and standing break during simulated nursing tasks. *Appl Ergon.* 2001;32(6):617-622.
7. Wicker P. Manual handling in the perioperative environment. *Br J Perioper Nurs.* 2000;10(5):255-259.
8. Franco G, Fusetti L. Bernardino Ramazzini's early observations of the link between musculoskeletal disorders and ergonomic factors. *Appl Ergon.* 2004;35(1):67-70.
9. Cook J, Branch TP, Baranowski TJ, Hutton WC. The effect of surgical floor mats in prolonged standing: an EMG study of the lumbar paraspinal and anterior tibialis muscles. *J Biomed Eng*. 1993;15(3):247-250.
10. Kant IJ, de Jong LC, van Rijsssen-Moll M, Borm PJ. A survey of static and dynamic work postures of operating room staff. *Int Arch Occup Environ Health*. 1992;63(6):423-438.
11. Standing problem. *Hazards Magazine.* 2005;91. http://www.hazards.org/standing/. Accessed September 23, 2010.
12. Redfern MS. Cham R. The influence of flooring on standing comfort and fatigue. *Am Ind Hyg Assoc J.* 2000;61(5):700-708.
13. Tüchsen F, Krause N, Hannerz H, Burr H, Kristensen TS. Standing at work and varicose veins. *Scand J Work Environ Health*. 2000;26(5):414-420.
14. McCulloch J. Health risks associated with prolonged standing. *Work.* 2002;19(2):201-205.
15. Luke B, Mamelle N, Keith L, et al. The association between occupational factors and preterm birth: a

United States nurses' study. *Am J Obstet Gynecol.* 1995;173(3 Pt 1):849-862.
16. Ha E, Cho SI, Park H, et al. Does standing at work during pregnancy result in reduced infant birth weight? *J Occup Environ Med*. 2002;44(9):815-821.
17. Occupational health and safety physical hazard: working on your feet. Canadian Auto Workers Union. http://www.caw.ca/assets/pdf/Working_On_Your_Feet.pdf. Accessed September 23, 2010.
18. Tapp LM. Pregnancy & ergonomics: potential hazards & key safeguards. *Prof Saf.* 2000;45(8):29-32.
19. Buckle P, Stubbs DA, Baty D. Musculoskeletal disorders (and discomfort) and associated factors. In: Corlett N, Wilson J, Mananica J, eds. *Proceedings of the International Conference on Working Postures, Zadar, Yugoslavia.* London, England: Taylor and Francis Group; 1986.
20. Madeleine P, Voigt M, Arendt-Nielsen L. Subjective, physiological and biomechanical responses to prolonged manual work performed standing on hard and soft surfaces. *Eur J Appl Physiol Occup Physiol.* 1998;77(1-2):1-9.
21. Is ergo matting fatiguing or anti-fatiguing? *Options Online Newsletter.* May 2006. http://www.oiweb.com/pages/newsarchive06.html. Accessed September 23, 2010.
22. Baty D, Stubbs DA. Postural stress in geriatric nursing. *Int J Nurs Stud.* 1987;24(4):339-344.

Nancy L. Hughes, MS, RN, is the director of the Center for Occupational and Environmental Health at the American Nurses Association, Silver Spring, MD. *Ms Hughes has 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.*

Mary W. Matz, MSPH, is a manager/consultant and industrial hygienist in the VHA Patient Safety Center of Inquiry at the James A. Haley Veterans Hospital, Tampa, FL. *Ms Matz has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

John D. Lloyd, PhD, MErgS, CPE, is the associate director of Health Science Research & Development Rehabilitation at the Patient Safety Center of Inquiry, James A. Haley Veterans Affairs Medical Center, Tampa, FL. *Dr Lloyd has no declared affiliation that could be perceived as posing a potential conflict of interest in the publication of this article.*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.