Guidelines for the Prevention of Work-Related Musculoskeletal Disorders for Cardiac Sonographers: Recommendations from the American Society of Echocardiography

Ashlee Davis, BSMI, ACS, RDCS, RCCS, FASE, (Chair), Allyson Boyle, MHA, ACS, RDCS, FASE, (Co-Chair), Jennifer Acevedo, ACS, RDCS, FASE, Jennifer Hake, RDCS, RDMS, RVT, FASE, Joshua Lander, ACS, RCS, FASE, Patrice McKay, RDCS, FASE, Dermot Phelan, MD, PhD, FASE, Brad J. Roberts, BS, ACS, FASE, and Triston Thompson, MHA, ACS, RCS, RDCS, RVT, FASE, *Durham, and Charlotte, North Carolina; Chicago, Illinois; Tacoma, Washington; Bozeman, Montana; West Palm Beach, Florida; and Plano and Houston, Texas*

Work-related musculoskeletal disorders (WRMSDs) affect up to 90% of cardiovascular sonographers and remain a leading cause of occupational injury despite improvements in technology and awareness. These guidelines, developed by the American Society of Echocardiography, provide evidence-based recommendations to reduce WRMSD risk through a shared-responsibility framework involving employers, sonographers, educators, manufacturers, and healthcare administrators. Topics include ergonomic equipment standards, safe scanning practices, environmental design, scheduling strategies, early symptom recognition, and the integration of technologies such as artificial intelligence and wearable feedback tools. Emphasis is placed on education, injury prevention, and cultivating a workplace culture that prioritizes safety and sustainability. These recommendations aim to preserve the long-term health and diagnostic capabilities of the cardiovascular sonography workforce. (J Am Soc Echocardiogr 2026;39:699-716.)

Keywords: Work-related musculoskeletal disorders, Echocardiography, Sonographer ergonomics, Occupational injury prevention, Ultrasound equipment

From the Duke University Hospital, Durham (A.D.), and Sanger Heart and Vascular Institute, Atrium Health, Charlotte (A.B., D.P.), North Carolina; Lurie Children's Hospital of Chicago, Chicago, Illinois (J.A.); Seattle Children's Hospital, Tacoma, Washington (J.H.); Bozeman Health Deaconess Hospital, Bozeman, Montana (J.L.); Thomas H. Corey VA Medical Center, West Palm Beach, Florida (P.M.); and Baylor Scott & White The Heart Hospital Cardiovascular Institute, Plano (B.R.), Baylor St. Luke's Medical Center, Houston (T.T.), Texas.

Reprint requests: American Society of Echocardiography, Meridian Corporate Center, 2530 Meridian Parkway, Suite 450, Durham, NC 27713 (E-mail: ase@asecho.org).

https://doi.org/10.1016/j.echo.2026.04.018

TABLE OF CONTENTS

INTRODUCTION

Work-related musculoskeletal disorders (WRMSDs) are a well-recognized occupational hazard in the sonography profession.[1,3] Cardiovascular sonographers are at particularly high risk due to the physical demands of echocardiography, which require prolonged transducer pressure, repetitive scanning, and sustained static postures to obtain high-quality images.[2] These demands often result in awkward neck and trunk positioning, shoulder abduction, and excessive reaching, contributing to significant musculoskeletal strain. In the United States and several other countries, echocardiographic image acquisition is primarily performed by sonographers, whereas in many parts of the world these examinations are performed by physicians, reflecting differences in workforce structure and ergonomic exposure. Accordingly, while this document focuses on cardiovascular sonographers, the principles and recommendations are broadly applicable to all healthcare professionals who perform cardiac ultrasound. Additionally, sustained grip force and downward pressure on the transducer place further stress on the wrists, forearms, and shoulders.[4] Despite advances in ergonomic equipment and increased awareness, WRMSDs affect up to 90% of sonographers during their careers.[7] Symptoms may develop within the first 6 months of employment, underscoring the need for early and effective preventive strategies.[7]

In response, the American Society of Echocardiography (ASE) has developed these evidence-based guidelines to address WRMSD prevention in cardiovascular sonographers. This document provides practical, implementable strategies to reduce ergonomic risk, improve workflow efficiency, and promote a culture of safety within healthcare institutions. It also emphasizes collaboration among employers, sonographers, educators, and manufacturers to support sustainable practice.[8] These recommendations aim to protect the long-term health of the sonography workforce while maintaining excellence in patient care.

Key Points

- Cardiovascular sonographers are at high risk for WRMSDs due to sustained static postures, repetitive motion, and transducer grip force.
- Symptoms may develop within the first 6 months of employment, emphasizing the need for early intervention.
- WRMSDs affect up to 90% of sonographers, underscoring the urgency of targeted prevention strategies.

Abbreviations

AI = Artificial intelligence

ASE = American Society of Echocardiography

IAC = Intersocietal Accreditation Commission

UEA = Ultrasound-enhancing agent

WRMSD = Work-related musculoskeletal disorder

CURRENT RECOMMENDATIONS

The prevention of WRMSDs in sonography is a priority for major professional organizations. The Society of Diagnostic Medical Sonography (SDMS) established industry standards following its 2016 Consensus Conference, outlining responsibilities for equipment design, employer practices, education, advocacy, and sonographer best practices and serving as the foundation for ergonomic and injury prevention efforts.[1,9,29]

These standards are endorsed by the American Institute of Ultrasound in Medicine (AIUM) and the Society for Vascular Ultrasound (SVU), which emphasize ongoing education, collaborative engagement among stakeholders, and continued research to advance ergonomic design and injury prevention.[2,4,8]

The Intersocietal Accreditation Commission (IAC) incorporates ergonomic risk reduction into its accreditation standards and supports WRMSD education through training and educational initiatives focused on workload and injury prevention.[6,10-14]

This document builds on these established recommendations by integrating emerging data and technologies to further support sonographer health, safety, and sustainable practice.[1,7,8]

STAKEHOLDER RESPONSIBILITIES

Shift from Individual to Shared Responsibility

Accurate diagnostic imaging depends not only on advanced technology but also on the health and expertise of the sonographer. Prevailing expectations often assume that high-quality imaging can be achieved regardless of personal, environmental, or equipment-related challenges, an unrealistic view that contributes to the high incidence of WRMSDs.[1]

Historically, occupational health has emphasized individual responsibility, placing the onus on sonographers to manage their well-being even in high-risk conditions. However, research such as the WRMSD Grand Challenge Alliance highlights the need for a systemic approach, identifying interconnected factors, from equipment limitations to training gaps, that require coordinated solutions across the healthcare system.[7]

Prevention of WRMSDs must move beyond the individual to a model of shared responsibility. The following sections outline the distinct but interdependent roles of employers, sonographers, manufacturers, and educators in fostering safer, more sustainable work environments.

Employer and Hospital Administration

Employers and hospital administrators play a pivotal role in protecting the ergonomic health and well-being of cardiovascular sonographers. As stewards of the work environment, they shape the structural, cultural, and operational conditions under which sonographers perform their duties. While individuals are responsible for safe scanning practices, institutional leadership ultimately determines whether ergonomics are prioritized. Without visible and sustained support, even well-designed interventions may face barriers to success.

A proactive workplace culture that prioritizes WRMSD prevention is essential. Leadership should integrate ergonomics into daily operations, strategic planning, and quality improvement initiatives.

Demonstrate a Visible Commitment to Safety. Leaders should foster a psychologically safe environment that supports early reporting and transparent communication. Encouraging timely disclosure of symptoms without fear of retaliation enables early intervention and may reduce injury severity.[1] Assigning safety champions, engaging with frontline staff, and ensuring access to ergonomic resources reinforce safety as a core institutional value.

Conduct Regular Ergonomic Risk Assessments. Annual assessments, conducted with active sonographer involvement, are essential to identifying hazards related to workspace design, environmental conditions, scanning protocols, and scheduling practices.[4] Findings should be documented, with corrective action timelines to support accountability and continuous improvement.

Integrate Ergonomics into Equipment Procurement. Equipment selection is a key opportunity to prevent injury. Sonographers should be included in procurement decisions to ensure that systems, transducers, tables, and chairs meet ergonomic standards and offer appropriate adjustability.[5] Investment in ergonomically optimized technology, including AI-assisted platforms and lightweight transducers, supports safer practice.[15,13]

Design Ergonomically Supportive Workspaces. Physical layout directly affects biomechanical stress and scanning efficiency.[7] Administrators should collaborate with frontline staff and facility planners to ensure exam rooms support optimal positioning, maneuverability, and accommodation of patient and staff needs (see WRMSD Prevention).

Align Scheduling Practices with Injury Risk. Workload management is a modifiable factor with significant implications for WRMSD risk.[6] Administrators should ensure patient volumes are realistic, exam times reflect study complexity, and breaks are protected. Scheduling policies should balance operational efficiency with staff well-being (see Scheduling and Workload Management).

In addition to direct medical and financial costs, WRMSDs may reduce workforce capacity when experienced sonographers limit clinical duties or leave the workforce. This may decrease laboratory throughput, increase workload for remaining staff, and amplify injury risk, underscoring the operational value of investing in sonographer well-being.

Embed WRMSD Prevention into Institutional Policy. Formal protocols for injury reporting, microbreaks, and return-to-work accommodations support consistency in practice.[5,6,13] These policies reduce ambiguity and position injury prevention as an organizational priority.

Budget for Ergonomics and Staff Support. Administrative commitment should include dedicated financial investment. Budget planning should incorporate ongoing support for ergonomic equipment, workspace optimization, and continuing education, as well as collaboration with occupational health and safety teams.[12]

Involve Sonographers in Decision-Making. Incorporating sonographer input into workflow, environment, and technology decisions improves feasibility and effectiveness. Participation in planning efforts, such as space design and protocol development, helps ensure solutions are practical and aligned with clinical care.[12,16]

By adopting these practices, employers and administrators can reduce preventable injury while supporting clinical quality, staff retention, and organizational resilience. Prevention of WRMSD should be recognized as a strategic priority integral to both employee health and patient care.

Manufacturers

Given the exceptionally high rate of WRMSDs in the sonography profession, it is imperative that ultrasound equipment manufacturers emphasize good ergonomic design in all machines, peripherals, and accessories. This includes not only developing products that accommodate a wide range of body types, work styles, and scanning environments, but also integrating ergonomic principles based on established WRMSD risk factors.[8]

Design Informed by Real-World Use. Manufacturers should consider the clinical realities in which their equipment is used. While ergonomic optimization in controlled environments is important, design should also reflect the variability of real-world practice, including tight exam spaces, portable imaging in crowded hospital rooms, and patients who are difficult to position. Equipment that supports neutral body mechanics across a range of clinical settings, patient sizes, and sonographer handedness may help reduce ergonomic strain (Table 1).[17]

Commitment beyond Design: Training and Support. Ergonomic success is not achieved through product design alone. Manufacturers have a responsibility to train users, comprehensively and repeatedly, on how to operate systems using ergonomic best practices. This includes in-depth applications training, demonstrations of ergonomic adjustments, real-time feedback on positioning and workflow, and educational materials that emphasize WRMSD prevention.[18] Training is particularly critical given that many systems include multiple adjustable features that may go unused if not clearly demonstrated.

Ongoing Industry Responsibility. The industry's role in protecting sonographers from injury extends beyond manufacturing and initial product delivery. Ongoing partnerships are essential. Industry leaders should

- Track and analyze injury trends related to equipment use.
- Participate in longitudinal ergonomic outcomes research.
- Continuously improve product design in response to evolving workplace challenges.
- Remain accountable for the full lifecycle of ergonomic performance, from research and development through clinical application.[19]

Sonographers

Prevention of WRMSDs requires consistent application of ergonomic practices. Sonographers, including students and physicians who scan, play a critical role in protecting their own health by identifying workplace hazards, applying self-management strategies, and optimizing their environment to minimize exposure to risk factors.[20] To reduce risk, sonographers should adjust the system, bed, and chair before each exam and incorporate microbreaks and visual rest throughout the day (see WRMSD Prevention: Optimal Sonographer Positioning).[21] Figures 1 and 2 illustrate common ergonomic errors and optimal body positioning, including guidance for both right- and left-handed sonographers.

Table 1 Manufacturer equipment ergonomics

Component	Ergonomic standards	Rationale/Impact
System console and mobility	Height-adjustable console for seated/standing use; accommodates 5th-95th percentile users; ample leg clearance; push/pull force ≤50 lbs; low-rolling-resistance casters; front/rear transport handles; accessible steering/brake controls	Reduces whole-body strain during setup/transport; supports neutral posture across user sizes and tasks; safer movement between rooms/intensive care unit
Control panel/deck	Independent height/tilt/axial rotation from monitor; lateral slide to minimize reach; programmable soft keys; left/right-handed layouts; reduced keystrokes (macros/shortcuts)	Keeps elbows ~90° and wrists neutral; limits repetitive motions and long reaches; accommodates handedness and workflow variability
Monitor/display	Independent height/tilt/depth; single-hand quick-lock; anti-glare, high-contrast panel; clear off-axis viewing; eye-screen distance 20-40 in (50-100 cm); allows centering with operator's midline	Maintains neutral head/neck; reduces visual fatigue and cervical rotation; supports shared viewing during teaching without awkward posture
Transducers (probes)	Lightweight, balanced housings; supportive palmar grip geometry; textured, non-slip surfaces; minimally required cable torque; quick-release/one-hand probe changes; optional on-probe controls (freeze/gain)	Lowers wrist deviation and pinch force; reduces forearm/shoulder load; faster exchanges reduce static postures
Cables and cable management	Flexible, lightweight, appropriate length; integrated cable hooks/ports; compatibility with wearable cable supports	Decreases shoulder abduction and contact pressure; reduces trip hazards and clutter that force awkward positioning
Exam table	Electric height-adjustable with generous vertical range; cardiac cutout/drop-away for apical access; lateral shift; Trendelenburg capability; side rails and transfer aids; bariatric ratings; easy brake access	Brings patient to the sonographer (not vice versa), minimizing reach and trunk flexion; safer transfers lower injury risk
Seating (scanning chair)	Seat height/depth and backrest adjustable; lumbar support; footrest platform; ~10°-20° seatback inclination; 360° swivel; slim arms or no armrests (to preserve proximity)	Supports neutral spine and elbow angles; enables smooth rotation between patient and console without overreaching
Foot support	Stable, nonslip, height-adjustable footrest or integrated console foot platform	Maintains hip-knee-ankle alignment and reduces lumbar load during prolonged seated scans
Accessories and supports	Gel dispensers requiring minimal grip force; soft arm supports/bolsters; antifatigue mats for standing; textured, form-fitting gloves; probe holders near point-of-use	Lowers sustained muscle exertion and contact pressure; shortens reach; improves comfort in long cases
External/secondary displays	Optional auxiliary monitor on adjustable arm for physician/learner viewing; capability for wireless image casting to external displays (e.g., TV, cath lab monitor, or control room screen)	Prevents the sonographer from twisting the neck/torso for shared viewing; improves teaching ergonomics
Software and automation	Auto-measurements (e.g., chamber quantification, border detection), user-programmable presets, context-aware protocols, voice/foot controls where safe	Cuts repetitive keystrokes/trackball use; shortens probe-on-chest time; supports consistency and reduces strain
Training and documentation	Embedded ergonomic setup guides; on-device prompts for monitor/deck positioning; comprehensive applications training at installation and refreshers	Ensures that adjustable features are used; translates design into sustained ergonomic benefit

Safe Patient Handling. Sonographers should not reposition or transfer patients without appropriate assistance and training. Manual handling tasks are a well-documented source of injury and should be performed using proper lifting or positioning devices.[22] Adherence to institutional safe patient handling protocols is essential.[23]

Proactive Health and Communication. If pain or injury symptoms arise, sonographers should report ergonomic concerns and seek medical evaluation early. Prompt communication supports early intervention and may prevent progression to chronic injury.[2] Collaboration with managers on staffing, scheduling, and task rotation can further reduce cumulative strain.[8]

Personal Wellness. Personal wellness practices, including adequate sleep, regular physical activity, and stress management, support musculoskeletal resilience and overall well-being.[7] Maintaining these habits can help sustain long-term career health.

School and Teaching Institutions

Schools and teaching institutions play a critical role in preparing sonographers to prevent WRMSDs. Early education in ergonomic

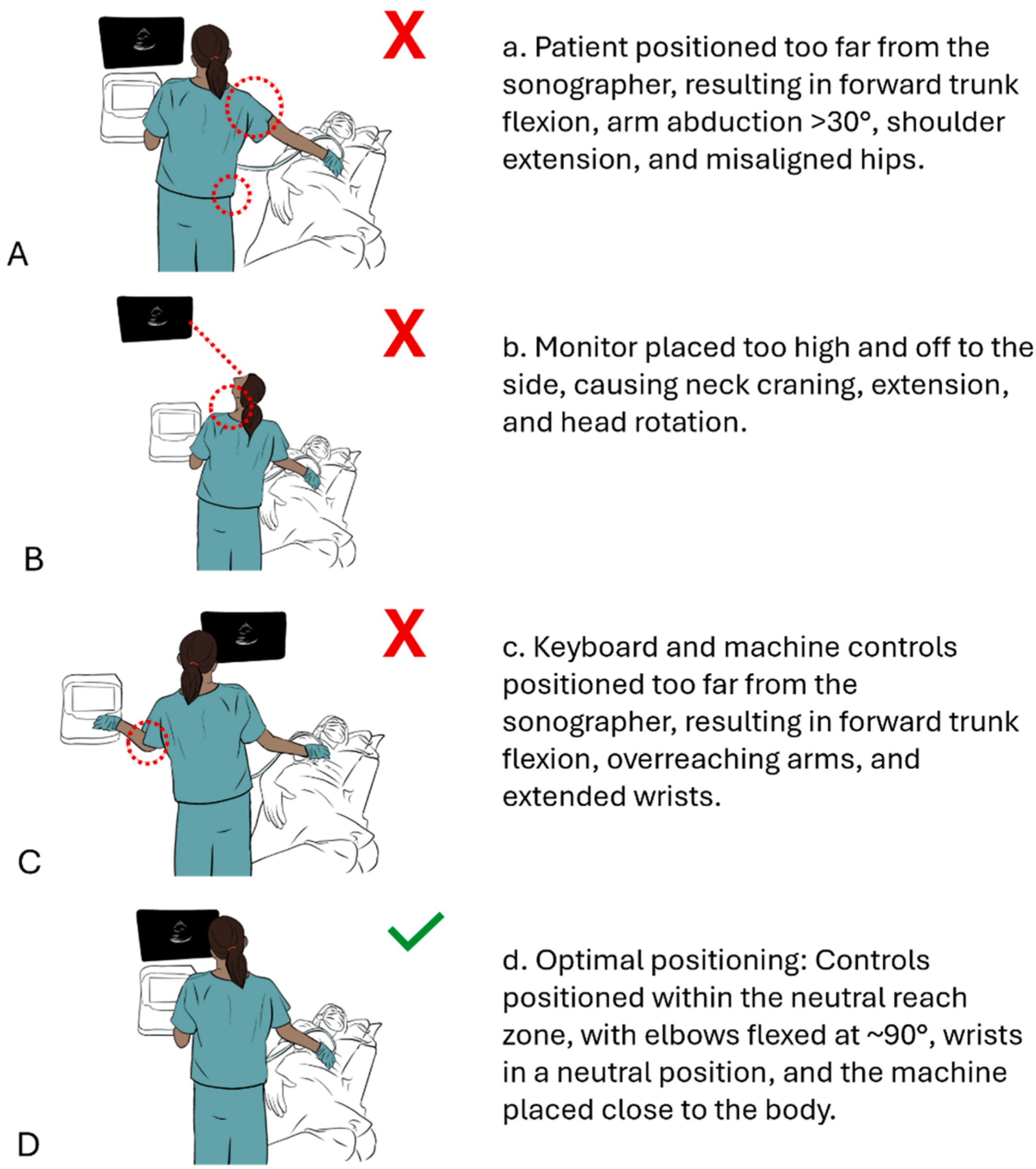

Figure 1 Comparison of suboptimal **(A, B, C)** and optimal **(D)** ergonomic scanning postures. Incorrect setups can result in excessive reach, arm abduction, neck strain, and wrist extension—all contributors to WRMSDs. Optimal positioning minimizes physical stress through upright posture, minimal reach, and monitor alignment at eye level.

principles is essential, as establishing proper scanning habits is more effective than correcting them after injury or years in practice.[23] Identifying common errors and teaching proper technique early in training is critical. Ergonomic education should begin on day one.[8]

Programs should manage total probe-time exposure and integrate ergonomics into training by demonstrating neutral posture, proper probe handling, and optimal room, machine, and patient positioning (see WRMSD Prevention: Optimal Sonographer Positioning). Education should also include preventive strategies such as warm-ups and microbreaks, as outlined in the Exercise and Complementary Therapies section. Instilling these habits early supports long, injury-free careers.[19]

Key Points

- WRMSD prevention requires a shared-responsibility model involving employers, sonographers, educators, and manufacturers.
- Institutional leadership plays a critical role in shaping ergonomic culture, resource allocation, and workflow design.
- Sonographers are responsible for applying safe practices, reporting symptoms early, and optimizing their work environment.
- Education and training programs are essential for establishing lifelong ergonomic habits and preventing early-career injury.

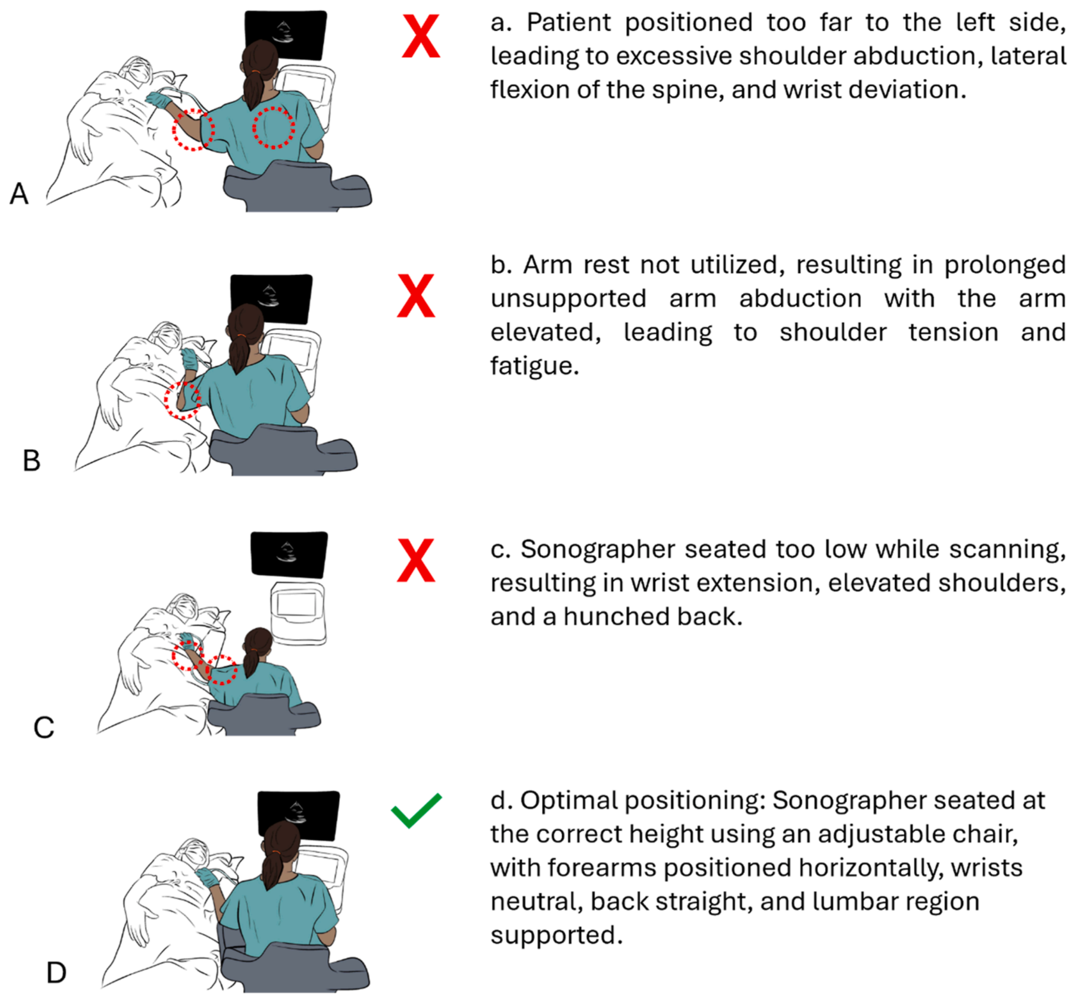

Figure 2 Comparison of suboptimal **(A, B, C)** and optimal **(D)** ergonomic scanning postures for left-handed sonographers. Improper positioning during left-handed scanning can result in shoulder elevation, spinal misalignment, and wrist extension. Ergonomic corrections such as proper patient proximity, arm support, and seated posture reduce strain and support sonographer well-being.

WRMSD PREVENTION

Scanning Environment and Work Practices

Work-related musculoskeletal disorders develop gradually and are often influenced by environmental and organizational factors. When sonographers lack ergonomic tools or adequate space, they may adopt suboptimal postures and repetitive movements that increase injury risk.

Ergonomic Work Practices. Environmental and organizational factors play a key role in mitigating or exacerbating WRMSD risk. Optimizing tools, room design, equipment adjustability, and operator positioning support safer scanning conditions and reduce physical strain.[5]

Use of Supportive Tools and Accessories. Supportive accessories can reduce musculoskeletal load during scanning. For example, wearable cable support devices redistribute the weight of the transducer cable, reducing arm fatigue and torque on the wrist and shoulder.[19] Cables should not be looped around the neck, as this may contribute to cervical strain.[22]

Scanning Room Design and Layout. The physical layout of the scanning room should allow for efficient movement and positioning. A minimum of 150 square feet is recommended to accommodate equipment, patient, and operator needs.[1] Floors should enable smooth equipment movement, and room design should support repositioning of chairs, tables, and machines. Adjustable lighting and temperature controls are also important for optimizing scanning conditions and comfort.[5] Frequently used supplies should be within easy reach to minimize unnecessary bending or stretching.

Equipment Configuration and Adjustability. Imaging systems should be adjustable to accommodate different users and scanning positions. Ultrasound consoles should support both seated and standing use, with independently adjustable keyboards, monitors, and control panels. Examination tables should be height-adjustable, allow lateral movement and Trendelenburg positioning, and include cardiac cutouts for apical access.[1] Scanning chairs should provide height and depth adjustment, lumbar support, a footrest, and slight recline. Armrests, if used, should be adjustable to maintain proximity to the patient without restricting access.[5]

Optimal Sonographer Positioning. Safe scanning begins with thoughtful preparation. Before each exam, operators should adjust

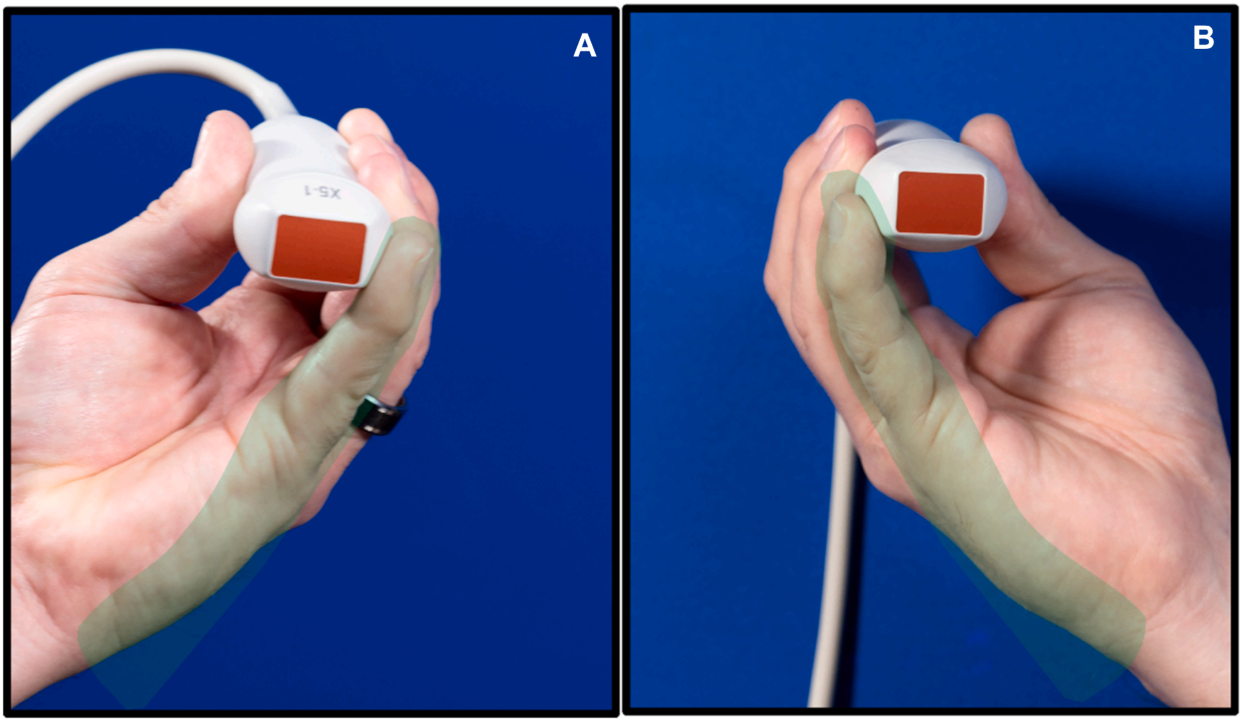

Figure 3 Standard left-handed **(A)** and right-handed **(B)** probe grips illustrating their mirrored configurations. Both demonstrate a fingertip grip with an opposing thumb technique, in which the probe body is held away from the palm. The *green-shaded areas* represent the probe-patient contact zones, which course along the ulnar side of the hand. These anchor points are critical for providing tactile feedback regarding probe positioning, applying downward pressure, and maintaining a stable imaging window.

equipment and patient position based on body habitus and study type. The patient, exam table, and ultrasound system should be positioned as close together as possible to minimize excessive reaching or arm elevation.[18] The monitor should be aligned with the operator's midline, placed at or slightly below eye level, and viewed from a minimum distance of 24 inches, with a slight backward tilt to encourage neutral neck posture.[8] The scanning arm should remain relaxed and close to the body, with the elbow bent at approximately 90° and the shoulder in a neutral position. When extended reach cannot be avoided, arm supports, cushions, or bolsters are recommended to reduce load on the shoulder and upper back.[22]

Transducer Handling and Grip Mechanics. Proper grip of the transducer is essential for image quality, dexterity, and injury prevention. The sonographer's hand serves as the physical interface between the patient, the transducer, and the ultrasound system. With experience, fine motor control becomes intuitive; however, the foundation of a neutral wrist and efficient grip should be taught early and reinforced throughout clinical practice.

A common novice error is to fully wrap the fingers around the transducer handle, like gripping a hammer. While strong, this grip limits fine control and places the wrist in a strained, non-neutral position. A more ergonomic technique involves grasping the probe lightly with the fingertips (up to the first knuckle) and positioning the thumb opposite the fingers. This "standard grip" maintains dexterity while reducing wrist strain and should be used in most imaging windows (Figure 3).

The probe should be held so that tactile contact points, referred to as probe-patient anchor areas, are formed along the patient-facing side of the hand (Figure 4). These anchors provide essential feedback regarding probe position, pressure, and stability, particularly when manipulating machine controls or performing measurements with the opposite hand. They also offer support for the hand and wrist, contributing to whole-body ergonomic alignment and reducing strain. Regardless of the grip being used, some degree of probe-patient contact anchor is necessary for the fine manipulation required during scanning.

While the standard grip is broadly applicable, certain imaging windows require modification based on handedness and anatomical approach.

- An overhand grip is typically used for subcostal long- and short-axis cardiac views and may revert to the standard grip with a vertical probe orientation for abdominal imaging (Figure 4).
- Left-handed sonographers may require a reverse or underhand grip for apical imaging, flipping the probe in the hand while maintaining an anchor area along the dorsal index finger (Figure 5).
- For parasternal and suprasternal views, both left- and right-handed sonographers generally maintain the standard grip, with only minor wrist or probe orientation adjustments based on position and patient anatomy (Figure 6).

Routine hand, wrist, and forearm strengthening exercises using inexpensive tools may further reduce injury risk by improving endurance and control.

Key Points

- The transducer grip should allow for fine motor control while maintaining a neutral wrist position.
- A fingertip grip with an opposing thumb provides stability without sacrificing dexterity.
- Probe-patient anchor areas help maintain image quality and reduce excessive transducer pressure.
- Strengthening exercises that target the hand and forearm may support long-term musculoskeletal health.

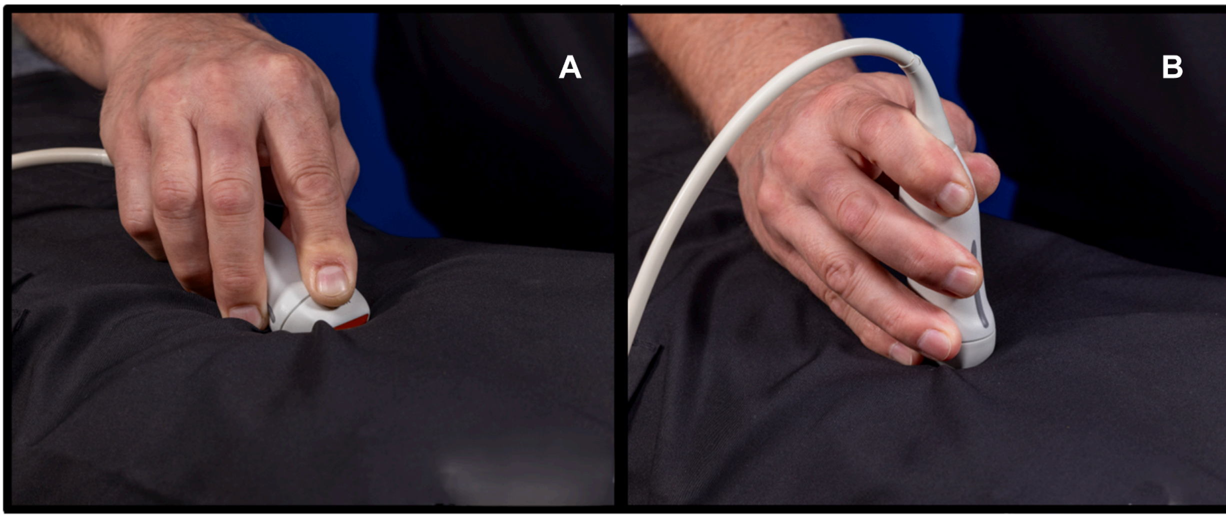

Figure 4 In the subcostal window, an overhand probe grip **(A)** is used for both long-axis and short-axis views of the heart. The index finger presses on the top center of the probe to assist with downward pressure. When imaging the aorta and inferior vena cava in long-axis or transverse views the grip should return to the standard grip **(B)** with the ulnar side of the hand functioning as the probe-patient contact anchor.

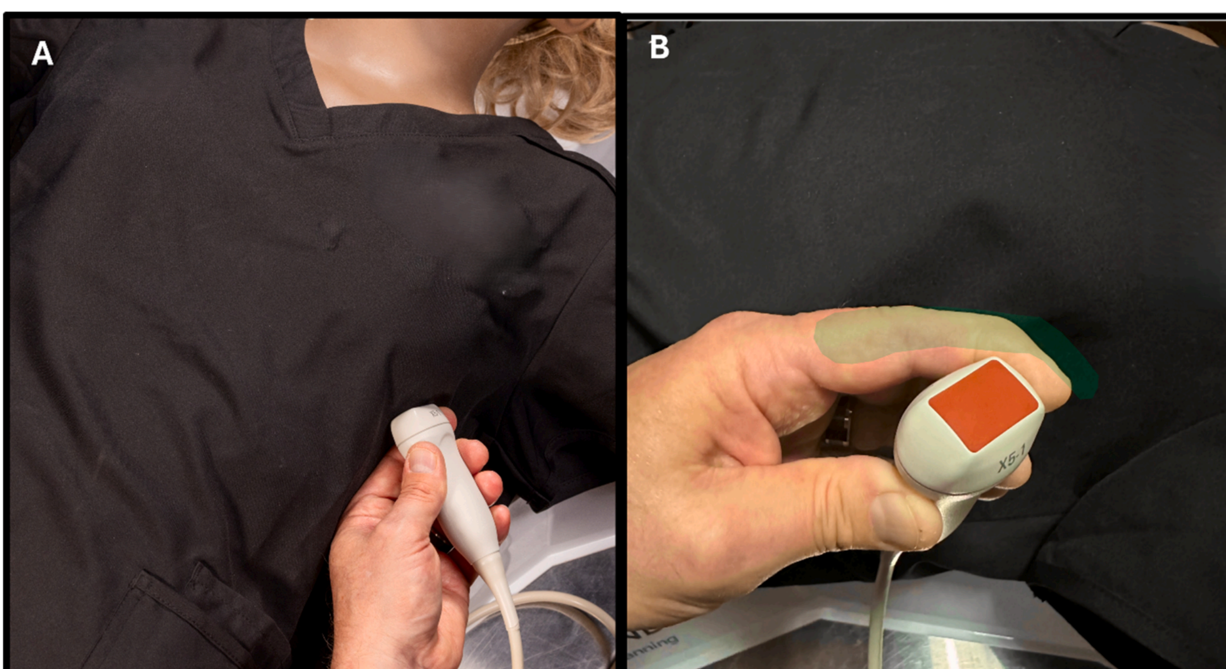

Figure 5 Left-handed probe grip when scanning in the apical window **(A)** requires an underhand grip. In this grip the probe-patient anchor area (*green shaded*, **B**) courses along the top surface of the index finger.

Physical Conditioning and Early Intervention Strategies

Workplace exercises and complementary therapies play an important role in preventing and managing WRMSDs. These interventions support musculoskeletal health, improve recovery, and enhance overall well-being. Integrating structured movement into the daily workflow can help reduce injury risk and support long-term sustainability.[24] Table 2 outlines exercise categories tailored for sonographers, including warm-ups, active breaks, rehabilitative movements, and restorative therapies.

Exercise and Complementary Therapies. Complementary approaches, including mind-body practices and manual therapies, may support workplace exercise by improving flexibility, reducing stress, and promoting postural balance. Examples include yoga, Pilates, acupuncture, massage therapy, and chiropractic care. These

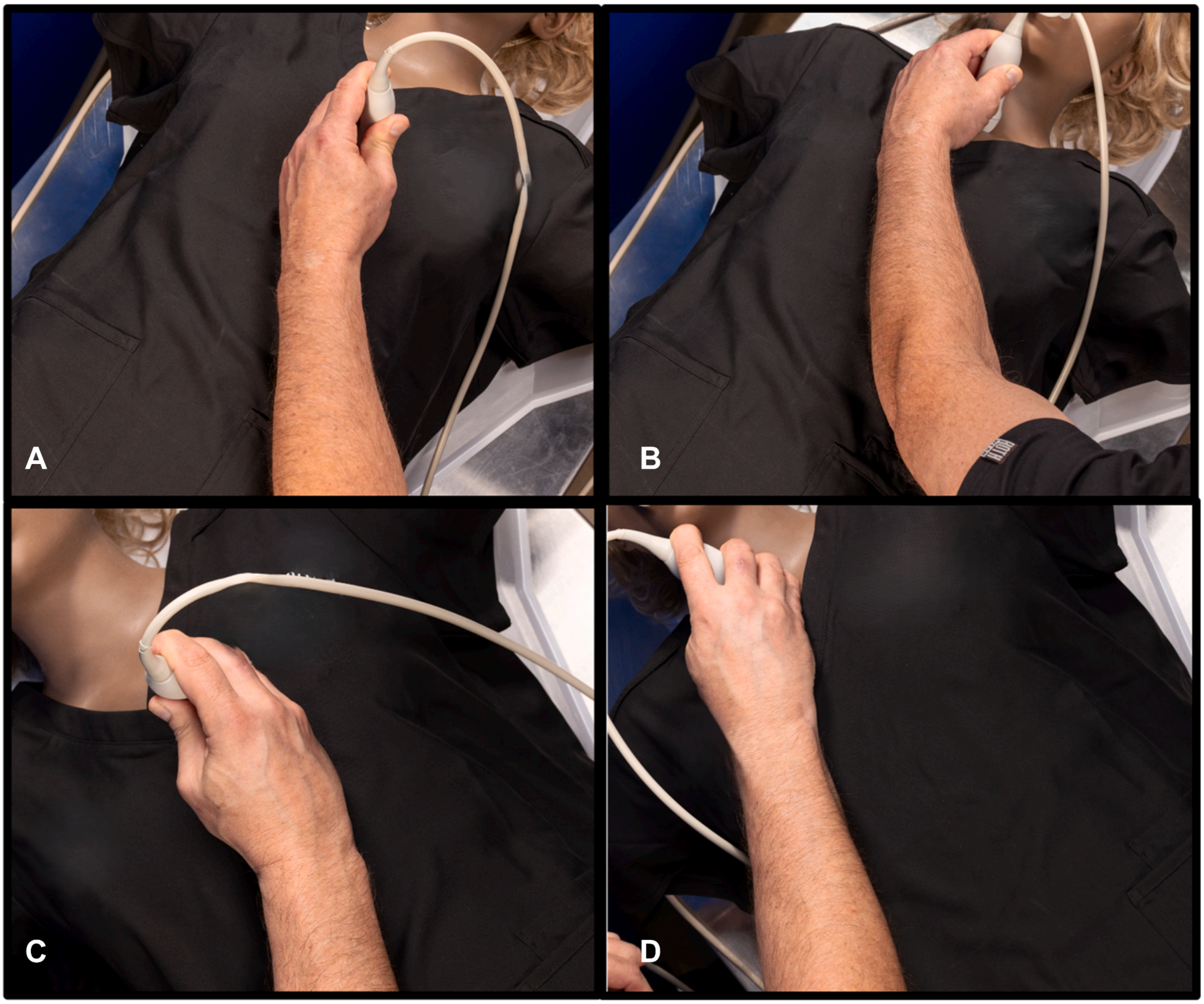

Figure 6 Probe grip and positioning are demonstrated for both left-handed and right-handed scanning in the parasternal and suprasternal notch imaging windows. Left-handed probe grips are shown for the parasternal **(A)** and suprasternal notch **(B)** views; right-handed probe grips are shown for the parasternal **(C)** and suprasternal notch **(D)** views. In both imaging windows, sonographers generally maintain the standard grip, with only minor wrist or probe orientation adjustments as needed based on scanning position and patient anatomy.

approaches should complement, not replace, core ergonomic strategies and structured exercise programs.

Incorporating Microbreaks and User-Based Habits. Micro-breaks during examinations can reduce sustained muscle contraction and relieve strain. Even brief pauses, such as removing the transducer from the patient and relaxing the hand, may reduce load on the scanning arm and shoulder.[8,25] Regular strength training supports spinal stability and reduces susceptibility to repetitive strain injuries.[25,24] Cardiovascular fitness is also important, with a recommended goal of at least 30 minutes of moderate-intensity activity on most days of the week.[25] These practices support resilience, recovery, and long-term musculoskeletal health.[19,16]

Recognizing Early Signs of WRMSDs. Early recognition is critical to preventing long-term injury.[18,19,26] Symptoms are often normalized as "part of the job," delaying intervention until more advanced stages.[7,18] Table 3 outlines common early symptoms and associated conditions to support early identification and response.

Taking Prompt Action to Prevent Progression. Delayed intervention may result in worsening symptoms, permanent injury, reduced efficiency, lost work time, and increased healthcare costs.[18,19,26] Early action, including activity modification, ergonomic adjustments, medical evaluation, and physical therapy, may prevent progression to chronic injury.[19,16]

Key Points

- Daily warm-ups and midshift stretches (3-5 minutes) can reduce muscle fatigue.
- Micro-breaks during scanning help relieve sustained muscle contraction.
- Regular strength training and cardiovascular activity support musculoskeletal resilience.
- Early recognition and intervention are critical to prevent progression of WRMSDs.

Table 2 Exercise for sonographers

Category	Purpose	Example activities
Preparatory exercise (warm-up)	Preventive—prepares the body for static and repetitive scanning motions	Dynamic stretches, gentle mobility drills, light resistance band exercises
Compensatory exercise (active breaks)	Preventive/rehabilitative—offsets strain from sustained postures	Shoulder rolls, wrist flexion/extension stretches, seated back twists
Relaxation and mind-body interventions	Restorative—reduces fatigue and mental stress after work	Stretching with breath control, guided meditation, progressive muscle relaxation
Therapeutic exercise and rehabilitation	Rehabilitative—restores function for those with symptoms or injury	Targeted strengthening/flexibility programs prescribed by physical therapy or occupational health
Maintenance or conservation exercise	Long-term prevention—preserves gains, promotes resilience	Ongoing stretching routines, Pilates, yoga, or low-impact conditioning

Exercise selection and frequency should be individualized based on workload, symptoms, and occupational health guidance.

Table 3 Common early symptoms and underlying conditions

Symptom	Possible underlying condition
Aching or fatigue in the shoulder, neck, wrist, or back (especially after scanning)	Muscle overuse, tendonitis, or early strain injury
Tingling, numbness, or burning sensations in hands or fingers	Nerve compression or entrapment (e.g., carpal tunnel, cubital tunnel)
Reduced grip strength or clumsiness with fine motor tasks	Median or ulnar nerve involvement; wrist tendonitis
Pain that improves with rest but returns during or after shifts	Early tendon inflammation or repetitive strain injury
Stiffness or reduced range of motion in joints	Joint irritation, bursitis, or muscle imbalance from static postures
Swelling or visible inflammation near frequently used joints	Tendon sheath inflammation (tenosynovitis) or localized bursitis

Early reporting and ergonomic intervention are strongly recommended to prevent progression to chronic injury.

Ergonomic Safety and Clinical Quality Protocols

In echocardiography, well-defined acquisition protocols support diagnostic consistency and image quality. However, their design and implementation can also influence the physical demands placed on sonographers. This section outlines strategies for developing protocols that support both clinical excellence and ergonomic safety.

Acquisition Protocols and Ergonomic Implications. Standardized protocols ensure consistency and completeness but may also affect sonographer workload and ergonomic risk.[7,27,15] Optimizing protocols with both clinical and physical demands in mind is an important strategy for reducing WRMSDs.[22,15]

Balancing Standardization with Flexibility. Protocols provide structure and reduce cognitive load, ensuring that key images and measurements are obtained consistently. However, rigid protocols that require unnecessary or duplicative images, extreme probe positioning, or limited flexibility for patient habitus can increase scan time and physical strain without improving clinical value.[7,27,15] Protocols should define core required views while allowing flexibility for experienced sonographers to adapt acquisition based on clinical indication, patient condition, and imaging feasibility, provided essential diagnostic elements are obtained.[15,16]

Strategies for Ergonomic-Friendly Protocols. Protocols should be evidence-based, aligned with ASE and IAC standards, and structured to distinguish required from optional measurements.[5,7,15,13] They should allow patient-specific modification based on imaging windows or physical limitations and be supported by workflow tools such as automated measurements, labeling shortcuts, and AI-guided acquisition aids.[8,9] Institutions should also assess the physical impact of protocol requirements. Regular review, ideally every 12 to 24 months, should include input from sonographers, medical and technical directors, and quality and occupational health representatives.[7,13] This approach helps ensure protocols remain clinically relevant, feasible, and ergonomically safe.

Key Points

- Acquisition protocols directly influence sonographer workload and ergonomic risk.
- Rigid or overly complex protocols may increase scan time and physical strain without improving clinical value.
- Protocols should balance standardization with flexibility to accommodate patient variability and imaging feasibility.
- Regular protocol review with sonographer input is essential to maintain both diagnostic quality and ergonomic safety.

Scheduling and Workload Management

Maintaining diagnostic proficiency requires a minimum annual volume of echocardiographic studies; however, current standards do not define safe daily workload limits. Sonographer workload should account for the physical demands of each exam, which vary based on patient condition, study complexity, and workflow. This section outlines factors influencing scan duration and ergonomic strain, along with strategies to support sustainable scheduling.

Balancing Volume and Sonographer Health. The IAC requires annual procedure volumes sufficient to maintain proficiency but does not define maximum daily scan numbers.[5,13] Daily workload is a key determinant of both diagnostic quality and musculoskeletal safety.[7,19] The appropriate number of exams per sonographer depends on study complexity, patient characteristics, and additional responsibilities such as measurements and reporting.[7,15] Excessive throughput targets are associated with increased fatigue, higher injury risk, and potential compromise in patient care.[19,27]

Exam Complexity and Time Variability. Exam duration varies based on study type, pathology, patient body habitus, cooperation, and imaging quality.[7,27,15] A routine outpatient exam with favorable imaging conditions may be completed efficiently, whereas a nonambulatory inpatient with complex disease may require prolonged probe time, repeated repositioning, and multiple Doppler acquisitions.[15,16] These differences highlight the need to tailor scheduling based on case complexity rather than applying uniform time allocations.[7,16]

Study Type Considerations. Different echocardiographic study types carry distinct ergonomic implications. Limited examinations focused on specific clinical questions (e.g., left ventricular function) are typically shorter and involve fewer acquisitions.[7,15]

In contrast, comprehensive studies in patients with complex pathology or technically challenging imaging conditions often require prolonged scan time, repeated acquisitions, and patient repositioning, increasing physical workload and musculoskeletal risk.[27,16] These differences should be considered when assigning scan volume and scheduling to ensure both diagnostic quality and sonographer safety.

Interventional and structural echocardiography procedures may pose additional ergonomic risks due to prolonged case duration, constrained positioning, and the use of lead protective equipment. Consideration should be given to workload distribution, use of lighter-weight lead, and limiting continuous exposure time to reduce cumulative strain.

Fetal echocardiography presents distinct ergonomic challenges, often requiring prolonged scan times, sustained static postures, and fine motor control. Maternal body habitus, fetal position, and limited imaging windows may further increase physical strain. Extended time allocation, appropriate scheduling, and distribution of these studies among experienced sonographers may help reduce cumulative musculoskeletal risk.

Sonographer Experience. Experience level influences efficiency. Senior sonographers may identify optimal imaging windows more quickly and avoid unnecessary repetitions, whereas less experienced sonographers often require additional time.[7,19] Scheduling should account for this variability to prevent fatigue and support skill development.[16]

Outpatient versus Inpatient Scanning. Outpatient echocardiography generally allows for optimal ergonomics, with cooperative patients, adjustable equipment, and dedicated imaging spaces.[7,8]

In contrast, inpatient and portable exams present higher ergonomic risk due to constrained environments, immobile patients, and limited equipment adjustability.[27,15] Sonographers should adopt positions that promote neutral posture, minimize reach, and provide adequate support. When ideal positioning is not possible, attention to body mechanics and frequent repositioning is essential.

Additional challenges include limited ability to adjust bed height, suboptimal patient positioning, and restricted access. Whenever possible, sonographers should optimize bed height, reposition equipment, and request assistance for patient positioning. The use of portable stools, adjustable chairs, or support devices may further improve ergonomics.

Importantly, healthcare institutions should actively evaluate and minimize the use of portable echocardiographic studies when clinically appropriate. Reducing nonessential portable imaging decreases the physical demands associated with transporting and maneuvering equipment and facilitates examination in controlled laboratory environments that are designed to support ergonomic best practices. In addition to improving sonographer safety, laboratory-based imaging often allows for superior image quality and more efficient study acquisition. From an operational perspective, transporting medically stable patients to the echocardiography laboratory may also represent a more efficient use of personnel resources, optimizing sonographer productivity during a period of workforce shortage.

Table 4 outlines practical strategies to reduce strain during portable imaging. When feasible, medically stable patients should be scanned in dedicated echocardiography labs, reserving portable studies for those unable to travel safely.[7,13]

Impact of Pathology on Ergonomic Demand. Certain pathologies significantly increase scan duration and physical strain. For example, evaluation of complex valvular disease may require multiple imaging windows, advanced Doppler techniques, and prolonged scanning from nonneutral positions.[27,15] These cases should be recognized as higher ergonomic risk and scheduled accordingly.[7,16]

Smart Scheduling Tools. Smart scheduling integrates electronic medical record data, prior imaging, and AI-based tools to align study complexity with sonographer expertise and appropriate time allocation.[7,8,9] Predictive tools may identify cases requiring contrast or extended scan time, allowing for longer appointment slots.[8,15] Complex studies can be assigned to experienced sonographers, while routine exams may be scheduled more efficiently.[16] Table 5 provides suggested exam durations to support ergonomic safety and recovery.

Note that due to variability in vascular ultrasound examinations, recommended durations are outside the scope of this document. Refer to the Society of Vascular Ultrasound Professional Performance Guidelines for additional guidance. Society for Vascular Ultrasound. SVU Professional Performance Guidelines. Society for Vascular Ultrasound. Available at: https://www.svu.org/

Key Points

- Daily workload and exam complexity are major determinants of WRMSD risk.
- Scheduling should account for study type, patient factors, and sonographer experience.
- Portable and inpatient studies present higher ergonomic risk and require additional planning and support.
- Matching case complexity with appropriate time allocation and expertise can reduce strain and improve outcomes.

Table 4 Strategies to reduce strain during portable imaging

Strategy	Ergonomic benefit
Use smaller, lighter portable machines with ergonomic transport features	Reduces push/pull force, eases maneuvering in tight spaces, and minimizes setup strain
Request assistance with patient repositioning or transfer	Prevents overexertion and decreases risk of back or shoulder injury
Complete volumetric or detailed measurements after bedside acquisition in a more ergonomic setting	Shortens bedside scan duration and reduces prolonged static postures
Administer UEAs early	Improves image quality quickly, reduces repeated scanning, and limits probe-on-chest time
Schedule portable exams with adjusted time allowances	Acknowledges higher physical demand and prevents cumulative fatigue

Table 5 Recommended exam durations, in minutes

Reason for echocardiogram	Patient care time	Report preparation time	Scheduled time
Routine echocardiographic study	45-60	15-20	60-80
Simple congenital heart disease	60	15-20	75-80
Complex congenital heart disease	75	15-20	90-120
Complex valvular disease	60-75	15-20	75-90
Fetal echocardiogram (normal)	45-60	15-20	60-80
Fetal echocardiogram (abnormal/twins/complex)	75	15-20	90-120
Focused/limited studies	30-45	15	45-60
Agitated saline/UEA add-on	+10	—	+10

Times may vary by patient habitus, pathology, and sonographer expertise.

practice-resources/professional-performance-guidelines/. Accessed June 11, 2026.

ULTRASOUND-ENHANCING AGENTS

The strategic use of ultrasound-enhancing agents (UEAs) holds significant potential to improve both imaging efficiency and sonographer safety. In patients with suboptimal acoustic windows, difficult-to-image cardiac segments often require extended scanning, repeated probe manipulation, and sustained nonneutral body positions.[7,15] By enhancing endocardial border delineation and overall image quality, UEAs enable sonographers to acquire diagnostic views more quickly and with less physical effort, particularly when evaluating ventricular function or wall motion in technically challenging studies.[8,15]

Evidence supports the role of UEAs in reducing both imaging time and physical strain. Implementation of sonographer-driven contrast protocols has been associated with improvements in time efficiency and reductions in physical workload.[15] These findings suggest that regular and timely use of UEAs can significantly decrease probe-on-chest time, thereby reducing repetitive motion exposure and static postural demands, 2 major contributors to WRMSD development.[7,9] Importantly, the use of UEAs should remain guideline directed and used as clinically indicated.

Key Points

- Ultrasound labs should adopt protocols that empower sonographer-driven UEA use when clinically appropriate.
- UEAs are particularly beneficial in cases with limited visualization or anticipated prolonged scanning.
- Appropriate use may improve diagnostic efficiency while reducing scan time and physical strain.

SHARED-OPERATOR AND TEACHING STRATEGIES

Collaborative approaches to echocardiography, including buddy scanning and structured teaching or preceptorship, provide opportunities to reduce ergonomic strain while enhancing workflow efficiency and educational outcomes. Both strategies distribute the physical demands of scanning across multiple operators, promote peer learning, and reinforce safe ergonomic practices.[7,16] In buddy scanning, one sonographer acquires images while the other assists with machine operation, patient positioning, or probe handling as needed. This division of labor is especially valuable during complex or portable examinations, where physical access is limited, patients are immobile, or acoustic windows are poor.[7,27,15] Table 6 outlines clinical scenarios where buddy scanning is recommended, based on ergonomic risk level, case complexity, and environmental constraints. Beyond ergonomic relief, this approach also improves workflow efficiency, reduces the need for repeat acquisitions, and contributes to higher-quality patient care.[27,15]

Teaching and mentoring share many of the same benefits. Instructors can delegate tasks to trainees, such as patient positioning, room setup, or machine adjustments, thereby reducing their own physical burden while providing meaningful learning opportunities.[7,28] Trainees who observe safe scanning techniques in real time are more likely to adopt proper ergonomic habits early in their careers.[19,29] However, teaching can also introduce additional ergonomic challenges. Instructors may prolong scanning to

Table 6 When to use buddy scanning

Complex cases	Patients with congenital or advanced valvular disease requiring prolonged probe time and multiple imaging windows
Portable exams	Bedside or intensive care unit studies where space limitations, nonadjustable beds, or patient immobility increase ergonomic strain
Difficult imaging windows	Obese, postoperative, or uncooperative patients who require extended scanning
Teaching settings	Allowing instructors to demonstrate techniques and findings while maintaining ergonomic safety

Table 7 Tips for ergonomic instruction

Model good habits	Demonstrate neutral posture, proper probe grip, and correct machine setup during every scan
Share the workload	Allow trainees to handle machine controls, adjust room setup, or assist with patient positioning
Time discussions wisely	Reserve detailed explanations of anatomy or pathology for after patient contact to limit prolonged probe use
Reinforce feedback	Provide real-time, constructive corrections to ensure ergonomic habits are consistently practiced

demonstrate anatomy or imaging techniques, maintain nonneutral postures while guiding probe placement, or overscan in order to explain concepts in real time.[19,16] These practices, when frequent or extended, increase cumulative musculoskeletal strain and highlight the importance of proactive ergonomic management in educational settings.[7,28] Table 7 offers practical strategies for instructors to integrate ergonomic principles into teaching workflows, including posture modeling, delegation, and structured debriefing.

Key Points

- Shared-operator models, such as buddy scanning, distribute physical workload and reduce ergonomic strain.
- Teaching environments provide opportunities to reinforce ergonomic best practices through modeling and feedback.
- Without ergonomic awareness, teaching activities may unintentionally increase cumulative strain.
- Structured delegation and workflow strategies can support both education and injury prevention.

SONOGRAPHER MENTORSHIP FOR ERGONOMICS

Peer mentorship is a powerful yet underutilized strategy in the prevention of WRMSDs among cardiovascular sonographers.[7,19,16] Establishing mentorship programs focused on ergonomic awareness and injury prevention can facilitate skill transfer, build a culture of safety, and promote early adoption of best practices, particularly among new sonographers.[2,19,16]

While formal ergonomic training may occur during orientation or continuing education courses, much of a sonographer's scanning technique is learned informally on the job. Without consistent reinforcement, even well-trained staff may revert to unsafe habits under time pressure or in challenging patient scenarios. A mentorship model pairs less-experienced sonographers with trained peers who model safe scanning practices, provide real-time feedback, and share adaptive strategies for difficult cases.[7,16,28]

To ensure consistency, mentorship should be recognized as an official responsibility rather than an informal activity, with expectations outlined in job descriptions or professional development plans and with protected time allocated for observation, feedback, and discussion.[7,28] Finally, documenting and sharing success stories, whether through staff meetings, newsletters, or informal forums, helps reinforce the value of safe practices, fosters collective learning, and encourages broader engagement in WRMSD prevention.[16,28]

Key Points

- Mentorship programs support the consistent adoption of ergonomic best practices.
- Informal learning environments can reinforce unsafe habits without structured guidance.
- Designating mentorship as a formal responsibility improves accountability and consistency.
- Peer-to-peer feedback promotes a culture of safety and continuous improvement.

HAND DOMINANCE

Traditionally, transthoracic echocardiography is performed with the patient in the left lateral decubitus position, which positions the heart closer to the chest wall while reducing lung interference and improving sound transmission and image quality. The ergonomics of probe handling in general and sonographer hand dominance in particular can play an important role in imaging efficiency and reducing sonographer risk for WRMSDs.[22,23]

Determinants of Scanning Hand

The hand a sonographer uses to hold the ultrasound probe is often influenced by a combination of training institution practices, workplace expectations, prior injuries or physical limitations, room setup, and hand dominance.[20,28] Although only ~10% of the global population is left-handed, left-handed scanning may offer certain ergonomic advantages. It positions the sonographer closer to the chest wall and may reduce excessive forward reach and patient contact. However, left-handed scanning can also involve significant shoulder abduction, increasing the risk for rotator cuff strain or injury.[22]

By contrast, right-handed scanning requires the sonographer to reach over the patient's torso. This often necessitates trunk flexion, shoulder abduction, and wrist flexion, especially in cases involving obesity. In such scenarios, the sonographer may have to lean or drape their upper body across the patient, potentially causing discomfort for both patient and operator.[22,15] Table 8 compares the ergonomic benefits and challenges of left- and right-handed scanning techniques and

Table 8 Benefits and challenges of ambidextrous scanning

Benefits	Challenges
Reduces risk of repetitive strain by alternating scanning hands, distributing musculoskeletal load	Requires intentional practice and feels awkward initially due to limited muscle memory and coordination
Increases adaptability in constrained spaces or when patient condition restricts access from one side	May prolong scan times while building proficiency with the nondominant hand
Enhances career sustainability by allowing sonographers to continue scanning if the dominant arm is injured	Concerns about image quality and consistency when using the non-dominant hand
Improves workflow efficiency by reducing the need to reposition patients or equipment in challenging or portable scenarios	Institutional support and extended appointment times may be necessary to facilitate training

highlights situations in which ambidextrous scanning may improve comfort and reduce cumulative strain.[23]

In addition to ergonomic considerations, the selection of scanning hand should account for fine motor control and image optimization. Sonographers may preferentially use the hand with the greatest dexterity for tasks requiring precise probe manipulation, particularly during detailed or technically challenging imaging.

Departments should support both left- and right-handed scanning preferences by ensuring that room layouts, equipment positioning, and workflow design can accommodate either approach. Such flexibility may reduce ergonomic strain and support individualized scanning strategies.

Key Points

- Ambidextrous scanning should be encouraged as a long-term ergonomic strategy.
- Sonographers may rely on the hand with superior fine motor control for detailed imaging tasks.
- Training programs should provide opportunities to develop proficiency with both hands.
- Laboratory environments should accommodate both left- and right-handed scanning.

WRMSD PREVENTION IN SONOGRAPHY EDUCATION

Ultrasound educational programs are uniquely positioned to play a critical role in mitigating the risk of WRMSDs by embedding prevention strategies early in the training process. Incorporating ergonomics and injury prevention into both the didactic curriculum and scan laboratory training can instill lifelong habits that protect sonographers throughout their careers.[7,28]

Didactic Education

Didactic education should introduce students to the essential terminology of ergonomics, neutral body positioning, and WRMSDs, while also providing context for their scope and impact in sonography.[7,18,26] Students should understand not only the high prevalence of WRMSDs but also their consequences for career longevity, income stability, and overall well-being, as well as the financial burden these injuries impose on employers.[18,19,28] Instruction should also cover the primary risk factors (see Introduction) so that learners are equipped with a foundational awareness of both the causes and the broader implications of WRMSDs before entering hands-on training.[19,28]

Hands-On Scan Lab Training

Table 9 outlines key components of hands-on scan lab training designed to promote ergonomic awareness and skill development early in sonographer education. It emphasizes the integration of daily warm-up routines, reinforcement of neutral scanning posture, and instruction in ergonomic probe-handling techniques. The table also highlights the importance of continuous monitoring and real-time feedback to support habit formation, as well as preparation for clinical environments where ergonomic challenges may be more difficult to control. Collectively, these elements aim to establish sustainable scanning practices that reduce the risk of WRMSDs over the course of a sonographer's career.

Key Points

- Ergonomic education should begin early and be reinforced throughout training.
- Hands-on instruction is critical for developing safe scanning techniques and habits.
- Ongoing feedback and monitoring support skill acquisition and injury prevention.
- Preparing students for real-world ergonomic challenges is essential for long-term career sustainability.

NOVEL TOOL INTEGRATION

Wearable Technology and Ergonomics

As cardiovascular sonography advances, wearable technology offers an emerging tool for proactive injury prevention. Devices such as posture monitors, inertial sensors, and electromyography (or EMG) patches provide real-time feedback on body mechanics, helping sonographers identify and correct harmful postures or repetitive motions during scanning. These tools address the subtle, dynamic deviations that often go unnoticed yet contribute to cumulative musculoskeletal strain.

Although still emerging in sonography, wearables have shown promise in other clinical fields by improving ergonomic awareness and reducing injury risk.[25] Pilot programs in echocardiography labs, developed in collaboration with occupational health teams or academic partners, can explore the use of posture-monitoring sensors and evaluate their impact on workflow and safety.

Artificial Intelligence–Powered Workflow Optimization

Artificial intelligence (AI) and machine learning are transforming healthcare workflows across disciplines. In cardiovascular sonography, AI presents a unique opportunity to reduce physical strain by

Table 9 Hands-on scan lab training

Objective	Details/Notes
Implement a daily warm-up Routine	Implement a brief daily warm-up targeting upper extremity and postural muscle groups (see Exercise and Complementary Therapies)
Demonstrate and reinforce neutral scanning position	Demonstrate and reinforce neutral scanning posture (see WRMSD Prevention: Optimal Sonographer Positioning)
Teach ergonomic probe handling technique	Introduce multiple ergonomic probe grips based on the sonographic windows (Figure 3). Reinforce grip that is firm and controlled, but not overly tense; effective in maintaining stable imaging plane; and protective against overuse strain on wrist, fingers, and forearm.
Promote ongoing monitoring and real-time feedback	Encourage students to self-monitor and maintain ergonomic practices throughout scanning. Scan instructors should monitor positioning and technique continuously, provide immediate, constructive feedback, and encourage habit formation through positive reinforcement and repetition.
Prepare students for clinical transition	Educate students on the challenges of maintaining ergonomic positions in clinical settings; provide them with strategies for advocating for their own health; and equip clinical preceptors with information on WRMSD risks and prevention strategies taught in the classroom to ensure continuity in student training.

Table 10 Recommendations for the use of AI to support ergonomics

Recommendation	Purpose/ergonomic impact
Support AI integration into echocardiographic workflows	Encourage pilot adoption of AI-enabled tools (automated measurements, image optimization, scan guidance) within existing ultrasound and picture archiving and communication system (or PACS) platforms, following validation for accuracy and reliability. Integration may streamline tasks, reduce repetitive movements, and improve workflow efficiency.
Leverage AI for scan planning and protocol efficiency	Use AI to analyze electronic medical record and prior imaging data to predict study complexity, identify patients likely to need UEAs, and tailor protocol duration accordingly. This minimizes unnecessary probe-on-chest time and reduces strain from prolonged scanning.
Reduce repetitive task load through automation	Implement AI automation for high-volume, low-complexity measurements (e.g., Doppler traces, chamber quantification) to limit repetitive keystrokes and trackball use, reducing cumulative motion exposure.
Educate sonographers on AI as a support tool, not a replacement	Provide training that emphasizes AI's role in supporting efficiency and ergonomic safety while maintaining the sonographer's diagnostic expertise. Build confidence, transparency, and adoption.
Encourage research on ergonomic impact of AI	Support studies evaluating how AI influences workload, scan duration, and WRMSD symptoms. Findings will guide evidence-based deployment and ergonomic policy refinement.

streamlining repetitive tasks, guiding image acquisition, and improving scan efficiency.[7,27,15]

Tasks such as image optimization, measurement acquisition, and documentation contribute significantly to workload and scanning time.[19] Contemporary AI-enabled tools, many of which are now commercially available within ultrasound platforms, support automated border detection, ejection fraction calculation, and real-time image quality feedback. These technologies can reduce the need for prolonged probe manipulation and limit repetitive keystrokes and trackball use.[27,15] In addition, emerging applications of AI include automated valvular assessment and disease detection. For example, fully automated AI-based assessment of aortic stenosis has demonstrated feasibility and accuracy in echocardiographic workflows,[30] while AI-driven detection of heart failure with preserved ejection fraction has shown associations with clinically meaningful outcomes, including cardiac mortality and hospitalization.[31]

By reducing cognitive load and physical demand, AI-enhanced workflows allow sonographers to focus on higher-level diagnostic interpretation while minimizing ergonomic risk.[19,15] Furthermore, real-time decision support can shorten examination times, reduce the number of required image acquisitions, and promote consistency across providers with varying levels of experience.[7,27,15] Table 10 provides practical recommendations for integrating AI tools into echocardiography workflows in ways that support ergonomic safety, including task delegation, automation targets, and sonographer training considerations.

When appropriately implemented and validated for accuracy and reliability, AI can serve as a powerful adjunct to sonographer expertise, improving diagnostic consistency while reducing the physical demands that contribute to musculoskeletal injury. Integration of AI into ergonomic strategies will be an important component of future-ready echocardiography laboratories.

Key Points

- Emerging technologies, including wearables and AI, offer new opportunities to reduce ergonomic strain.
- AI-enabled tools can streamline repetitive tasks, improve efficiency, and reduce scan time.
- Technology adoption should be accompanied by validation, training, and workflow integration.
- These tools should complement, not replace, sonographer expertise.

ERGONOMIC CULTURE SCORE AND BENCHMARKING TOOLS

While policies, training, and equipment upgrades are essential components of WRMSD prevention, the true driver of long-term success is a workplace culture that consistently prioritizes ergonomics and sonographer well-being.[7,8,9] To assess and strengthen this culture, institutions can adopt an Ergonomic Culture Score, a standardized benchmarking tool that reflects how effectively a lab integrates ergonomic principles into daily practice.[7,13,9]

Many departments lack structured feedback mechanisms to measure how their ergonomic efforts translate into practical, sustainable change.[7,19,9] As a result, gaps in implementation often go unnoticed, and sonographers may not feel empowered to voice concerns or suggest improvements. A validated, repeatable scoring system can make the intangible elements of workplace culture more visible and actionable.[8,13]

An Ergonomic Culture Score allows echo labs to self-assess and compare their performance across domains such as equipment optimization, staff engagement, injury-reporting transparency, training frequency, and managerial responsiveness.[7,13,9] It also supports continuous quality improvement and justifies investment in ergonomic initiatives by providing measurable outcomes.[19,13]

To implement an effective program, departments should first develop a standardized scoring framework, a multidomain tool such as a survey or checklist that evaluates ergonomic practices and policies.[7,17,9] Core categories may include access to and routine use of ergonomic equipment, the frequency and quality of staff training on WRMSD prevention, protocols for injury reporting and follow-up, leadership commitment to ergonomic improvements, and the inclusion of sonographer feedback in workflow design.[7,13,9] Defined scoring tiers (e.g., developing, proficient, and exemplary) should guide interpretation and action planning, with lower scores prompting targeted interventions such as new training programs, workspace redesign, or workflow audits.[7,8]

Departments are encouraged to complete the assessment annually to promote accountability, identify trends, and highlight successful strategies. Linking high scores to institutional incentives such as equipment funding, recognition programs, or ergonomic improvement grants can further reinforce engagement and investment.[7,13,9] It is also essential that the process include anonymous sonographer input to capture the real-world experience of ergonomic culture, not solely managerial perspectives.[7,19,13] By adopting an Ergonomic Culture Score, echocardiography laboratories can move beyond compliance toward accountability, transparency, and continuous improvement, creating a culture that values health and safety as integral to productivity and professional excellence.[7,9] This structured yet flexible approach supports safer, more sustainable sonographer working conditions and fosters a culture that values health as much as productivity.[7,13]

Key Point

- A strong ergonomic culture is essential for sustained WRMSD prevention.
- Benchmarking tools can help quantify and track ergonomic practices within a department.
- Regular assessment promotes accountability, transparency, and continuous improvement.
- Inclusion of sonographer feedback is critical to accurately evaluate workplace conditions.

FINANCIAL CONSIDERATIONS

Financial Cost of Ergonomic Equipment versus Injury

Investing in ergonomic equipment and prevention strategies is not only a matter of safety and employee retention, but also a sound financial policy. While the initial costs of ergonomic tools may appear significant, they are a fraction of the expenses associated with even a single case of WRMSD.[17,19,12]

Cost of Injury

Work-related injuries among sonographers are both common and costly.[17,18,19,27] A single WRMSD injury can cost an institution between $28,000 and $54,000 in direct and indirect expenses, with severe or prolonged cases potentially exceeding $700,000 when including costs related to surgery, time off work, replacement staffing, retraining, legal claims, and increased insurance premiums.[17] Indirect costs such as productivity loss, decreased morale, fatigue-related errors, and staff turnover are often 2 to 5 times higher than direct medical expenses.[17] Beyond the financial burden, WRMSDs contribute to reduced departmental efficiency, increased scheduling pressure on remaining staff, and heightened risk of burnout, all of which can compromise patient care and overall quality outcomes.[27,21]

Cost of Ergonomic Prevention

Ergonomic investments are modest when compared to the high costs associated with work-related injuries.[19,12,13] Height-adjustable scanning chairs typically range from $800 to $2,500, while height-adjustable exam tables with cardiac cutouts cost approximately $4,000 to $12,000. Lightweight, ergonomically designed transducers are often included in newer ultrasound system packages.[13] Additional tools such as antifatigue mats, gel bottle holders, and wearable cable supports are available for under $100 each.[12] Ergonomic ultrasound machines with fully adjustable consoles are generally part of capital equipment planning and are amortized over 5 to 10 years. When these costs are distributed over the lifespan of the equipment and weighed against the financial and operational impact of even a single injury, they represent high-value, low-risk investments that support long-term workforce health and efficiency.[17,12]

Key Points

- WRMSDs impose significant direct and indirect financial costs on healthcare systems.
- Ergonomic investments are cost-effective when compared to the expense of injury.
- Prevention strategies support workforce retention, productivity, and quality of care.
- Financial planning should include ongoing investment in ergonomic equipment and training.

FUTURE DIRECTIONS AND RESEARCH PRIORITIES

Robust research efforts are essential to fully understand and address the multifactorial causes of WRMSDs. Future studies should prioritize identifying the prevalence of WRMSDs across different sonography specialties and geographic regions, while also investigating occupational and individual risk factors such as scanning frequency, body mechanics, and physical fitness.[19,27,21] It is crucial to evaluate the effectiveness of ergonomic equipment and workstation designs in reducing injury rates and improving user comfort. Additionally, advanced technologies including voice-activated controls and automated imaging tools warrant exploration for their potential to alleviate repetitive strain.[22,15]

Task-specific analyses should focus on high-risk procedures such as vascular, bedside, pediatric, fetal, and interventional echocardiography studies to better understand the unique challenges of these activities and develop targeted solutions.[27,21] The efficacy of intervention programs such as stretching regimens, physical therapy, and on-the-job exercise initiatives should also be examined to determine their role in preventing or mitigating symptoms.[25,24] Long-term studies are needed to assess the sustainability of injury prevention strategies and their influence on career longevity and productivity.[7]

Moreover, research should delve into the impact of workplace culture and administrative support on the adoption of safe practices. Investigating the financial and organizational outcomes of WRMSD prevention programs will provide valuable data to strengthen the case for widespread investment in these initiatives.[17] Together, these research efforts will form the foundation for evidence-based recommendations to reduce WRMSDs and improve the overall well-being of sonographers.

CONCLUSIONS

The prevention of WRMSDs among cardiovascular sonographers has become a critical issue in the field of echocardiography. Despite increased awareness and advancements in ergonomic equipment, the prevalence of WRMSDs remains high, impacting both individual sonographers and the healthcare system. These recommendations aim to provide practical guidance for sonographers, employers, educators, and administrators to address WRMSD prevention. By fostering a culture of safety, promoting ergonomic practices, and advocating for systemic change, we seek to empower sonographers to prioritize their health while delivering excellent patient care. Although this report is focused on the sonographer's perspective, many of the principles discussed may also apply to other healthcare professionals working in similar environments. These guidelines serve as a foundation for developing policies and practices that mitigate WRMSD risks in clinical settings.

NOTICE AND DISCLAIMER

REVIEWERS

This document was reviewed by members of the 2025-2026 ASE Guidelines and Standards Committee, the ASE Board of Directors, and the ASE Executive Committee.

CONFLICTS OF INTEREST

A.D. is on the Speaker's Bureau for Cytokinetics and Edwards Life Sciences and is a member of the Echocardiography Board of Directors and the Intersocietal Accreditation Commission. J.A. is a former member of the Board of Directors Sonographer Chair for Society of Pediatric Echocardiography and is a consultant for Bracco and Phillips. The remaining authors have no conflicts to declare.

ACKNOWLEDGMENTS

The writing committee thanks Marjan Miri, BS, RDCS, FASE, for her contributions to the document.

REFERENCES

1. Society of Diagnostic Medical Sonography (SDMS). Industry standards for the prevention of work-related musculoskeletal disorders in sonography. J Diagn Med Sonogr 2017;33:370-91.
2. American Institute of Ultrasound in Medicine (AIUM). Statement on preventing work-related musculoskeletal disorders. Available at: https://www.aium.org. Accessed January 26, 2026.
3. Craig M. Sonography: an occupational hazard. J Diagn Med Sonogr 1985; 1:121-6.
4. Society for Vascular Ultrasound (SVU). Standards for the prevention of work-related musculoskeletal disorders in sonography. Available at: https://www.svu.org. Accessed January 26, 2026.

5. Intersocietal Accreditation Commission (IAC). Ergonomics policy (echocardiography). Available at: https://www.intersocietal.org. Accessed January 26, 2026.
6. Intersocietal Accreditation Commission (IAC). Work-related musculoskeletal disorders in medical imaging. Available at: https://www.intersocietal.org. Accessed January 26, 2026.
7. WRMSD Grand Challenge Alliance. Sonographers and vascular technologists offer potential solutions to promote the health and well-being of their workforce. J Diagn Med Sonogr 2024;40:127-39.
8. American Institute of Ultrasound in Medicine (AIUM). Practice principles for work-related musculoskeletal disorder. J Ultrasound Med 2023;42:1139-57.
9. Society of Diagnostic Medical Sonography (SDMS). Industry standards for the prevention of work-related musculoskeletal disorders in sonography: consensus conference report. Plano, TX: Society of Diagnostic Medical Sonography; 2016.
10. AIUM. Ergonomics in sonography: education and awareness. Available at: https://www.aium.org. Accessed January 26, 2026.
11. AIUM. Positioning recommendations for sonographers. Available at: https://www.aium.org. Accessed January 26, 2026.
12. WorkSafeBC. Ergonomic accessories and workplace layout for healthcare imaging professionals. Available at: https://www.worksafebc.com; 2015. Accessed January 26, 2026.
13. IAC. Accreditation standards for echo lab ergonomic safety. Available at: https://www.intersocietal.org. Accessed January 26, 2026.
14. AIUM. Statement on WRMSDs in ultrasound. Available at: https://www.aium.org. Accessed January 26, 2026.
15. Barros-Gomes S, Pislaru C, Lin G, et al. Real-world ergonomic strategies in echocardiography: a multicenter evaluation. J Am Soc Echocardiogr 2020;33:1280-8.
16. Alshuwaer TA, Gilman F. Evidence-based ergonomic interventions for cardiovascular sonographers. J Diagn Med Sonogr 2021;37:52-9.
17. WorkSafeBC. Preventing musculoskeletal injuries (MSIs): A guide for employers and joint committees. Vancouver, BC: WorkSafeBC Publications. Available at: https://www.worksafebc.com; 2013.
18. Evans K, Roll S, Baker J. Work-related musculoskeletal disorders among registered diagnostic medical sonographers and vascular technologists: a representative sample. J Diagn Med Sonogr 2009;25:287-99.
19. Murphey S. Work-related musculoskeletal disorders in sonography. J Diagn Med Sonogr 2017;33:354-69.
20. Hardyck C, Petrinovich LF. Left-handedness. Psychol Bull 1977;84:385-404.
21. Onwordi E, Harris A, Atkinson C, et al. Prevalence, characteristics and clinical impact of work-related musculoskeletal pain in echocardiography. Echo Res Pract 2024;11:6.
22. Alshuwaer TA, Gilman F. Prevention of shoulder injuries in sonographers: a systematic review. J Diagn Med Sonogr 2019;35:392-9.
23. Seto E, Biclar L. Ambidextrous sonographic scanning to reduce sonographer repetitive strain injury. J Diagn Med Sonogr 2008;24:127-35.
24. Cocchiara RA, Peruzzo M, Mannocci A, et al. The use of yoga to manage stress and burnout in healthcare workers: a systematic review. J Clin Med 2019;8:284.
25. Soares CO, Pereira BF, Gomes MV, et al. Preventive factors against work-related musculoskeletal disorders: narrative review. Rev Bras Med Trab 2020;17:415-30.
26. Evans K, Roll S, Baker J. Injury onset and reporting behavior in new sonographers: a retrospective analysis. J Diagn Med Sonogr 2011;27:161-8.
27. Barros-Gomes S, Pislaru C, Lin G, et al. Characteristics and consequences of work-related musculoskeletal pain among cardiac sonographers compared with peer employees: a multisite cross-sectional study. J Am Soc Echocardiogr 2019;32:1138-46.
28. Seto E. Workflow modifications to support ergonomic education in sonography programs. J Diagn Med Sonogr 2010;26:85-90.
29. SDMS. Professional guidelines for sonographer safety and injury prevention. Available at: https://www.sdms.org. Accessed January 26, 2026.
30. Krishna H, Desai K, Slostad B, et al. Fully automated artificial intelligence assessment of aortic stenosis by echocardiography. J Am Soc Echocardiogr 2023;36:769-77.
31. Cassianni C, Huntley GD, Castrichini M, et al. Automated echocardiographic detection of heart failure with preserved ejection fraction using artificial intelligence is associated with cardiac mortality and heart failure hospitalization. J Am Soc Echocardiogr 2024;37:91406.