

การพยาบาลยุคใหม่ในการตรวจสอบสมรรถภาพหัวใจ ขณะหัวใจทำงานหนัก: ความปลอดภัย การเฝ้าระวัง และการดูแล

Modern Nursing Approaches in Dobutamine and Exercise Stress Echocardiography : Safety, Monitoring, and Patient Care

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บทคัดย่อ

การตรวจหัวใจด้วยคลื่นเสียงความถี่สูงขณะหัวใจทำงานหนัก (Stress echocardiography) โดยใช้ยากระตุ้นการเต้นของหัวใจ (โดบูตามีน) หรือการออกกำลังกาย เป็นวิธีการตรวจที่ไม่รุกรานซึ่งใช้กันอย่างแพร่หลายในการประเมินภาวะขาดเลือดของกล้ามเนื้อหัวใจ ความมีชีวิตของกล้ามเนื้อหัวใจ และการทำงานของหัวใจ ซึ่งพยาบาลมีบทบาทสำคัญในการดูแลความปลอดภัยของผู้ป่วย การเฝ้าระวังอย่างมีประสิทธิภาพ และเกิดผลลัพธ์ที่ดีที่สุดในการทำหัตถการ

บทความนี้เน้นวิธีการพยาบาลสมัยใหม่โดยให้ความสำคัญกับการดูแลผู้ป่วยเป็นศูนย์กลาง ความรับผิดชอบก่อนการตรวจ รวมถึงการประเมินผู้ป่วยอย่างละเอียด การให้ความรู้ การเตรียมความพร้อม และการเตรียมอุปกรณ์ให้พร้อม ในระหว่างการตรวจพยาบาลจะเฝ้าติดตามสัญญาณชีพอย่างต่อเนื่อง เฝ้าระวังอาการที่ผิดปกติที่อาจเกิดขึ้น และทำงานร่วมกับแพทย์และผู้ทำการตรวจอัลตราซาวด์อย่างใกล้ชิดเพื่อให้มั่นใจว่าสามารถช่วยเหลือได้อย่างทันท่วงที การดูแลหลังการตรวจมุ่งเน้นการสังเกตอาการหลังฟื้นตัว การจัดการอาการผิดปกติและการให้ความรู้แก่ผู้ป่วยเพื่อป้องกันภาวะแทรกซ้อนที่อาจเกิดขึ้นในภายหลัง ด้านความก้าวหน้าทางเทคโนโลยี เช่น การเฝ้าติดตามคลื่นไฟฟ้าหัวใจอัตโนมัติ สารเพิ่มประสิทธิภาพอัลตราซาวด์ และระบบข้อมูลดิจิทัล ได้ขยายบทบาทของพยาบาลในการดูแลที่แม่นยำและการประกันคุณภาพ การศึกษาต่อเนื่อง การพัฒนาความสามารถ การทำงานเป็นทีมแบบสหวิชาชีพ และการปฏิบัติตามมาตรฐานการตรวจวินิจฉัยตามหลักฐานเชิงประจักษ์ ล้วนมีความสำคัญต่อการรักษามาตรฐานทางการพยาบาล ในขณะที่การตรวจหัวใจด้วยคลื่นเสียงความถี่สูงขณะหัวใจทำงานหนัก (stress echocardiography) ยังคงพัฒนาอย่างต่อเนื่อง

คำสำคัญ: การตรวจหัวใจด้วยคลื่นเสียงความถี่สูงร่วมกับการใช้ยาโดบูตามีน, การตรวจหัวใจด้วยคลื่นเสียงความถี่สูงขณะออกกำลังกาย, การเฝ้าติดตามระบบไหลเวียนโลหิต, การจัดการทางการพยาบาล, ความปลอดภัยของผู้ป่วย

Abstract

Stress echocardiography, using dobutamine or exercise modalities, is a widely used noninvasive method for evaluating myocardial ischemia, viability, and cardiac function. Nurses play a central role in ensuring patient safety, effective monitoring, and optimal outcomes throughout the procedure.

This review highlights modern nursing approaches with an emphasis on patient-centered care. Pre-procedural responsibilities include thorough patient assessment, education, preparation, and equipment readiness. During the examination, nurses continuously monitor vital signs, identify adverse reactions early, and collaborate closely with physicians and sonographers to ensure prompt intervention. Post-procedural care focuses on recovery observation, symptom management, and patient education to prevent delayed complications. Technological advances—such as automated ECG monitoring, ultrasound enhancement agents, and digital data systems—have expanded nursing roles in precision care and quality assurance. Ongoing education, competency development, interdisciplinary teamwork, and adherence to evidence-based protocols are essential for maintaining high standards of nursing practice as stress echocardiography continues to advance.

Keywords: Dobutamine stress echocardiography; Exercise stress echocardiography; Hemodynamic monitoring; Nursing management; Patient safety

Introduction

Stress echocardiography (SE) is a noninvasive imaging technique used to assess cardiac function and myocardial perfusion under stress conditions. It is performed using either pharmacologic stimulation, most commonly dobutamine, or physical exercise such as treadmill or bicycle testing. Both approaches increase myocardial workload, allowing detection of wall motion or contractility abnormalities that may not be evident at rest.¹ Dobutamine stress echocardiography uses a β -adrenergic agonist to mimic the physiological effects of exercise by increasing heart rate and myocardial oxygen demand², while exercise stress echocardiography relies on actual physical exertion to achieve cardiac stress.³

SE is valuable for identifying myocardial ischemia, assessing myocardial viability, and evaluating functional capacity in patients with suspected or established coronary artery disease. Clinically, it supports the diagnosis of ischemic heart disease, evaluation after myocardial infarction, assessment of viable myocardium prior to

revascularization, and investigation of valvular disease or hypertrophic cardiomyopathies.^{1,3,4}

The accuracy and safety of SE depend on multidisciplinary collaboration.⁵ This article highlights the crucial role of nurses in patient preparation, continuous monitoring, risk assessment, psychological support, and post-test care. As techniques advance and patient complexity increases—especially among high-risk populations—specialized, evidence-based nursing practice remains essential for ensuring safe, high-quality testing.

Overview of Dobutamine and Exercise Stress Echocardiography

Dobutamine stress echocardiography (DSE) and exercise stress echocardiography (ESE) share the same diagnostic goal of assessing myocardial ischemia and cardiac function, but they differ in method, protocol, and nursing care.⁶

DSE is used for patients who cannot perform physical exercise because of orthopedic problems, poor conditioning, or significant comorbidities.⁷

Dobutamine is infused starting at a low dose (5–10 µg/kg/min) and increased stepwise up to 40 µg/kg/min until the target heart rate or diagnostic endpoints are achieved.² Atropine may be added if the heart rate response is inadequate.³ DSE is useful for diagnosing coronary artery disease, assessing myocardial viability after infarction, and evaluating valvular disease or cardiomyopathy.^{1,4,8} Potential complications include arrhythmias, blood pressure changes, and chest discomfort⁷, requiring close nursing monitoring and rapid response.

ESE evaluates cardiac function during physiologic stress induced by treadmill or bicycle exercise. Standardized protocols, such as the Bruce or modified Bruce protocol⁹, progressively increase workload until target heart rate, symptoms, or endpoints are reached. Images are obtained immediately after exercise to detect ischemia.⁷ ESE also provides prognostic information, including exercise capacity and blood pressure response, aiding long-term risk assessment (Table 1).

Table 1. A comparative summary between DSE and ESE procedures.

Aspect	Dobutamine Stress Echocardiography (DSE)	Exercise Stress Echocardiography (ESE)
Stress Induction	Pharmacologic (dobutamine infusion ± atropine)	Physical exercise (treadmill or bicycle)
Indications	Patients unable to exercise; myocardial viability; valvular disease	Functional assessment; ischemia detection; fitness evaluation
Monitoring	Continuous ECG, BP, SpO ₂ , symptom observation	ECG, BP, symptom observation during and after exercise
Advantages	Suitable for non-ambulatory patients; reproducible	Reflects physiologic stress; functional capacity assessment
Risks/Complications	Arrhythmias, hypertension, chest pain	Fatigue, syncope, exercise-induced arrhythmias
Nursing Focus	Drug administration, emergency preparedness, hemodynamic stability	Safety supervision, physical endurance monitoring, recovery care

ECG = Electrocardiography; BP = Blood pressure; SpO₂ = Saturated percutaneous oxygen

Nursing Roles and Responsibilities

Nurses play a central role in ensuring the safety, accuracy, and effectiveness of dobutamine and exercise stress echocardiography (DSE and ESE). Their responsibilities span the pre-procedural, intra-procedural, and post-procedural phases and require clinical knowledge, close monitoring, and patient-centered care. Effective nursing management minimizes complications, supports diagnostic quality, and improves patient comfort.

Pre-procedural nursing management focuses on patient readiness and test validity. Nurses verify

patient identity and test orders, review medical history, medications, allergies, and prior stress tests¹⁰, and identify contraindications such as unstable angina, acute myocardial infarction, severe arrhythmias, or uncontrolled hypertension.^{2,3,7} Baseline vital signs, oxygen saturation, and ECG are assessed. Patient preparation includes clear explanation of the procedure, fasting instructions, avoidance of caffeine or nicotine, medication adjustments as prescribed, and ensuring appropriate clothing for ESE.⁶ Equipment readiness is essential, including functional echocardiography and monitoring devices, IV access

for DSE, and availability of emergency drugs and resuscitation equipment.⁶ Psychological support is provided by addressing anxiety, encouraging questions, and involving family when appropriate.¹¹

Intra-procedural nursing management emphasizes continuous monitoring and safety. Nurses closely observe heart rate, rhythm, blood pressure, oxygen saturation, and symptoms, documenting changes at each stage. They assist with dobutamine and atropine administration during DSE, support exercise protocols during ESE, and coordinate with the physician and sonographer for image acquisition. Prompt recognition and reporting of ischemia, arrhythmias, or adverse reactions are critical, and nurses must be prepared to terminate the test and initiate emergency protocols if needed.¹²

Post-procedural nursing management centers on recovery and education. Nurses monitor patients until vital signs and ECG return to baseline, watch for delayed complications, and ensure safe discharge.¹³ Patient education includes warning signs after discharge, follow-up instructions, and risk-reduction advice. Accurate documentation and participation in quality assurance activities support patient safety and continuous improvement.¹²

Safety Considerations and Risk Management

Safety in stress echocardiography relies on appropriate patient selection, vigilant monitoring, early recognition of complications, and effective emergency response. Thorough pre-procedure risk assessment is essential. Absolute contraindications include recent acute myocardial infarction, unstable angina, severe aortic stenosis or hypertrophic obstructive cardiomyopathy, uncontrolled arrhythmias or hypertension, and acute pulmonary embolism or aortic dissection.^{7,14} Relative contraindications include left main coronary artery disease, moderate valvular disease, severe electrolyte

imbalance, and physical or neurological limitations that prevent safe exercise.³

Emergency preparedness is a core nursing responsibility. Stress echocardiography units must be equipped for advanced cardiac life support (ACLS). Nurses verify readiness of defibrillators, oxygen, suction, airway equipment, and establish intravenous access, particularly for dobutamine stress echocardiography. Emergency medications, including atropine, beta-blockers, nitrates, and adrenaline, must be readily available, and nurses should be proficient in ACLS protocols.⁶

Continuous monitoring during the procedure is critical. Nurses monitor ECG, blood pressure, oxygen saturation, and patient symptoms, documenting findings at each stage.¹² Close observation is required for chest pain, dyspnea, dizziness, pallor, diaphoresis, or cyanosis, as well as drug-related adverse effects during pharmacologic stress.¹⁰

Complications such as arrhythmias, ischemic chest pain, blood pressure instability, syncope, or drug reactions require immediate test termination and appropriate intervention according to protocol. Post-procedural care includes monitoring until hemodynamic stability is achieved, observing for delayed complications, and ensuring safe discharge with clear instructions.^{3,10}

Nurses also contribute to risk management through accurate documentation, incident reporting, adherence to updated clinical guidelines, ongoing life-support certification, and effective interdisciplinary communication to maintain patient safety and quality care.¹⁵

Modern Monitoring and Technological Advances

Stress echocardiography (SE) has evolved markedly with modern monitoring technologies and digital innovations, improving diagnostic accuracy, patient safety, and procedural efficiency. These

advances have expanded nursing roles from basic observation to technology-supported monitoring, data management, and quality assurance. Both dobutamine and exercise stress echocardiography now rely on integrated systems that combine imaging, hemodynamic monitoring, and electronic documentation.

Advanced multichannel ECG and hemodynamic monitoring systems provide real-time rhythm analysis and automated alerts for ischemic changes or arrhythmias.¹⁶ Nurses are responsible for proper equipment setup, responding to alarms, correlating symptoms with ECG findings, and ensuring continuous monitoring of blood pressure and oxygen saturation.

Digital imaging platforms enable real-time acquisition, enhancement, storage, and comparison of rest and stress images. Nurses support image quality by maintaining patient stability, verifying patient identifiers, coordinating with sonographers, and ensuring secure transfer of data to hospital archiving systems while maintaining confidentiality.¹⁰

Ultrasound contrast agents have improved image quality in patients with suboptimal acoustic windows. Nursing responsibilities include preparing and administering contrast according to protocol, monitoring for adverse reactions, maintaining venous access, and educating patients about contrast safety.¹⁰

Artificial intelligence–assisted echocardiography now supports automated wall motion analysis and cardiac function assessment, such as left ventricular ejection fraction.¹⁷ Nurses ensure accurate data entry and understand system limitations, recognizing that clinical interpretation remains physician led.

Wireless and telemetry-based monitoring enhances patient comfort and allows broader safety oversight, particularly in high-volume settings and extended recovery periods. Tele-echocardiography

further supports collaboration with remote specialists.¹⁸

Modern systems also provide automated documentation and audit trails that support quality improvement and accreditation. 190 ongoing education is essential for nurses to maintain competence in advanced monitoring, digital documentation, data security, and simulation-based emergency response using evolving technologies.

Patient-Centered Nursing Care

Patient-centered nursing care is fundamental to safe, compassionate, and effective practice in both dobutamine and exercise stress echocardiography. Although these tests are diagnostic, they can provoke anxiety, fear, or discomfort, particularly in patients unfamiliar with cardiac procedures. Nurses therefore play a dual role: managing technical aspects while addressing emotional, cultural, and educational needs through a holistic and empathetic approach.¹¹

Psychological support and clear communication are central to patient-centered care. Stress echocardiography involves physical exertion, intravenous medications, and continuous monitoring, all of which may cause apprehension. Nurses reduce anxiety by establishing trust through a calm, reassuring manner and by explaining the procedure in simple, understandable terms before and during the test.²⁰ Describing expected sensations, such as increased heart rate or mild warmth, helps normalize the experience. Active listening, ongoing reassurance, and encouraging patients to report discomfort promptly allow patients to feel supported and in control, improving cooperation and procedural safety.²¹

Cultural sensitivity and individualized care further strengthen patient-centered practice. Nurses must respect cultural values, privacy, and modesty,¹⁵ and use interpreters when language

barriers exist. Awareness of religious practices, family involvement preferences, and personal beliefs enables nurses to tailor care plans that align with individual needs and enhance trust.¹¹

Patient education is especially important for those with limited health literacy or heightened anxiety. Nurses should assess understanding, use non-technical language and visual aids, provide clear step-by-step explanations, and confirm comprehension using the teach-back method. Written or digital materials in the patient's preferred language can reinforce learning.¹¹

Finally, a positive patient experience is shaped by a welcoming environment, respect for privacy and time, gentle professional care, and clear post-test communication. These elements collectively improve patient satisfaction and confidence in care.

Education, Competency, and Professional Development

The expanding role of nurses in dobutamine and exercise stress echocardiography demands strong foundational knowledge, advanced clinical skills, and an ongoing commitment to professional development. As technology advances and patient complexity increases, continuous education and competency-based training are essential to ensure patient safety, diagnostic accuracy, and efficient care delivery.¹⁵

Nurses must first develop a solid theoretical foundation in cardiovascular anatomy, physiology, and pathophysiology, along with echocardiographic principles and hemodynamic monitoring. Core knowledge includes stress testing protocols, pharmacology of dobutamine and adjunct agents, and recognition of ischemia, arrhythmias, and adverse drug reactions. This preparation is typically achieved through academic programs, institutional training, and specialized workshops prior to independent

practice.¹⁵

Clinical competency requires demonstrable proficiency in key skills. These include pre-procedural assessment and preparation, continuous ECG and vital sign monitoring, administration of pharmacologic or exercise stress protocols, emergency response, and accurate documentation. Regular competency validation, often annually or biannually, helps ensure consistent standards, particularly when new protocols or technologies are introduced.

Continuing professional development is critical to maintaining best practice. Nurses benefit from workshops, simulation-based emergency training, e-learning modules, and professional conferences focused on cardiac diagnostics. Certification programs offered by recognized professional organizations further validate expertise, enhance clinical confidence, and support career progression. Institutional support through funding, study leave, and mentorship is vital to sustaining these efforts.¹⁵

Interprofessional collaboration and mentorship enhance learning and clinical judgment. Working closely with cardiologists, sonographers, and technical specialists promotes shared responsibility for patient safety and fosters adaptation to innovations such as digital platforms and AI-assisted analysis.²² Nurses also contribute significantly to research, quality improvement, and evidence-based practice by participating in audits, studies, and guideline implementation.

Current research into diagnostic testing led by multidisciplinary teams—including nurses and cardiac physiologists—demonstrates that these procedures can be performed safely with clinical results comparable to those achieved by physicians. However, maintaining high standards often requires cardiologist supervision for complex interpretation and quality control. This evolution presents a significant

opportunity and challenge for the nursing profession, necessitating advanced expertise and specialized training to meet future demands²³.

With experience, nurses may advance into leadership roles involving education, protocol development, and quality assurance. Lifelong learning and adaptability remain essential as stress echocardiography continues to evolve within an increasingly digital and technology-driven healthcare environment.

Challenges and Future Perspectives in Nursing Management of Dobutamine and Exercise Stress Echocardiography

Nurses play a critical role in dobutamine and exercise stress echocardiography; however, several challenges affect patient care, workflow efficiency, and professional development. Patient-related issues include anxiety and fear, which may alter hemodynamic responses and test accuracy, as well as multiple comorbidities that increase monitoring complexity. Limited health literacy further necessitates repeated, individualized education and clear communication.

Procedural challenges include the need for rapid recognition of rare but serious adverse events such as arrhythmias, hypotension, or ischemia. Continuous ECG and hemodynamic monitoring in time-pressured outpatient settings demands sustained vigilance. In addition, variations in institutional protocols, drug dosing, and target heart rates can create inconsistencies in nursing practice and training. Resource constraints, including staff shortages and increasingly complex monitoring equipment, further add to workload and stress. Ongoing technological upgrades and incomplete integration of digital systems may also compromise documentation efficiency. From a professional standpoint, rapid advancements in imaging and

pharmacology require frequent upskilling, yet access to structured training and certification remains uneven, contributing to burnout.

Future perspectives offer solutions to these challenges. Artificial intelligence and automated monitoring systems can support real-time decision-making and early detection of complications. Standardized, evidence-based protocols and digital integration can improve consistency, safety, and workflow efficiency. Simulation-based education and competency certification programs may enhance confidence, preparedness, and career development. Greater interprofessional collaboration and patient engagement tools can further strengthen patient-centered care.^{17,18}

Overall, addressing current challenges requires investment in technology, education, and standardized practices, with nurses empowered as key drivers of quality improvement and innovation in stress echocardiography.

While modern stress echocardiography is bolstered by advanced monitoring, artificial intelligence, and digital platforms, patient safety and diagnostic accuracy remain deeply rooted in nursing clinical judgment. Nurses play a pivotal role throughout the pre-, intra-, and post-test phases—conducting comprehensive assessments, maintaining continuous hemodynamic monitoring, and integrating technological data into real-time clinical decisions. Consequently, ongoing competency development in digital health literacy and emergency response is vital. This expertise not only maximizes the benefits of technological innovation but is fundamental to preventing adverse events and enhancing patient satisfaction.

Conclusion

Dobutamine and exercise stress echocardiography are key diagnostic tools in

cardiology, offering vital information on myocardial ischemia, viability, and overall cardiac function. Their success highly depends on effective nursing management, which includes patient preparation, continuous monitoring, risk management, psychological support, and post-procedure care. Nurses play a central role in ensuring procedural safety, optimizing outcomes, and enhancing the patient experience.

Modern nursing practice emphasizes patient-centered care that incorporates individualized education, cultural sensitivity, and emotional support to reduce anxiety and improve cooperation. Technological advancements-such as digital monitoring systems, AI-assisted imaging, wearable devices, and integrated electronic health platforms-have expanded nursing responsibilities, enabling more accurate monitoring and timely intervention during adverse events.

Despite these advancements, nurses face challenges related to increasing patient complexity, procedural risks, and rapidly evolving technologies, highlighting the need for continuous professional development and interdisciplinary collaboration. Future improvements through standardized protocols, simulation-based training, evidence-based practice, and continuous quality improvement initiatives are expected to further enhance nursing performance. Overall, nursing remains an indispensable component in ensuring safe, effective, and patient-centered stress echocardiography.

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