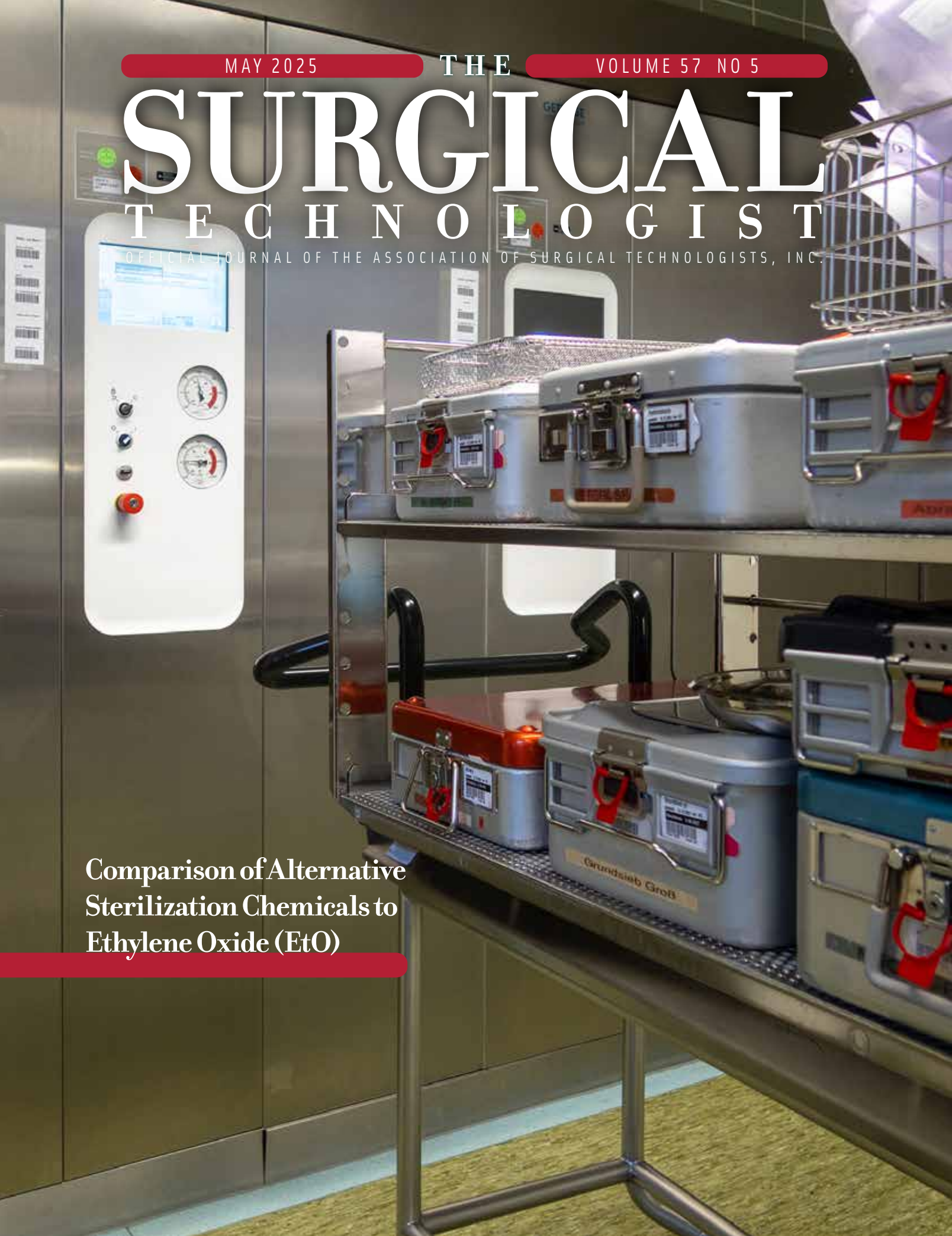
MAY 2025 VOLUME 57 NO 5

THE SURGICAL TECHNOLOGIST

OFFICIAL JOURNAL OF THE ASSOCIATION OF SURGICAL TECHNOLOGISTS, INC.

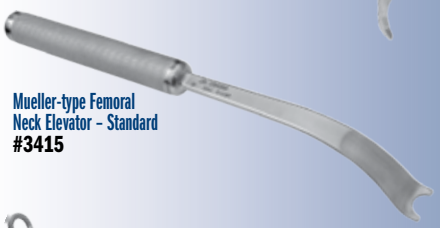


Comparison of Alternative Sterilization Chemicals to Ethylene Oxide (EtO)

Direct Anterior Approach Instrument Set

A General Use Set of Innomed Instruments for Direct Anterior Approach Total Hip Arthroplasty

Single Prong Acetabular Retractor - Standard
#6570

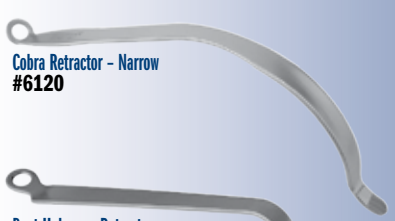


Mueller-type Femoral Neck Elevator - Standard
#3415

Cobra Retractor - Standard with Sharp Tip
#6129

Deep Hohmann-style Retractor with Large Handle - Standard
#C1009

Modified Hohmann Retractor - Narrow
#4535



Cobra Retractor - Narrow
#6120

Bent Hohmann Retractor - Narrow with Extra Long Handle
#7110-01

Bone Hook - Large
#5920

Rivero Extra Grip Femoral Head Remover with Zimmer Hall Quick-connect
#3706

Complete Set **#6500-01**
Also Available Individually

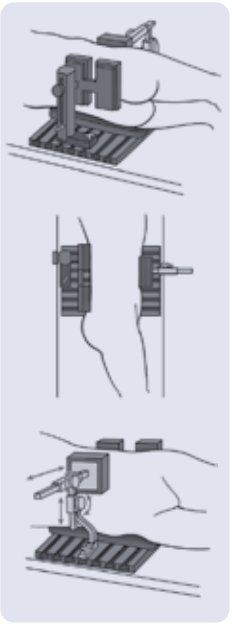
USA MADE

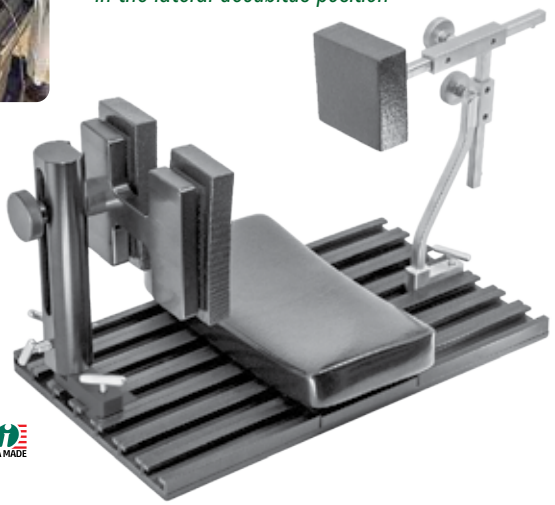
Set includes (2) #6120 and (1) of the other instruments shown

Belfast Sagittal Plane Positioner

Designed by David Beverland, FRCS

A sturdy and stable patient support system for posterior approach total hip arthroplasty in the lateral decubitus position





- Very secure an easy to tighten
- Accommodates the very obese patient
- Does not attach to the table, making it compatible with all OR tables

Set **#4170-00**
Also Available Individually

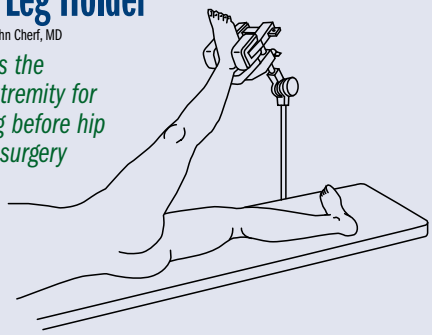
USA MADE

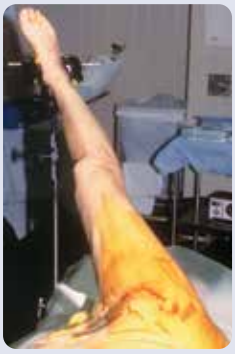
Cherf Leg Holder

Designed by John Cherf, MD

Supports the lower extremity for prepping before hip or knee surgery

USA MADE





#2270

Meyerding Type Retractors with Contour Grip

Designed for soft tissue retraction, the contour grip allows for a better grip and less fatigue

Features a non-glare finish.

MADE EXCLUSIVELY FOR INNOMED IN GERMANY

New!

50 x 16 mm Blade
#6241-01

75 x 15 mm Blade
#6242-01

75 x 25 mm Blade
#6243-01

www.innomed.net

FREE TRIAL ON MOST INSTRUMENTS

ISO 13485:2016

103 Estus Drive, Savannah, GA 31404
info@innomed.net

912.236.0000 Phone
912.236.7766 Fax

Innomed-Europe Tel. +41 41 740 67 74
info@innomed-europe.com

1.800.548.2362

AST
Association of Surgical Technologists

6 West Dry Creek Circle ▲ Littleton, CO 80120
Tel 303-694-9130 ▲ Fax 303-694-9169
Member Number (toll free 8-4:30 pm MT, Mon-Fri)
800-637-7433 ▲ www.ast.org

STATEMENT OF EDITORIAL PURPOSE The purpose of the *Journal* is to advance the quality of surgical patient care by providing a forum for the exchange of knowledge in surgical technology and by promoting a high standard of surgical technology performance.

THE SURGICAL TECHNOLOGIST (ISSN 0164-4238) is published monthly by the Association of Surgical Technologists, Inc, 6 West Dry Creek Circle, Suite 200, Littleton, CO 80120-8031. Telephone 303-694-9130. Periodical postage is paid at Littleton, Colorado, and additional mailing offices. Correspondence to *The Surgical Technologist* can be sent to communications@ast.org.

SUBSCRIPTIONS A one-year subscription is $40 for nonmembers and $55 (US funds) for foreign. Back issues are available for $5 each (specify date of issue). Written requests for replacement issues will be honored up to 60 days after date of publication only. Please address all requests to the editor.

JOURNAL DEADLINES The deadline for editorial copy is 8 weeks prior to the cover date (eg, the deadline for the July issue is May 1).

POSTMASTER Send address corrections to The Surgical Technologist, 6 West Dry Creek Circle, Suite 200, Littleton, CO 80120-8031.

Connect with AST on LinkedIn, Facebook, Instagram, and Pinterest to grow your professional network!

MAY 2025 THE VOLUME 57 NO 5

THE SURGICAL TECHNOLOGIST

OFFICIAL JOURNAL OF THE ASSOCIATION OF SURGICAL TECHNOLOGISTS, INC.

Comparison of Alternative Sterilization Chemicals to Ethylene Oxide (EtO)

AST STAFF

EtO has long been an essential chemical used by manufacturing and the healthcare industry. EtO was discovered by the French chemist Charles-Adolphe Wurtz in 1859. EtO continues to be produced in large quantities by companies because of its use as an important source in the manufacturing of common items. More recently, the EPA announced their most recent ruling regarding commercial EtO sterilizers to reduce exposure to the colorless gas. This has also led to the research and development of alternative sterilization chemicals as a possible replacement for EtO in healthcare facilities.

In This Issue

In Every Issue

Professionalism in Action

DR. STEPHANIE AUSTIN, CST, FAST, AST DIRECTOR

BOARD MESSAGE

As we approach the 2025 AST National Conference in Orlando attendees are diligently preparing for this significant event. The AST staff is finalizing the week's activities, while members ensure their travel arrangements, wardrobe, and agendas are set. However, one crucial aspect we must all remember is the standard of professionalism we uphold in our field.

For years, we have emphasized the importance of respect for our profession within the healthcare community. Yet, as we convene at the conference, it's essential to recognize that not all attendees maintain the high professional standards that distinguish us from other allied health professions. While the atmosphere is exciting, our primary purpose is to learn from one another and from the esteemed speakers presenting at the conference. Attending each presentation demonstrates our commitment to continuing education, while punctuality reflects our dedication to excellence. Furthermore, adhering to professional dress codes expresses respect for our colleagues and the patients we serve. We must take pride in what we aim to achieve.

Additionally, each state assembly has the opportunity to send six delegates and up to six alternates. Those attending as delegates represent the voices of their respective state assemblies and carry the honor of advocating for their members. As a delegate, you also voice — for your patients — their needs and concerns. It is your responsibility to act as a catalyst for change within our organization and ensure that the candidates running for national office uphold the highest standards for our profession as you cast your votes for new members of the AST Board of Directors.

As a delegate, you are tasked with posing challenging questions that can determine the appropriateness of a candidate for the board. It is your obligation to prepare thoroughly: familiarize yourself with the candidates, attend all business sessions, engage with members of your state assembly before the conference, and understand the stakes as you enter the polling booth.

We must advocate for ourselves, and one effective way to achieve this is by ensuring the right individuals are in positions to represent and fight for us all.

The field of surgical technology stands at a critical juncture that will influence our future. In the short term, online programs are proliferating across states, and our profession risks being undervalued by those who do not recognize the significant impact of our work. We must advocate for ourselves, and one effective way to achieve this is by ensuring the right individuals are in positions to represent and fight for us all.

If you are attending this year's conference, be prepared to present yourself and our profession with the utmost professionalism. Ensure you are informed about the issues at hand and the candidates being considered for office. Represent both your profession and you in a manner of which you can be proud. Our profession and our patients depend on our collective commitment and dedication!

AST Surgical Technology Conference will be so bright, you'll need to wear shades.

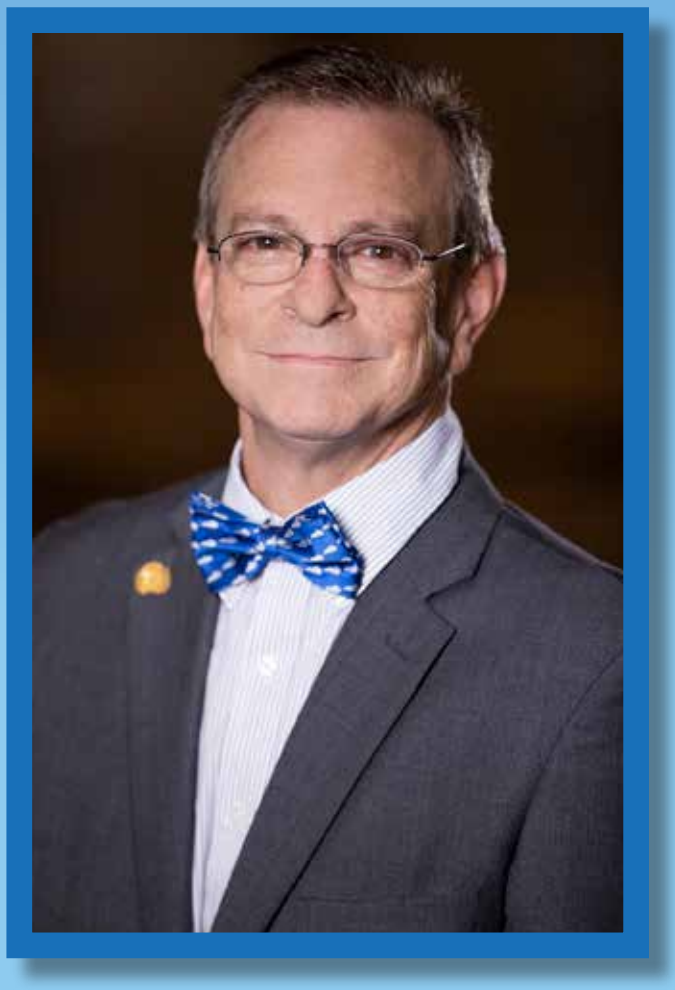
Get ready to soak up the sun, fun, friends, and Florida hospitality in beautiful Orlando. Register at www.ast.org.

AST
Association of Surgical Technologists

In Memoriam

Kevin "KC" Craycraft, CST, FAST, AST's 39TH PRESIDENT

June 5th, 1967 - March 3rd, 2025



It's with extreme sadness that we share the passing of AST's most recent past president Kevin Craycraft, CST, FAST, who passed away after a courageous battle with cancer in March. Kevin Craycraft, known by many as KC, served as AST's 39th president from 2021-2023. His prior service included various roles on AST's national board since 2014 including director and vice president. Kevin also was an active leader within the Kentucky State Assembly serving as its president, vice president and as a director from 2014-2021. He also served on AST's Education and Professional Standards Committee (EPSC) before his time on the national board.

Many got their start in the field by learning the role and the ropes with KC as their esteemed educator. He served as a tenured surgical technology program director at Bluegrass Community and Technical College in Lexington, Kentucky.

To know KC was to know his warmth and enthusiasm for everyone he met and worked with. His warm smile and larger-than-life personality touched many in this industry and organization, and his presence will be missed.

To honor his legacy and leadership, AST donated $1,000 to a charity close to his heart, Toyota Bluegrass Miracle League.

In his own words, "Peace and be safe." We'll miss you, KC.

AST News

AT A GLANCE

CALL FOR SPEAKERS

AST is looking for speakers for our 2026 annual Surgical Technology Conference and Educators Conference. Know someone who would be a good fit for either event? Apply or encourage them to complete our speaker form on our website – ast.org – Conference.

DISCOUNTS

Member-Get-A-Member

Earn two or more months of FREE membership with the Member-Get-A-Member program. Recruit colleagues and AST will extend your membership by the appropriate number of months. Here's how:

- Recruit a valid new member at the one-year membership rate of $80.
- Make sure that each person you recruit provides AST with your name and your AST member number when filling out their application.
- After AST receives the recruited member's application, we will extend your membership by two months for each person you recruit.
- Recruit two members at the $80-level, and we'll extend your membership by four months! The more people you recruit, the longer your membership gets extended.

Bonus membership months are not applicable to members who recruit themselves, students or retired/disabled members. No substitutions will be permitted. Your membership must be current to receive the bonus months. Potential members MUST supply your name and your AST member number in order for you to receive bonus membership months. If a person's membership has lapsed for more than a year, they are considered a new member.

Call our Member Services team at 1-800-637-7433 for more information.

CONTINUING EDUCATION CREDITS

Make it easy with CE packages!

In a time crunch or just want to get your CEs done all at once? Check out our latest CE credit packages.

- Package 18 - 16 CEs - $26 – AST Guideline for Laundering Scrub Attire, AST Guideline for Wearing Jewelry, AST Guideline for the Use of Eye Protection During Invasive Surgical Procedures, AST Guideline for the Decontamination of Surgical Instruments, AST Guideline for Packaging Material and Preparing Items for Sterilization, AST Guideline for Normothermia in the Perioperative Patient, AST Guideline for Environmental Practices in the Operating Room, AST Guideline for Use of Mobile Information Technology in the Operating Room
- Package 19 - 9.5 CEs - $13 – Video Package - Craniofacial Surgery; Cutting Edge of Laser Safety; MRI-guided Neurosurgery; Reconstructive Neurosurgery; Surgery for Prostate Cancer; Teamwork, Tourniquets, & Trauma; Updates in Transplant Surgery
- Package 20 - Preceptor Course - 5.5 CEs - $10
- Package 21 - 10 CEs - $10 – Surgical Management of Benign Tumors of the Heart; Breast Implants – Current Insights on a Common Medical Device; Inges-

tion of Sharp Foreign Objects: A Case Series; Day-case versus Inpatient Stapes Surgery for Otosclerosis; Surgery and Chronic Stress – Ultimately Leading to Major Health Risks; Laparoscopic Lavage and Drainage in the Management of Complicated Diverticulitis; Allograft Nephrectomy for Malignancy: Report of Seven Cases

- Package 22 - 17.5 CEs - $28 – New Interventional Technologies Expand Treatment Options for Cardiovascular Disease; Perfusion: A Historical Perspective; Thoracic Trauma; Off-pump Coronary Artery Bypass Grafting; Open Thoracotomy Approach to Bronchoesophageal Fistula Repair; Aortic Valve Replacement; Carotid Endarterectomy; Transcatheter Aortic Valve Replacement (TAVR); Abdominal Aortic Aneurysm Resection; Bilateral Femorol-Popliteal Artery Bypass Grafting – From Supine to Prone; Abdominal Aortic Aneurysm Repair; Cervical Mediastinal For Exploration Staging of Lung Cancer; Pulmonary Embolism: A Survivor's Story; Pectus Carinatum: Pigeon Chest; Robotic Versus Thoracoscopic Lung Resection
- Package 23 - 15 CEs - $24 – Alternatives to Blood Transfusions; A Crash Course in Microbiology: A Review of Pathogens and Disease; Taking Control of Infection Control; The Modern-Day C-section; A Facial Rejuvenation Short-scar Face-lift/Simple MACS; Adenocarcinoma of the Appendix; Single-site Laparoscopic Total Hysterectomy; Sterile Processing: The Other Side of Surgical Services; Mammoplasty to Treat Macromastia; Damage Control Surgery; Organ Procurement
- Package 24 - 9.5 CEs - $14 – Orthopedic Surgery During the American Civil War; The Surgical Legacy of World War II, Part 1: Pearl Harbor, Preparation and Portability; The Surgical Legacy of World War II, Part 2: The Age of Antibiotics; The Surgical Legacy of World War II Part 3: Blood and Valor; The Surgical Need – 50 Years of Surgical Technology
- Package 25 – 5.5 CEs - $10 – The Rise of Microbiology - The Rise of MRSA; The Spread of the Superbug; Dealing with Infectious Disease – Ebola

CONTINUING EDUCATION RESOURCES

Earning CE

Many of the CE credits processed by AST for CSTs for CSFAs are earned through one or more of the ways listed below.

None of these are subject to a processing fee.

- AST Distance CE (journal tests or CE packages)
- Hospital in-services
- Live lectures at AST state assemblies, national conference and others, such as ACS Congress
- College Courses
- Healthcare Manufacturer's Events. AST accepts CE credits that are offered at in-person events that have been planned and are sponsored and advertised by healthcare manufacturers - referred to as commercial interest organizations (CIO). However, in order for the CE credits to be accepted by AST, the in-person program must be approved by AST and the program must be relevant to the practice of surgical technology or surgical first assisting. In-person events are stand-alone events, such as forums or hands-on workshops that are the sole responsibility of the CIO to plan and market as well as offer the CE credits, and are held at the location of the CIO's choice.

CE credit fees

These only apply to a very small percentage of credits earned through commercial providers due to the increased time and resources required to research and assess CE credits earned through those providers, particularly those CE credits offered by commercial businesses that contract with healthcare facilities, and now live events. There are no refunds given for AST online CE tests or CE credit packages.

Number of CE Credits	Processing Fee
* 1- 10	$15
*11-20	$30
*21-30	$45
*31-40	$60
*41-50	$75
*51+	$90

Members: See above for any additional fee for processing CE credits excluding AST tests.

Nonmembers: Nonmembers may be subject to a processing fee at the time of submission.

Money orders, personal checks, institutional checks, Visa, MasterCard and American Express are accepted. Checks payable to AST.

Qualifying CE Credits Checklist

- ✔ Are all CE your credits earned while an AST member?
- ✔ Are all CE credits earned within your current certification cycle established by the NBSTSA?
- ✔ Are all your CE credits relevant to the medical-surgical practice of surgical technology and surgical assisting?
- ✔ Have you submitted a CE Reporting Form? CE credits will be returned without a CE Reporting Form.
- ✔ Did you list each educational activity on the CE Reporting Form?
- ✔ Did you submit proper documentation for each education activity listed on the CE Reporting Form? Keep originals of documentation and submit copies.
- ✔ Is any applicable fee enclosed?

2 Ways to Submit Your CE Credits

- Mail to: AST, 6 West Dry Creek Circle, Ste 200, Littleton, CO 80120-8031
- Email scanned CE credits in PDF format to AST Member Services. Do not mail credits that were previously emailed.

The vast majority of all CE credits processed by AST for CSTs for CSFAs are earned through one or more of the ways listed below. ***None of these are subject to a processing fee.***

- AST Distance CE (journal tests or CE packages)
- Hospital Inservices
- Live lectures at AST state assemblies, national conference and others, such as ACS Congress
- College Courses
- Healthcare Manufacturer's Live Events. AST now accepts CE credits that are offered at lives events that have been planned and are sponsored and advertised by healthcare manufacturers - referred to as commercial interest organizations (CIO). However, in order for the CE credits to be accepted by AST, the live program must be approved by AST and the program must be relevant to the practice of surgical technology or surgical first assisting. Live events are standalone events, such as forums or hands-on workshops that are the sole responsibility of the CIO to plan and market as well as offer the CE credits, and are held at the location of the CIO's choice.

Qualifying CE Credits Checklist

- ✔ Are all CE your credits earned while an AST member?
- ✔ Are all CE credits earned within your current certification cycle established by the NBSTSA?
- ✔ Are all your CE credits relevant to the medical-surgical practice of surgical technology and surgical assisting?
- ✔ Have you submitted a CE Reporting Form? CE credits will be returned without a CE Reporting Form.
- ✔ Did you list each educational activity on the CE Reporting Form?
- ✔ Did you submit proper documentation for each education activity listed on the CE Reporting Form? Keep originals of documentation and submit copies.
- ✔ Is any applicable fee enclosed?

3 Ways to Submit Your CE Credits

- Mail to: AST, 6 West Dry Creek Circle, Ste 200, Littleton, CO 80120-8031
- Email scanned CE credits in PDF format to AST Member Services. Do not mail credits that were previously emailed.

Apply for a Medical Mission Scholarship

Did you serve on a medical mission during the first couple months of this year, prior to the global pandemic? If so, you may be eligible to apply for a medical mission scholarship.

Eligibility

To be eligible for a mission scholarship you must:

- Be an active AST member with currency.
- Complete and submit the Mission Medical Application and the Medical Mission Verification Form by December 31 of the year of your mission.
- Provide a description of your membership history—join date and any AST involvement.
- Upload official documentation of the mission program

you have described.

- Upload official receipts documenting the costs incurred by the individual and all costs must be shown in dollars. All assistance is determined after the medical mission trip has occurred and the appropriate documentation has been provided. Upload supporting documents below.
- Upload two letters of recommendation, along with an article describing your experience for *The Surgical Technologist* journal and related photos.
- Write an article describing your experience for *The Surgical Technologist* and provide related photos before you are reimbursed.

WRITE FOR US

Calling All Writers!

We are always looking for new CE authors and surgical procedures that detail the latest advancements in the surgical arena. We'll also help you every step of the way, AND you'll earn CE credits by writing a CE article that gets published! Here are some guidelines to kick start your way on becoming an author:

- An article submitted for CE must have a unique thesis or angle and be relevant to the surgical technology profession.
- The article must have a clear message and be accurate, thorough, and concise.
- It must be in a format that maintains the Journal's integrity of style.
- It must be an original topic (one that hasn't been published in the Journal recently).

Ready to get started? Email us at communications@ast.org.

MILESTONES

Congratulations to the following state assembly as it celebrates anniversaries this month! AST appreciates your hard work, dedication and all your years of service for making our state assemblies the backbone of this organization.

- Tennessee - 25 years

A First-Hand Look at the Critical Role Surgical Technologists Have in the OR

AST CEO visits Northside Hospital

JODI LICALZI, CHIEF EXECUTIVE OFFICER
ASSOCIATION OF SURGICAL TECHNOLOGISTS

In March, I had the pleasure of accompanying AST Treasurer, Dustin Cain, CST, FAST, and employee at Northside Hospital in Atlanta, Georgia, through Northside's multiple operating rooms, sterile processing facilities and simulation labs to get a better understanding of the role of a surgical technologist as well as how all the elements of a surgical operation flow.

While I have worked at the Association of Surgical Technologists for 14 years in the communications/marketing department, I am not a surgical technologist, nor do I have a medical background. My understanding of the surgical technology profession and the critical role a surgical technologist plays in patient safety has been through the years learning about different procedures, reading first-hand accounts of the role and the day-in-the-life narratives, by speaking with many of you in the profession and listening to the challenges and obstacles as well as the highs and lows of the role. And of course, all the social media comments!

When I applied to be AST's next CEO last year after more than a decade working for this organization, I knew many areas of the business and had a solid understanding of the role and the profession. This visit actually *showed* me the role in action.

From witnessing counts to set up to draping of the robotic arms, working with the circulating nurse and observing multiple surgeries, I'll be able to take all the details – and there are many – forward into impacting every day and long-term decisions that the AST Board of

AST CEO Jodi Licalzi stands with AST Treasurer and Northside Hospital employee Dustin Cain, CST, FAST, inside Northside before getting a tour of the facilities.

Directors and AST staff is making as we renew our commitment to our members and this organization.

I am extremely passionate about advocating for you – our members – as you show your passion and professionalism each day whether that is in surgery, as an educator teaching the next generation or mentoring others in the surgical arena. Every opportunity I have to better understand the role, the people and the profession I am representing and advocating for is a golden chance at advancing the organization and its benefits, better connecting with our members and innovating for needs and solutions now and in the future.

Being able to view your role behind the red line, behind the Mayo and standing aside the patient, inspires me to champion even harder for the crucial education and training that is necessary for safe surgeries.

I am beyond grateful to Dustin and the Northside staff for welcoming me into their environment and allowing me to be a part of their day. I look forward to further championing the role of the surgical technologist and working with our stakeholders to develop the future of this organization as we continue to strive to enhance the profession to ensure quality patient care.

Jodi Licalz, AST CEO with Dustin Cain, CST, FAST, and other Northside employees in the Northside Hospital Simulation Lab practicing various aspects of the surgical technologist role.

ADVOCATE FOR YOURSELF.

AST
Association of Surgical Technologists

You advocate for your patients – no question. Now it's time to advocate for the critical role you play as a key member of the surgical team and how important your role is to patient safety.

AST developed a toolkit specifically for surgical technologists to use when you're explaining just how crucial is it that certified surgical technologists earn education from an accredited program thus making them eligible to sit for the national certifying exam and earn the distinguished CST credential. Scan the QR code to access documents, AST position statements and other resources you need to keep advocating for the profession.

AST Position Statement on Accreditation, Certification, Official Title of Profession, and On-the-Job Training

American College of Surgeons Statement on Surgical Technology Training and Certification

Council on Surgical & Perioperative Safety Statement in Support of CST

Empower YOURSELF

YOUR VOICE, YOUR POWER

- The Workforce Shortage: A Message from AST
- Turning the Workforce Chute into a Ladder
- CSTs Many Lifesaving Roles
- Education and Certification as an Appropriate Minimum
- Standard for Surgical Technology and Patient Safety
- AST Position Statement on Minimum Education for Surgical Technologists
- AST Position Statement on Accreditation, Certification, Official Title of the Profession, and OJT Training
- ACS Statement Supporting Surgical Technology Accredited Education and the CST
- AORN Job Description Supporting Surgical Technology Accredited Education and the CST
- CSPS Surgical Team Member Roles - Partner Organizations and Credentials
- AST Encourages Healthcare Facility Leaders to Support Local, Accredited Surgical Technology Educational Programs
- AST Recommendations for CSTs, Program Directors, and State Assemblies when Addressing OTH Training with a Healthcare Facility
- Message to Surgical Technology Program Directors Regarding Alternative Certification Credentials from the AST, ARC/STSA, and NBSTSA
- Should Healthcare Facilities Require CST Certification for Surgical Technologists? Yes...Here's Why

AST
Association of Surgical Technologists
Your Voice Your Power
ADVOCATING FOR THE PROFESSION


GETINGE
Grundsieb Groß

Comparison of Alternative Sterilization Chemicals to Ethylene Oxide (EtO)

AST STAFF

EtO has long been an essential chemical used by manufacturing and the healthcare industry. EtO was discovered by the French chemist Charles-Adolphe Wurtz in 1859.[1] In 1914, the German chemical manufacturing business Badische Anilin- und Sodafabrik (BASF – Baden Aniline and Soda Factory), built the first EtO plant.[1]

During the 1930s and '40s, it was used to fumigate hospital ward rooms and by the 1950s was commonly used to sterilize surgical instruments.[2] Other landmark dates include the following.[2]

- 1928 – Scientists reported that EtO is a strong insecticide.
- 1940 – Two executives at Griffith Laboratories, now called Griffith Foods located in Chicago, patented a method that pumped EtO into a vacuum chamber to sterilize spices. The U.S. Army later used EtO to fumigate troop rations during World War II.
- 1948 – A study establishes that EtO is a mutagen.
- 1987 – California declares EtO is a human carcinogen.
- 1990s - Other sterilizers to possibly replace EtO are developed including hydrogen peroxide and peracetic acid.

EtO continues to be produced in large quantities by companies because of its use as an important source in the manufacturing of common items. In 2018, the U.S. produced 2.92 metric tons of EtO

LEARNING OBJECTIVES

- Compare and contrast alternative sterilization chemicals to ethylene oxide
- Discuss the advantages of alternative sterilization chemicals
- List the disadvantages between EtO and CD, ND, VHP
- Debate whether one of the chemicals has more perceived sustainability than the others
- Explain the reasons why healthcare facilities might use one of the chemicals over the others

worth $3.49 billion.[3] More than 97% of the amount produced is used to make other chemicals that are used to manufacture a range of products, including adhesives, antifreeze (ethylene glycol or propylene glycol), detergents, plastics, and textiles.[3] Less than 1% of manufactured EtO is used as a fumigant, to sterilize food (spices) and cosmetics.[3] Yet, EtO is the most used sterilization method for medical devices in the U.S, with more than 20 billion devices sold in the U.S. annually that are sterilized with EtO, equal to approximately 50% of devices that require sterilization.[4] However, because of health concerns, the controversy of using EtO in healthcare facilities increased over time prompting the EPA to tighten regulations to decrease the potential risk of exposure from EtO sterilization processes. On March 14, 2024, the EPA announced their most recent ruling regarding commercial EtO sterilizers to reduce exposure to the colorless gas.[5]

This has also led to the research and development of alternative sterilization chemicals as a possible replacement for EtO in healthcare facilities. The remainder of this article will discuss the alternative sterilization chemicals chlorine dioxide (ClO_2 – referred to as CD), nitrogen dioxide (NO_2 – referred to as ND), and vaporized hydrogen peroxide (VH_2O_2 - referred to as VHP).

Alternative sterilization chemicals have been in existence for several decades. For example, the vapor form of hydrogen peroxide was first identified as a sterilant in the late 1970s.[6] In the late 1980s, the first hydrogen peroxide gas plasma system for sterilization of medical and surgical devices was field-tested, and later in the 1990s, the use of vaporized hydrogen peroxide slightly increased. However, alternative sterilization chemicals are still not in wide use and primarily used by commercial sterilization businesses and healthcare manufacturers.

CHLORINE DIOXIDE

CD is one of the newer sterilization agents that provide manufacturers with an environmentally alternative to sterilization of medical devices that avoids carcinogenic emissions. It was registered as an EPA sterilant in 1988. In early 2021, the US Food and Drug Administration (FDA) approved CD for contract sterilization of medical devices and subsequently, ClorDiSys Solutions, located in New Jersey, became an FDA-registered contract sterilization facility.[7]

CD is produced by a chemical reaction by mixing sodium chlorite ($NaClO_2$) with an acidic solution, typically hydrochloric acid (HCl), which then fills the sterilization chamber. It is a greenish yellow or reddish yellow colored gas that smells like chlorine at an ambient temperature. It is effective as a biocide against bacteria, fungi, spores, and viruses.[8] It kills microbes by disrupting the cell membrane and cellular proteins through the process of oxidation.[8]

CD has multiple advantages over EtO.

- CD is a true gas sterilant and operates at ambient temperature.[9]
- Facilities using EtO can convert the chamber into a CD sterilization chamber.[9]
- An important advantage because CD is not explosive, devices embedded with batteries, such as pacemakers, can be sterilized using the agent.[8]
- Shorter sterilization cycle time and aeration than EtO providing a faster turnover time of medical devices and instrumentation. Aeration typically is under 60 minutes.[9]
- CD has not been linked to birth defects or cancer. However, because there have been no cancer studies completed on human exposure to CD, the EPA cannot assign a carcinogenicity classification.[8]
- CD is used to sterilize a variety of items including artificial joints, electronic devices, endoscopes, implantable contact lenses, prefilled syringes, surgical kits, suture products, and vial stoppers.
- At normal sterilizing condition of 4% concentration CD is not explosive or flammable. However, over 10% concentration it is explosive and therefore, prohibited from transport by the US Department of Transportation unless shipped frozen.[8]
- It does not pose a risk to patients because it does not leave a residue on medical devices making it a surface sterilant that can be used to sterilize pre-filled syringes without effecting the integrity of the drug. It also has the capability to sterilize medical devices with narrow lumens and complex geometries.[8] Additionally, because of no residue, its by-products can be exhausted to the environment. The by-products are chlorate, chloride, and chlorite that are non-carcinogenic, non-cytotoxic, and non-teratogenic.

There are drawbacks to the use of CD. The agent is not manufactured in large enough quantities as compared to EtO. At the commercial sterilization level, the chambers are not as large as the big EtO chambers, thus reducing the amount of product that can be sterilized simultaneously.[8]

NITROGEN DIOXIDE

ND is the most recent addition of the three alternative sterilization methods discussed. There isn't a documented date for the discovery of ND as a sterilant. The FDA categorizes sterilization processes as either "established" (Category A), which includes current methods such as dry heat, electron beam, EtO, and gamma radiation, or "novel" (Category B), which includes technologies that do not have an established history for sterilizing medical devices that includes ND.[10] However, in June 2016, Noxilizer, Inc. received FDA 510(k)[a] clearance for a medical device terminally sterilized using its ND sterilization process.[11] Additionally, in June 2019, the FDA announced their *Innovation Challenge 1: Identify New Sterilization Methods and Technologies* and subsequently, in November 2019, Noxilizer, Inc. was chosen to work with the FDA in further developing ND sterilization.[12]

Liquid nitrogen that is stored in a container is vaporized to create the true gas that is injected into the sterilization chamber. It is non-carcinogenic and non-flammable. It kills microorganisms by damaging their DNA referred to as "DNA degradation."[13] Because of its low boiling point, 21˚ C, ND sterilizes at an ultra-low temperature of 10˚ - 30˚ C making it ideal for heat-sensitive items.[13] Cycle times are shorter than EtO and humidity added to the sterilizing chamber assists in speeding up the sterilization process. The low boiling point coupled with a low sterilant concentration, allows rapid aeration by the introduction of air into the sterilization chamber making it possible to immediately handle sterilized packages.[13,14] The low boiling point also allows the gas to be introduced into the sterilization chamber with minimal to no vacuum.[14]

ND gas does not condense on devices because of the low sterilant concentration. Therefore, it is a surface sterilant providing the advantage that it can be used to sterilize pre-filled syringes without compromising the drug and reach complex geometries of medical devices.[13] ND is compatible with aluminum, glass, gold plating, polycarbonate, polyethylene, polypropylene, PVC, silicone, and stainless steel.[13] Therefore, ND can be used with non-woven polypropylene packaging, Tyvek® pouches, and Tyvek® - Mylar® pouches, and silicone rubber.

A disadvantage is that porous packaging is required, so medical grade paper cannot be used because cellulosic materials are not compatible with the ND sterilization process.[13] Another disadvantage ND is toxic gas and proper safety precautions must be followed during handling.

> In the late 1980s, the first hydrogen peroxide gas plasma system for sterilization of medical and surgical devices was field-tested, and later in the 1990s, the use of vaporized hydrogen peroxide slightly increased. However, alternative sterilization chemicals are still not in wide use and primarily used by commercial sterilization businesses and healthcare manufacturers.

VAPORIZED HYDROGEN PEROXIDE

VPH will be discussed in greater detail because of its rise in popularity with healthcare facilities, which can be attributable to the ANSI/AAMI ST 91 standard that advocates for flexible endoscope reprocessing to be consistently changed from high-level disinfection to sterilization.[15] There are different types according to the additive such as ozone or plasma, but the sterilizing agent is the VHP. To fully understand VHP plasma also needs to be understood. Plasma is the fourth state of matter with gas, liquid, and solid being the other three. Plasma is created when a gas is heated adequately or exposed to a strong electromagnetic field. When the gas becomes plasma, it has undergone a chemical reaction causing it to become an ionized gas.[16]

Examples of manmade plasmas include fluorescent light bulbs, neon signs, nuclear fusion, and plasma displays used for computer monitors and televisions. Naturally occurring examples are the well-known Northern Lights, tales of comets, fire, lightening, sun and stars.

The sterilization cycle occurs in three phases: conditioning, sterilization, and venting. Conditioning begins with air removal from the chamber to facilitate the penetration of VHP and to remove traces of moisture remaining on the load.[17] Sterilization starts with heating the liquid hydrogen peroxide to convert to a gas. The

The use of CD and ND, primarily by manufacturers, and VHP by healthcare facilities and manufacturers represent an advancement in the field of sterilization, material compatibility, environmental safety and health care personnel and patient safety.

gas is heated to a higher temperature to convert to plasma that is injected into the chamber.[16] VHP condenses inside the chamber and forms a microlayer of condensate on the enclosed items.[17] The sterilization phase is repeated one or more times. During the venting phase, the plasma is transferred to a catalytic convertor to convert the plasma to oxygen and water that is safely evaporated into the atmosphere.[17] Because VHP is an oxidizing agent it kills microorganisms by destroying the microbes DNA, enzymes, and proteins.

An important detail to emphasize is ensuring that items to be sterilized are completely dried following the manufacturer's instructions. As with any sterilization process, instruments are cleaned and disinfected according to the manufacturer's instructions. However, failure to thoroughly dry the instruments can cause complications such as impeding the ability of the VHP to properly contact the surface of the instruments causing items to be non-sterile as well as the moisture can act as a protective shield for microorganisms. Additionally, residual hydrogen peroxide can remain on the surface of the load at the end of the cycle causing risks to health care personnel and patients.[17] As mentioned, a low amount of residual moisture will evaporate during the conditioning phase. However, a high amount of moisture continues evaporating during the vacuum, that impedes pressure reduction and can cause the cycle to abort. Secondly, the evaporated moisture reduces the temperature of the heat from the evaporation of remaining liquid causing it to form ice.[18] The ice could prevent the VHP to contact the surface of the items in the load as well as block narrow lumens.[18] Therefore, it is essential to ensure that moisture on items to be sterilized is at a minimum or non-existent.

On July 24, 2023, the FDA's Center for Devices and Radiological Health (CDRH) announced that it updated the *Recognized Consensus Standards* database to include complete recognition of the ISO[b] 22441:2022 *Sterilization of health care products – Low temperature vaporized hydrogen peroxide – Requirements the development, validation, and routine control of sterilization process for medical devices*.[19] Because of this recognition, the FDA switched VHP from a novel sterilization technique (Category B) to established (Category A) on January 8, 2024. The FDA commented "that it considers vaporized hydrogen peroxide (VHP) to be an established method of sterilization for medical devices, recognizing VHP's long history of safety and effectiveness. [T]he FDA is adding VHP to Established Category A, which the agency expects will strengthen industry's capacity to adopt alternative sterilization processes that pose less potential risk to the environment and communities in which they operate."[4]

Medical devices that healthcare facilities commonly sterilize using VHP include the following.

- Non-hollow devices: defibrillator pads, dopplers, electrocautery instruments, laser probes, ophthalmic lenses
- Hollow devices: fiber optic light cables, laryngoscopes, surgical power equipment (drills, saws)
- Endoscopes: flexible and rigid
- Advantages of VHP include the following.
- VHP operates at lower temperatures that reduce energy utilization making it an energy-efficient system.[17]
- The sterilization process is less than one hour, with the average cycle running 35-45 minutes contributing to a faster turnover of sterilized items.[17]
- It is environmentally friendly and safe. Because VHP does not produce toxic fumes or residue, a long aeration cycle is not required, and the sterilized items can be immediately handled by health care personnel.

There are two main disadvantages. Only Tyvek® packaging materials can be used and because VHP does not penetrate as well as EtO, medical devices with lumens are challenging to sterilize.

The use of CD and ND, primarily by manufacturers, and VHP by healthcare facilities and manufacturers represent an advancement in the field of sterilization, material compatibility, environmental safety and health care personnel and patient safety. The three alternative sterilization methods provide a future for sustainable practices

that are cost effective and poised to play a continuing role in advancing medical device safety.

510(k) is a premarket submission made to the FDA to demonstrate that a device to be marketed is safe and effective and substantially equivalent to a legally marketed device. The applicant must compare their device to one or more similar legally marketed devices and support their equivalence claims. (U.S. FDA, Premarket Notification 510(k), August 22, 2024, https://www.fda.gov/medical-devices/premarket-submissions-selecting-and-preparing-correct-submission/premarket-notification-510k.

ISO, International Organization for Standardization, is an independent, international standard development organization whose membership consists of other national standards organizations of member countries. It has published over 25,000 international standards addressing multiple areas of technology and manufacturing, including healthcare. (ISO, https://www.iso.org/home.html)

Disclaimer: Mention and reference of commercial businesses or products in the article do not imply that AST endorses the commercial businesses or products. The commercial businesses or products are mentioned within the context of technical information.

REFERENCES

1. American Chemical Society. Ethylene oxide. Molecule of the Week Archive. November 18, 2019. Accessed February 18, 2025. https://www.acs.org/molecule-of-the-week/archive/e/ethylene-oxide.html#:~:text=Ethylene%20oxide%20is%20the%20smallest,ethylene%20oxide%20and%20potassium%20chloride
2. Hawthorne M. From discovery of a powerful chemical to shutting down Sterigenics. Chicago Tribune. October 16, 2019. Updated April 15, 2024. Accessed February 18, 2025. https://www.chicagotribune.com/2019/10/16/from-discovery-of-a-powerful-chemical-to-shutting-down-sterigenics-160-years-of-ethylene-oxide/
3. Economics & Statistics Department. The economic benefits of ethylene oxide and the potential cost of deselection. American Chemistry Council. June 2019. Accessed February 18, 2025. https://www.americanchemistry.com/industry-groups/ethylene-oxide/resources/the-economic-benefits-of-ethylene-oxide
4. FDA News Release. FDA facilitates broader adoption of vaporized hydrogen peroxide for medical device sterilization. U.S. Food & Drug Administration. January 8, 2024. Accessed February 18, 2025. https://www.fda.gov/news-events/press-announcements/fda-facilitates-broader-adoption-vaporized-hydrogen-peroxide-medical-device-sterilization
5. U.S. Environmental Protection Agency. EPA announces final rule to slash toxic emissions of ethylene oxide and reduce cancer risk. United States Environmental Protection Agency. March 14, 2024. Accesses February 18, 2025. https://www.epa.gov/newsreleases/epa-announces-final-rule-slash-toxic-emissions-ethylene-oxide-and-reduce-cancer-risk#:~:text=Home-,EPA%20announces%20final%20rule%20to%20slash%20toxic%20emissions,oxide%20and%20reduce%20cancer%20risk&text=WASHINGTON%20%E2%80%93%20Today%2C%20March%2014%2C,sterilization%20facilities%20across%20the%20country
6. McEvoy B, Eveland R. Vaporized hydrogen peroxide: a well-known technology with a new application. *Biomed Instrum Technol*. 2020. doi: 10.2345/0899-8205-54.s3.74
7. Kritz F. FDA approves chlorine dioxide gas for medical device contract sterilization. AAMI Array. April 21, 2021. Accessed February 22, 2018. https://array.aami.org/content/news/fda-approves-chlorine-dioxide-gas-medical-device-contract-sterilization
8. Hammerand J. What is chlorine dioxide sterilization for medical devices? Medical Design & Outsourcing. June 20, 2023. Accessed February 22, 2025. https://www.medicaldesignandoutsourcing.com/chlorine-dioxide-sterilization-medical-devices-clo2-eto-alternative/
9. ClorDiSys. Medical device sterilization with chlorine dioxide gas. n.d. Accessed February 22, 2025. https://www.clordisys.com/pdfs/brochures/ClorDiSys%20Medical%20Device%20Sterilization%20Brochure.pdf
10. Visnovsky D. 510(k)s for sterile devices: FDA releases 2024 final guidance. AAMI Array. January 17, 2014. Accessed February 22, 2025. https://www.acs.org/molecule-of-the-week/archive/e/ethylene-oxide.html#:~:text=Ethylene%20oxide%20is%20the%20smallest,ethylene%20oxide%20and%20potassium%20chloride
11. bwtech@UMBC. Noxilizer announces FDA 510(k) clearance of a medical device sterilized using a nitrogen dioxide process. myUMBC. June 1, 2016. Accessed February 22, 2025. https://my3.my.umbc.edu/groups/bwtech/posts/60498
12. U.S. Food & Drug Administration. FDA innovation challenge 1: identify new sterilization methods and technologies. November 25, 2019. Accessed February 22, 2025. https://www.fda.gov/medical-devices/general-hospital-devices-and-supplies/fda-innovation-challenge-1-identify-new-sterilization-methods-and-technologies
13. Noxilizer. Technology overview. 2025. Accessed February 22, 2025. https://noxilizer.com/overview/#:~:text=Nitrogen%20dioxide%20gas%20sterilization%20is,not%20leach%20through%20the%20stopper
14. Goulet E. Sterilizing with nitrogen dioxide. *Pharm Technol*. 2013; 37(3). Accessed February 22, 2025. https://www.pharmtech.com/view/sterilizing-nitrogen-dioxide
15. Association for the Advancement of Medical Instrumentation. *ANSI/AAMI ST91:2021 flexible and semi-rigid endoscope processing in health care facilities*. AAMI; 2021.
16. Tuttnauer Product Experts. Low temperature hydrogen peroxide plasma sterilization. 2025. Accessed February 22, 2025. https://tuttnauer.com/blog/low-temperature-hydrogen-peroxide-plasma-sterilization
17. Estahbanati MRK. Advances in vaporized hydrogen peroxide reusable medical device sterilization cycle development: technology review and patent trends. *Microorganisms*. October 15, 2023. Accessed February 22, 2025. doi: 10.3390/microorganisms11102566
18. Truong DV, Morrison T, inventors; ASP Global Manufacturing GMBH, assignee. Apparatus and method for detecting moisture in a vacuum chamber. US patent application 20,240,003,624. January 4, 2024.
20. Schwartz S. CDRH announces new standards recognition to support innovation in medical device sterilization. July 24, 2023. Accessed February 25, 2025. https://www.fda.gov/medical-devices/medical-devices-news-and-events/cdrh-announces-new-standards-recognition-support-innovation-medical-device-sterilization

Comparison of Alternative Sterilization Chemicals to Ethylene Oxide (EtO)

#500 MAY 2025 1 CE CREDIT $6

1. What percentage of medical devices are sterilized with EtO?
A. 20%
B. 30%
C. 40%
D. 50%

2. Which of the following packaging material is not compatible with nitrogen dioxide?
A. Tyvek
B. Cellulose
C. Polypropylene
D. Silicone rubber

3. How does chlorine dioxide kill microorganisms?
A. DNA degradation
B. Disrupts cellular metabolism
C. Oxidation
D. Causes lysis of cellular wall

4. What federal organization changed vaporized hydrogen peroxide from a novel sterilization technique to established?
A. EPA
B. AAMI
C. FDA
D. ISO

5. Which of the following is an advantage of chlorine dioxide?
A. Devices with batteries can be sterilized
B. Aeration is not required.
C. High concentrations can be transported
D. Sterilizing chambers are larger than EtO chambers

6. What is added to the nitrogen dioxide sterilizing chamber to speed up the sterilization cycle?
A. Oxygen
B. High heat
C. Humidity
D. Electromagnetic field

7. What EPA carcinogenic classification has been assigned to chlorine dioxide?
A. B
B. C
C. D
D. No category

8. How does nitrogen dioxide kill microorganisms?
A. Denature enzymes
B. DNA degradation
C. Cause leakage of protoplasm
D. Alkylation of cellular proteins

9. During the venting phase, vaporized hydrogen peroxide is converted to:
A. Oxygen and water
B. Residue
C. Oxygen only
D. Gas

10. What substance can form within the vaporized hydrogen peroxide chamber if there is too much evaporated moisture?
A. Hydrogen peroxide residue
B. Oxygen
C. Plasma
D. Ice

COMPARISON OF ALTERNATIVE STERILIZATION CHEMICALS TO ETHYLENE OXIDE (ETO)
 # 500 MAY 2025 1 CE CREDIT $6

AST Member No.

☐ My address has changed. The address below is the new address.

Name

Address

City State Zip

Telephone

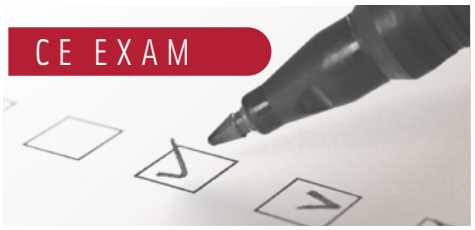
☐ Check enclosed ☐ Check Number

	a	b	c	d
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐

Make It Easy - Take CE Exams Online

You must have a credit card to purchase test online. We accept Visa, MasterCard and American Express. Your credit card will only be charged once you pass the test and then your credits will be automatically recorded to your account.

Log on to your account on the AST homepage to take advantage of this benefit.



Earn CE Credits at Home

You will be awarded continuing education (CE) credits toward your recertification after reading the designated article and completing the test with a score of 70% or better. If you do not pass the test, it will be returned along with your payment.

Send the original answer sheet from the journal and make a copy for your records. If possible use a credit card (debit or credit) for payment. It is a faster option for processing of credits and offers more flexibility for correct payment. When submitting multiple tests, you do not need to submit a separate check for each journal test. You may submit multiple journal tests with one check or money order.

Members this test is also available online at ***www.ast.org.*** No stamps or checks and it posts to your record automatically!

Members: $6 per credit
(per credit not per test)

Nonmembers: $10 per credit
(per credit not per test plus the $200 nonmember fee per submission)

After your credits are processed, AST will send you a letter acknowledging the number of credits that were accepted. Members can also check your CE credit status online with your login information at ***www.ast.org.***

2 WAYS TO SUBMIT YOUR CE CREDITS

Mail to: AST, Member Services,
6 West Dry Creek
Circle Ste 200, Littleton, CO 80120-8031

E-mail scanned CE credits in PDF format to:
memserv@ast.org

For questions please contact Member Services - ***memserv@ast.org*** or 800-637-7433, option 3.
Business hours: Mon-Fri, 8 am - 4:30 pm MT

YOUR NEW JOB IS IN SIGHT

AST's Career Center can help you:

Find and apply to hundreds of jobs for surgical technologists, surgical assistants and surgical technology educators

- Post your resume and create a profile so recruiters can find you quickly
- Save your search criteria and sign up to be notified when new jobs are posted
- Watch instructional videos on resume writing, networking, behavioral interviewing and more
- Read "10 Tips for Salary Negotiations" and other helpful articles to better your career

Ready for the next step in your career?

Positions available include Surgical Technologist 2 and Surgical Technologist 3 with up to $20,000* sign-on bonuses!

Visit AST's career site today to view the latest postings and apply!

***Sign-on bonuses vary from positions and institutions. Applicants should clarify with recruiters regarding their offerings and options.**

http://careercenter.ast.org/jobseekers/

WRITE FOR US!

We are always looking for CE authors and surgical procedures that haven't been written about or the latest advancements on a commonplace surgery. You don't have to be a writer to contribute to the Journal. We'll help you every step of the way, AND you'll earn CE credits by writing a CE article that gets published! Here are some guidelines to kick start your way on becoming an author:

1. An article submitted for a CE must have a unique thesis or angle and be relevant to the surgical technology profession.
2. The article must have a clear message and be accurate, thorough and concise.
3. It must be in a format that maintains the Journal's integrity of style.
4. It must be an original topic (one that hasn't been published in the Journal recently.)

How to Get Started

The process for writing a CE can be painless. We are here to assist you every step of the way and make sure that you are proud of your article.

- Write to **communications@ast.org,** and state your interest in writing, and what topic you would like to author.
- Submit an outline of your proposed topic for review. Once the outline is returned to you for approval, begin writing your manuscript. Getting your outline approved will save you time and effort of writing a manuscript that may be rejected.
- Submit your manuscript, as well as any art to illustrate your authored topic. You will be notified upon receipt of receiving the manuscript and as well as any changes, additions or concerns.

Things to Remember:

- **Length:** Continuing education articles should run a minimum of 2,000 words and a maximum of 5,000 words.
- **References:** Every article concludes with a list of ALL references cited in the text. All articles that include facts, history, anatomy or other specific or scientific information must cite sources.
- **Copyright:** When in doubt about copyright, ask the AST editor for clarification.
- **Author's Responsibility:** All articles submitted for publication should be free from plagiarism, should properly document sources and should have attained written documentation of copyright release when necessary. AST may refuse to publish material that they believe is unauthorized use of copyrighted material or a manuscript without complete documentation.

Don't delay! **Become an author today. Write to us at communications@ast.org**

Impact of Anti-Fatigue Floor Mat on Surgical Staff Comfort Levels in Head and Neck Surgery Cases

B. S. Jacey Elliott[1] | Pawan Acharya[2] | Lurdes Queimado[1,3] | Daniel Zhao[2] | Wesley Greene[1] | Greg Krempl[1] | Rachad Mhawej[1]

[1]Departments of Otolaryngology, The University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, USA | [2]Biostatistics & Epidemiology, The University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, USA | [3]Cell Biology, The University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma, USA

Correspondence: Rachad Mhawej (rachad-mhawej@ouhsc.edu)

Received: 4 September 2024 | **Revised:** 6 December 2024 | **Accepted:** 2 January 2025

Funding: The authors received no specific funding for this work.

Keywords: anti-fatigue floor mat | ergonomics of surgery | fatigue | head and neck surgery | occupational diseases | otolaryngology | work-related musculoskeletal symptoms

ABSTRACT

Objective: Musculoskeletal symptoms are common among surgical staff and can have long-term implications on health and wellbeing. The purpose of this study is to evaluate the impact of anti-fatigue floor mat on the comfort level of surgical teams during head and neck surgeries lasting ≥ 3 h.

Methods: Over 4 months, we prospectively randomized 34 major (≥ 3 h) head and neck procedures to the use or not of an anti-fatigue floor mat. Anonymous questionnaires measured the comfort levels in different subjects including the surgeons, assistant surgeons, and surgical scrub technicians ($n = 57$). Subjects completed questionnaires before, immediately after, and one day after surgery. Variables collected included demographics, overall discomfort level, overall energy level, discomfort level in different body parts, number of breaks taken during the case, time since last physical exercise, and frequency of physical exercise. The analysis of variance (ANOVA) technique was used for data analysis.

Results: The group that used anti-fatigue floor mats reported lower increases in discomfort from pre-op to immediately post-op and 24 h post-op compared to the group that did not ($p = 0.009$ and $p < 0.001$). Participants who used the mats reported significant lower levels of pain in the ankles and feet, knees, and shoulders immediately post-op compared to participants who did not. Participants who used the mats reported lower increases in discomfort in their back, hips, knees, neck, and shoulders from pre-op to post-op.

Conclusions: Using anti-fatigue floor mats during surgery is an effective and low-cost intervention to decrease the musculoskeletal symptoms experienced by the surgical team.

Level of Evidence: 2.

1 | Introduction

Awareness surrounding healthcare workers' health and wellness has significantly increased in recent years. Work-related fatigue and body strain is common among surgeons and operating room staff and can have long-term implications on a person's health and wellbeing. Over time, this strain can lead to time off work, medical and/or surgical intervention, and even early retirement [1].

Musculoskeletal fatigue is common among surgeons and operating room staff due to the considerable lengths of time spent

standing and working in static positions [2]. Previous studies have found that over 90% of otolaryngology residents experience at least one musculoskeletal symptom at any point in time, ranging from upper body pain (including shoulder, neck, and back pain) to lower body pain (hip, thigh, and foot pain) [3]. In one study of 141 otolaryngologists, 6.4% of residents reported missing work due to musculoskeletal symptoms, and 16.3% of residents reported stopping during an operation due to musculoskeletal pain. 88.3% of these residents attributed these musculoskeletal symptoms to their surgical training [4]. Other studies found that approximately 95% of the surgeons surveyed had experienced at least one work-related musculoskeletal symptom within the last six months [5, 6]. The likelihood of experiencing pain and fatigue increases as surgery length increases [3].

Historically, healthcare workers have some of the highest rates of occupational injuries. Nationwide, hospitals pay $0.78 in workers compensation for every $100 in payroll, resulting in approximately $2 billion annually in workers' compensation for occupational injuries [7]. Reducing the burden of musculoskeletal fatigue provides an opportunity for hospitals to potentially save billions of dollars each year.

Previous studies have suggested that the use of anti-fatigue floor mats in the operating room can improve energy levels and decrease discomfort for surgeons both during surgery and postoperatively [5]. This study evaluates the effectiveness of anti-fatigue floor mats at reducing the surgical team fatigue and discomfort during head and neck operations lasting ≥3 h. The incorporation of anti-fatigue floor mats into operating rooms could decrease both short-term and long-term physician fatigue and discomfort, leading to improved surgical performance and improved overall wellbeing.

2 | Materials and Methods

This study was a prospective randomized controlled trial of head and neck surgical cases lasting ≥3 h. Subjects were limited to head and neck surgeons, assistant surgeons (residents/fellows), and surgical scrub technicians within the Otolaryngology department at the University of Oklahoma Health Sciences Center from August 2021 to November 2021. The study protocol was approved by the University of Oklahoma Health Sciences Center Institutional Review Board.

This was a two-arm study: During the first arm, no surgical mats were used in the operating room. During the second arm, cases which were allotted a time ≥3 h on the surgery schedule were randomly selected to have anti-fatigue floor mats in the operating room. The otorhinolaryngology surgery schedule was obtained on a weekly basis from the surgical scheduler on staff. Only the cases which did surpass the 3-h criteria were ultimately included in data analysis.

The anti-fatigue floor mats that were used for the study were medical grade mats from the brand name GelPro. Mats used were 20″ × 32″ in size. Retail price was 167 USD with tax per mat.

The surgical team members involved in the case completed an anonymous questionnaire (Data S1) at three different points in time: pre-operatively, immediately post-operatively, and 24 h postoperatively. Informed consent was obtained from participants by means of approval to complete the questionnaire. Every participant was given three copies of the questionnaire for each case: one for pre-operation, one for post-operation, and one for 24 h post-operation. The study investigator kept a log which included the questionnaire number, the date of the procedure, the operating room number, and the presence of anti-fatigue mat or not. The participants returned the completed questionnaires to a mailbox kept in a secure location in the operating room.

The variables collected on this questionnaire included: date of procedure, status at the time of the survey completion (pre-op/post-op/24 h post-op), position on the surgical team (attending, resident, scrub tech), age (in years), surgical experience (in years), duration since last day of exercise (days), frequency of exercise regimen (number of days per week), case number of the day (first, second, etc), number of breaks taken during case, presence of anti-fatigue mats, overall discomfort level, overall level of energy, and level of discomfort/pain in different body parts (feet, ankle, knees, hips, back, shoulders, neck) (Figure 1).

Background characteristics of the surgical team participants were summarized using counts and proportions for categorical and mean and standard deviation for continuous variables.

Item on Questionnaire	Units
Date of procedure	
Status at the time of survey completion	pre-op/ post-op/ 24 hours post-op
Position on the surgical team	attending/ resident/ scrub technician
Age	years
Surgical experience	years
Duration since last day of exercise	days
Frequency of exercise regimen	days per week
Case number of the day	first/ second/ third
Number of breaks taken during the case	1-3
Presence of anti-fatigue floor mat	yes/no
Overall discomfort level	1-10
Overall energy level	1-10
Level of discomfort/pain in feet	1-10
Level of discomfort/pain in ankles	1-10
Level of discomfort/pain in knees	1-10
Level of discomfort/pain in hips	1-10
Level of discomfort/pain in back	1-10
Level of discomfort/pain in shoulders	1-10
Level of discomfort/pain in neck	1-10

FIGURE 1 | Questionnaire values.

Similarly, the mean and standard deviation of all 8 parameters of fatigue measurements were estimated for baseline, immediately after surgery, and 24 h after surgery. The difference in the fatigue scores (immediately after surgery-baseline, 24 h after surgery-baseline, and 24 h surgery-immediately after surgery) according to the use of an anti-fatigue gel mat (yes/no) were estimated and the association between change in fatigue scores and gel mat use was assessed using the analysis of variance (ANOVA) method. Analyzed values sets had a normal distribution. Measured observations were independent since the groups were randomized. Statistical significance was set at $p < 0.05$ and the statistical analysis was performed using SAS 9.4.

3 | Results

Assuming a total 20% difference in the mean overall discomfort level between the two groups, an alpha of 0.05, and power of 0.8, it was determined that at least 32 procedures in total, with 16 procedures in each group, were required for data analysis.

Analysis of the results found that the anti-fatigue floor mats were effective at reducing the discomfort felt by the surgical team members both immediately post-operation and 24 h post-operation when compared with the surgical team members who did not use the floor mats during surgery.

These results reflect survey responses across 34 operations with an $n = 57$. Analysis of the study population characteristics revealed no significant differences in age ($p = 0.587$), duration since exercise ($p = 0.600$), years of operating room experience ($p = 0.209$), or number of breaks taken ($p = 0.364$) between the participants who used the mats in the operating room and those who did not (Figure 2). There was a slight significance found between the two groups for frequency since exercise, with the group using the mats having an average frequency of 2.5 ± 1.8 and the group not using the mats having an average frequency of 2.0 ± 0.8 ($p = 0.048$).

When comparing the baseline survey responses between the two groups pre-operatively, there were no significant differences in the overall energy ($p = 0.650$), overall discomfort ($p = 0.392$), ankles/ft discomfort ($p = 0.981$), knee discomfort ($p = 0.087$), hip discomfort ($p = 0.935$), back discomfort ($p = 0.497$), shoulder discomfort ($p = 0.734$), or neck discomfort ($p = 0.663$) between the participants who used the mats and those who did not use the mats (Figure 3).

In every category, the mean discomfort levels immediately post-operation was lower for the participants using the mats compared to the participants not using the mats. This trend remains true even for the values that did not reach statistical significance. The levels of ankle/ft discomfort ($p = 0.012$), knee discomfort (0.005), and shoulder discomfort ($p = 0.044$) were significantly lower for the participants who used the anti-fatigue floor mats during surgery compared to those who did not use the floor mats during surgery (Figure 4).

Comparing the change in discomfort levels from pre-operation to immediately post-operation revealed that the participants who used the anti-fatigue floor mats experienced significantly smaller increases in their overall discomfort ($p = 0.009$), ankles/ft discomfort ($p = 0.004$), knee discomfort ($p = 0.035$), hip discomfort ($p = 0.047$), back discomfort ($p = 0.012$), shoulder discomfort ($p = 0.005$), and neck discomfort ($p = 0.017$)

Variable		Without Mats	With Mats	Parametric p-value
Age	Mean	38 ± 11	37 ± 10	0.587
	Median	33	34	
Duration Since Exercise	Mean	3.4 ± 3.8	3.1 ± 2.9	0.600
	Median	3	2	
Frequency of Exercise	Mean	2.5 ± 1.8	2.0 ± 0.8	0.048
	Median	2	2	
Years OR Experience	Mean	9.4 ± 6.9	8.0 ± 4.7	0.209
	Median	8	8	
Number of Breaks Taken	Mean	0.5 ± 0.6	0.3 ± 0.6	0.364
	Median	0	0	

FIGURE 2 | Characteristics of the study population.

Variable	Without Mats (n=30)	With Mats (n=27)	Parametric p-value
Overall Energy	7.4	7.6	0.650
Overall Discomfort	2.0	2.3	0.392
Ankles/Feet Discomfort	1.6	1.6	0.981
Knee Discomfort	2.1	1.4	0.087
Hip Discomfort	1.7	1.7	0.935
Back Discomfort	1.8	2.0	0.497
Shoulder Discomfort	1.9	2.0	0.734
Neck Discomfort	1.7	1.9	0.663

FIGURE 3 | Baseline pre-operation energy and discomfort levels.

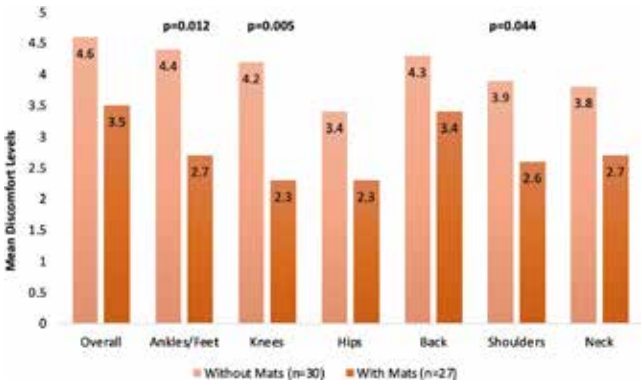


FIGURE 4 | Mean discomfort levels immediately post-operation.

Variable	Δ Without Mats (n=30)	Δ With Mats (n=27)	Parametric p-value
Overall Energy	-2	-1.5	0.193
Overall Discomfort	2.6	1.2	0.009
Ankles/Feet Discomfort	2.8	1.2	0.004
Knee Discomfort	2.0	0.9	0.035
Hip Discomfort	1.6	0.6	0.047
Back Discomfort	2.5	1.3	0.012
Shoulder Discomfort	2.0	0.6	0.005
Neck Discomfort	2.1	0.8	0.017

FIGURE 5 | Change in discomfort levels from pre-op to immediately post-op (mean values).

Variable	Δ Without Mats (n=30)	Δ With Mats (n=27)	Parametric p-value
Overall Energy	-1.7	1.0	0.040
Overall Discomfort	1.9	-1.0	<0.001
Ankles/Feet Discomfort	1.3	0.5	0.193
Knee Discomfort	1.0	0.3	0.233
Hip Discomfort	0.4	-0.5	0.078
Back Discomfort	1.3	-1.0	0.011
Shoulder Discomfort	0.9	-1.0	0.028
Neck Discomfort	0.9	0.3	0.166

FIGURE 6 | Change in energy and discomfort levels from pre-op to 24 h post-op (mean values).

compared to the participants who did not use the floor mats in the operating room (Figure 5). It stands to reason that any member of the surgical team will feel more uncomfortable and more fatigued after surgery than they did before surgery. These response values suggest use of the anti-fatigue floor mats mitigated the severity of discomfort and energy less felt during surgery.

The change in overall energy levels from pre-operation to 24 h post-operation was significantly greater for the participants who used the mats during surgery compared to those who did not use the mats ($p = 0.040$). The increase in discomfort levels from pre-operation to 24 h post-operation were significantly lower for the participants who used the mats compared to those who did not when evaluating overall discomfort ($p < 0.001$), back discomfort ($p = 0.011$), and shoulder discomfort ($p = 0.028$) (Figure 6).

Multivariate analysis revealed that back, hip, and knee discomfort are significantly correlated with age, exercise regimen, years of operating room experience, and the number of breaks taken during the case (Figure 7). Change in back discomfort from pre-operation to post-operation was statistically significant when analyzed alongside age ($p = 0.004$), duration since last exercise ($p = 0.004$), frequency of exercise ($p = 0.004$), years of OR experience ($p = 0.007$), and number of breaks taken ($p = 0.028$). Similarly, change in hip discomfort from pre-operation to post-operation was statistically significant when analyzed alongside age ($p = 0.003$), duration since last exercise ($p = 0.003$), frequency of exercise ($p = 0.003$), years of OR experience ($p = 0.004$), and number of breaks taken ($p = 0.028$). Change in knee discomfort from pre-operation to post-operation was statistically significant when analyzed alongside years of OR experience ($p = 0.049$) and number of breaks taken ($p = 0.011$). These results indicate a need for further study into mitigating back, hip, and knee discomfort, particularly among older surgeons.

4 | Discussion

The use of anti-fatigue floor mats in the operating room was found to be effective in reducing the discomfort levels felt by members of the surgical team immediately post-operation and 24 h post-operation. The surgical team members who used the anti-fatigue floor mats in the operating room reported significantly lower levels of discomfort in their ankles, feet, knees, and shoulders immediately post-operatively compared to those who did not use the floor mats. It is useful to note that the discomfort levels in every part of the body were lower for the participants who used the mats, even those that did not reach statistical significance. Participants who used the floor mats during surgery experienced smaller increases in the discomfort between pre-operation and post-operation in the following body regions: ankles, feet, knees, hips, back, shoulders, neck, and overall body.

Previous studies have identified similar results using anti-fatigue floor mats in various occupational settings. A 2002 study of assembly line workers, who also stand in one static position during long workdays, found statistically significant correlations between the type of flooring used and pain/discomfort level when comparing hard floor and mats. The flooring types included shoe insoles, floor mats, hard block floors, and a shoe insole plus floor mat combination. Participants reported the highest levels of discomfort on the hard block floors, and the lowest levels of discomfort using the shoe insole plus floor mat combination [8]. A 2004 study of factory workers found that standing on floor mats produced less discomfort compared to standing on a hard wooden floor. The use of shoe insoles was found to be the most effective intervention for reducing discomfort, followed second by the use of anti-fatigue floor mats [9]. A 2016 study of surgeons using different flooring options in the operating room found that 70% of the surgeons said they would recommend the use of anti-fatigue mats to a friend, 65% of surgeons preferred the use of a floor mat to hard concrete floors, and 45% said the mat helped reduce their musculoskeletal related symptoms [10].

There are numerous potentially confounding factors that could contribute to the level of fatigue experienced by the surgical team [11]. One potential confounding factor is the choice of footwear among the surgical team members. This is highlighted in the previous studies mentioned in which the use of shoe insoles was found to significantly reduce discomfort. Another potentially confounding factor could be the amount of rest received by

Variable	N	discomfort_Back_1_0			
		Pearson CC	Pearson P-value	Spearman CC	Spearman P-value
Age	55	0.378	**0.004**	0.381	**0.004**
Duration_since_last_day_of_exerc	55	-0.091	**0.004**	0.006	**0.004**
Frequency_of_exercising__days_we	55	-0.193	**0.004**	-0.089	**0.004**
Years_of_OR__Experience	54	0.202	0.143	0.361	**0.007**
number_breaks	54	0.260	0.058	0.299	**0.028**

Variable	N	discomfort_hips_1_0			
		Pearson CC	Pearson P-value	Spearman CC	Spearman P-value
Age	55	0.546	**<.001**	0.390	**0.003**
Duration_since_last_day_of_exerc	55	-0.111	**<.001**	0.039	**0.003**
Frequency_of_exercising__days_we	55	0.008	**<.001**	0.141	**0.003**
Years_of_OR__Experience	54	0.299	**0.028**	0.386	**0.004**
number_breaks	54	0.212	0.123	0.343	**0.011**

Variable	N	discomfort_knees_1_0			
		Pearson CC	Pearson P-value	Spearman CC	Spearman P-value
Age	55	0.390	**0.003**	0.261	0.054
Duration_since_last_day_of_exerc	55	-0.147	**0.003**	-0.066	0.054
Frequency_of_exercising__days_we	55	0.041	**0.003**	0.228	0.054
Years_of_OR__Experience	54	0.194	0.160	0.269	**0.049**
number_breaks	54	0.310	**0.023**	0.344	**0.011**

FIGURE 7 | Multivariate analysis.

the surgical team member in the hours preceding the operation. It would be reasonable to suggest that a provider ending an overnight shift, or a shift with a particularly heavy caseload, would experience more fatigue and body discomfort than a provider who was more rested before the operation in question. Previous studies have found that the BMI of the patient receiving the surgery could impact the level of discomfort and musculoskeletal fatigue experienced by the operating staff [12]. Other confounding factors that could influence the risk of ergonomic injuries in surgical team members include gender and hand size [13]. In fact, previous studies have shown that female surgeons were at higher risk of work-related musculoskeletal injuries than their male counterparts [14]. In addition, surgeons with smaller hand/glove size were also shown to have more surgery ergonomic related issues [15].

The findings from this study could be generalizable to other surgical fields where length of surgery in >3 h and the surgical team is performing the surgery in the standing up position and not using any types of additional standing stools. In addition, the relatively low cost of this intervention makes it a cost-effective way to reduce surgical team fatigue. The relative low cost also means that institution could easily adopt it as a measure to reduce workers fatigue and injuries, potentially saving on long term workers injuries related costs.

This study is limited by the lack of blinding of study participants. Blinding was not possible in this study, as the participants were aware of the presence or absence of anti-fatigue floor mats in the operating room. Future studies with interventions that are more amenable to blinding could potentially result in a lower risk of bias. In addition, the questionnaire used for this study was developed by the authors and was not a validated questionnaire. Using an ad hoc questionnaire is also a limitation. Another possible limitation to this study is the reality that not every surgery included was similar in nature. The inclusion criteria for this study required that cases were ≥ 3 h in length. This resulted in a wide variety of cases, some lasting many hours longer than others. As mentioned before, previous studies have shown that the level of discomfort and fatigue experienced by the surgical team

increases as surgery length increases. In future studies, it would be helpful to examine the cases in context to other cases of similar length, and to evaluate the effectiveness of the anti-fatigue mats at reducing discomfort and fatigue depending on different surgery lengths. However, the study was limited to surgeries being done via an open approach with the surgical team standing up for the procedure and did not include any robotic or endoscopic approaches in order to reduce confounding factors, Two of the investigators in this study also completed questionnaires during their time in the operating room, making them participants in the study; this could potentially be a source of bias. In addition, as mentioned earlier, several additional confounding factors and variables were not included in this study due to the wide variability in those factors which would have required an unrealistic large sample size to conduct the study. Examples of these factors include biometric features such as height and hand/gloves size and variables such as the type of footwear used, It is well known that surgical ergonomic health depends on multiple factors; consistent use of anti-fatigue floor mats is one of those factors. However, a number of human factors that are non-equipment related such as taking small breaks or interruption, also play an important role in ergonomic health and those are very specific to each individual. This study was limited to the use of anti-fatigue floor mats, but there is a need for more research into other ways to enhance the ergonomics of surgery, particularly as it relates to upper-body musculoskeletal fatigue.

5 | Conclusion

Floor mats are an effective and low-cost intervention to decrease the musculoskeletal symptoms and body fatigue experienced by members of the head and neck surgical team, including surgeons, assistant surgeons, and surgical scrub technicians. Regular use of floor mats in the operating room could reduce musculoskeletal injuries among surgeons, extend the number of years that surgeons are able to practice, and save hospitals billions of dollars each year.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. A. Vijendren, M. Yung, J. Sanchez, and K. Duffield, "Occupational Musculoskeletal Pain Amongst ENT Surgeons – Are We Looking at the Tip of an Iceberg?," *Journal of Laryngology & Otology* 130, no. 5 (2016): 490–496, https://doi.org/10.1017/s0022215116001006.

2. I. J. Kant, L. C. G. M. de Jong, M. van Rijssen-Moll, and P. J. A. Borm, "A Survey of Static and Dynamic Work Postures of Operating Room Staff," *International Archives of Occupational and Environmental Health* 63, no. 6 (1992): 423–428, https://doi.org/10.1007/bf00386939.

3. A. Bin Dahmash, F. Alkholaiwi, A. Alahmari, A. M. Shadid, A. M. Alharbi, and O. Al Hussain, "Work-Related Musculoskeletal Symptoms in Otorhinolaryngology-Head and Neck Surgery Residents," *Sultan Qaboos University Medical Journal* 20, no. 2 (2020): 202–208, https://doi.org/10.18295/squmj.2020.20.02.011.

4. K. Wong, K. M. Grundfast, and J. R. Levi, "Assessing Work-Related Musculoskeletal Symptoms Among Otolaryngology Residents," *American Journal of Otolaryngology* 38, no. 2 (2017): 213–217, https://doi.org/10.1016/j.amjoto.2017.01.013.

5. G. Haramis, J. C. Rosales, J. M. Palacios, et al., "Prospective Randomized Evaluation of Foot Gel Pads for Operating Room Staff Comfort During Laparoscopic Renal Surgery," *Urology* 76, no. 6 (2010): 1405–1408, https://doi.org/10.1016/j.urology.2010.01.018.

6. H. Raake, *Decreasing Musculoskeletal Injuries Among Operating Room Decreasing Musculoskeletal Injuries Among Operating Room Personnel Through the Use of Anti-Fatigue Mats Personnel Through the Use of Anti-Fatigue Mats* (Louisvuille, KY: University of Louisville, 2019), accessed July 25, 2022, https://ir.library.louisville.edu/cgi/viewcontent.cgi?article=1023&context=dnp.

7. U.S. Department of Labor, "Worker Safety in Your Hospital: Know the Facts," 2014, https://www.osha.gov/dsg/hospitals/documents/1.1_Data_highlights_508.pdf.

8. P. M. King, "A Comparison of the Effects of Floor Mats and Shoe In-Soles on Standing Fatigue," *Applied Ergonomics* 33, no. 5 (2002): 477–484, https://doi.org/10.1016/s0003-6870(02)00027-3.

9. A. R. Orlando and P. M. King, "Relationship of Demographic Variables on Perception of Fatigue and Discomfort Following Prolonged Standing Under Various Flooring Conditions," *Journal of Occupational Rehabilitation* 14, no. 1 (2004): 63–76, https://doi.org/10.1023/b:joor.0000015011.39875.75.

10. R. K. Voss, Y. J. Chiang, K. D. Cromwell, et al., "Do no Harm, Except to Ourselves? A Survey of Symptoms and Injuries in Oncologic Surgeons and Pilot Study of an Intraoperative Ergonomic Intervention," *Journal of the American College of Surgeons* 224, no. 1 (2017): 16–25.e1, https://doi.org/10.1016/j.jamcollsurg.2016.09.013.

11. S. Epstein, E. H. Sparer, B. N. Tran, et al., "Prevalence of Work-Related Musculoskeletal Disorders Among Surgeons and Interventionalists," *JAMA Surgery* 153, no. 2 (2018): e174947, https://doi.org/10.1001/jamasurg.2017.4947.

12. E. L. Moss, P. Sarhanis, T. Ind, M. Smith, Q. Davies, and M. Zecca, "Impact of Obesity on Surgeon Ergonomics in Robotic and Straight-Stick Laparoscopic Surgery," *Journal of Minimally Invasive Gynecology* 27, no. 5 (2020): 1063–1069, https://doi.org/10.1016/j.jmig.2019.07.009.

13. A. Basager, Q. Williams, R. Hanneke, A. Sanaka, and H. M. Weinreich, "Musculoskeletal Disorders and Discomfort for Female Surgeons or Surgeons With Small Hand Size When Using Hand-Held Surgical Instruments: A Systematic Review," *Systematic Reviews* 13, no. 1 (2024): 57, https://doi.org/10.1186/s13643-024-02462-y.

14. B. Fram, M. E. Bishop, P. Beredjiklian, and D. Seigerman, "Female Sex Is Associated With Increased Reported Injury Rates and Difficulties With Use of Orthopedic Surgical Instruments," *Cureus* 13, no. 5 (2021): e14952, https://doi.org/10.7759/cureus.14952.

15. S. V. Green, D. E. Morris, D. N. Naumann, et al., "One Size Does Not Fit all: Impact of Hand Size on Ease of Use of Instruments for Minimally Invasive Surgery," *Surgeon* 21, no. 5 (2023): 267–272, https://doi.org/10.1016/j.surge.2022.11.001.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Interested in serving on a medical mission?
Check out our Medical Missions page with details and resources,
and start planning your pathway to assist those in need.

Visit www.ast.org - About Us - Medical Missions

AST
Association of Surgical Technologists

Keeping It Sterile Since 1969

AST
Association of Surgical Technologists

AST
Association of Surgical Technologists

The Association of Surgical Technologists has been fighting for surgical technologists for more than 50 years.

77 Procedures
12 Surgical Specialties

Check out AST's Procedures PowerPoint Surgical Series

Teaching surgical procedures takes time and ingenuity. Images to illustrate the various steps in a procedure are difficult to find but are crucial to students' comprehension and retention. Enter AST's Surgical Procedures PowerPoint Series as it puts teaching procedures at your fingertips!

And in this time of remote learning, AST's Surgical Procedures PowerPoint Series is exactly the tool you need to teach your students. Not only do they present procedural steps, the series includes information such as patient presentation and pathophysiology, case preparation tips, and built-in tools to highlight and engage critical thinking skills.

AST's Procedure PowerPoint Series includes access to **77 procedures spanning 12 surgical specialties** included in the 6th edition of the *Core Curriculum for Surgical Technology.*

Specialties include:

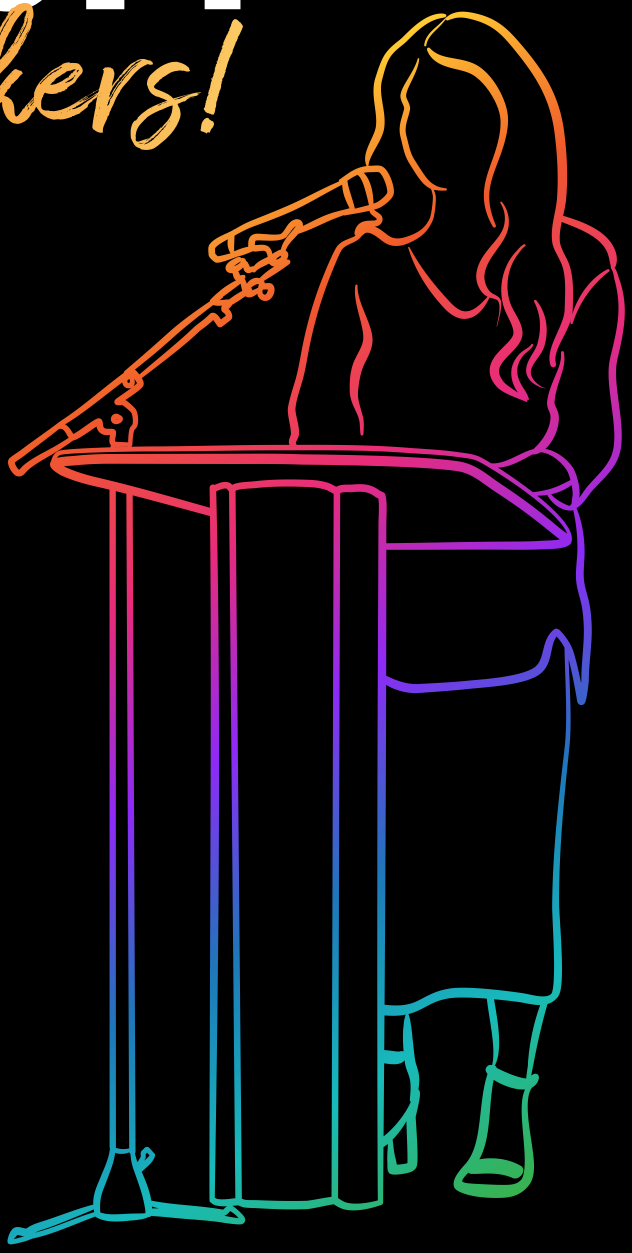
- Cardiothoracic
- General
- Genitourinary
- Gynecological
- Miscellaneous
- Neurosurgery
- Ophthalmological
- Orthopedic
- Otorhinolaryngology
- Peripheral Vascular
- Plastic
- Trauma

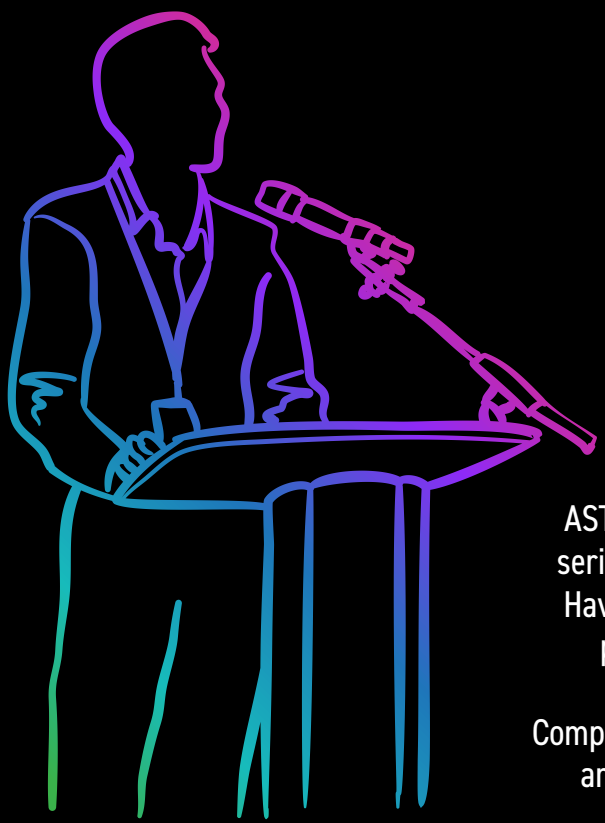
The entire AST Procedures PowerPoint Series can be purchased for $1200/year in an annual subscription.

Get started!

SPEAK UP!

Call for speakers!





AST is currently seeking speakers for our clinical webinar series, AST Educators Event and our national conferences. Have a good topic you'd like to see presented or know of a peer or surgeon who would make a good presenter?

Complete our speaker application and help us provide relevant and timely information to surg techs around the nation!

Visit ast.org - Educators - Events to get started.

Joseph E. Murray, MD: The Pioneer of Kidney Transplantation

AST Staff

MEDICAL MARVELS

In fact, basic scientists were pessimistic about the feasibility of human transplantation. For example, in his book The Biological Basis of Individuality, Dr. Leo Loeb categorically stated that transplantation between individual humans would never be possible. Although his thesis was accepted as dogma by some, it did not seem irrefutable to me. Surgeons, by nature, tend to be optimist - Joseph Murray.[1]

Preceding the 1950s, organ transplantation was considered an achievement that would never occur. Attempts had been made but resulted in the donor kidney being rejected. However, it all changed when Dr. Joseph Murray (April 1, 1919 - November 26, 2012) became the first surgeon to successfully perform renal transplantation in identical twins, then in non-identical twins, and eventually using a cadaveric kidney. Because of this he received the Nobel Prize in Physiology or Medicine in 1990.

Dr. Murray was born in Milford, Massachusetts, a town located 30 miles southwest of Boston. He was influenced by the family physician to become a physician himself. He attended the College of the Holy Cross, a small liberal arts college in Worcester, Massachusetts. His primary focus was on literature and philosophy explaining in his autobiography, "Assuming I'd receive ample science in medical school, I took the minimum of chemistry, physics, and biology."[2] He attended Harvard Medical School and was completing internship at the Peter Bent Brigham Hospital in Boston, renamed Brigham and Women's Hospital in 1980, when he was drafted into the U.S. Army during World War II. He was stationed at Valley Forge General Hospital that had opened in 1943, a major military hospital located near Philadelphia, Pennsylvania that was known for its plastic surgery center where he cared for war casualties. "I learned only years later that Colonel James Barrett Brown, Chief of Plastic Surgery, had noticed my day and night presence on the wards and requested that Lt. Murray be kept at VFGH and not sent overseas like the rest of the 'nine-month wonders.'"[2] It was here that he described a turning point in his professional career as a physician in providing care to Charles Woods.

In 1944, Woods was a 22-year old pilot who sustained burns over 70% of his body when the fuel plane he was flying exploded on take-off and he was the only crew member to survive.[2] Initial treatment included covering the burned areas with cadaveric skin grafts taken from a recently dead soldier whose family has given permission.[1,3] The grafts lasted long enough to allow his own healthy skin to be harvested for use as autografts. He underwent 24 operations in which the surgical team remodeled his eyelids, hands, mouth, and nose.[1] Woods survived the ordeal and had a successful career in construction and radio and television stations. Dr. Murray would recall, "The questions raised and lessons learning in trying to help Charles would determine the course of the rest of my professional life."[3] Helping Woods was an incentive for his interest in transplantation because he had been able to directly observe how tissue from another person could be used to transform the life of a severely injured person.

After the war, Dr. Murray returned to Boston to complete his training in plastic reconstructive surgery, but transplant surgery was his passion. At the time there was no hope for end-stage renal disease patients, so he began his renal transplant experiments on dogs who did not reject the organ. During the procedures he refined the surgical techniques for ureteral and vascular anastomoses.

In 1954, he was presented with the opportunity to put his knowledge and skill to the test when Richard Herrick was a patient at Peter Bent Brigham Hospital suffering from renal failure. However, he had a healthy twin brother, Ron-

ald. Cross-skin grafting was a success, and the surgical teams moved forward in preparing for the donor and recipient procedures.[1] But Dr. Murray realized the donor procedure presented a first in the arena of medical ethics, essentially removing a healthy kidney at no personal benefit to the donor and possibly causing harm, or in other words, he needed to make sure the physicians were not breaking Hippocrates' Oath of "First Do No Harm."[1] The surgical team consulted with medical and religious leaders who eventually agreed that the surgery should proceed because it was focused on saving a life. The procedures were performed on 23 December 1954 with Dr. Murray, the lead physician for the recipient team, and Dr. J. Hartwell Harrison, the lead physician for the donor team.[1] Subsequently, Dr. Murray become known as the first surgeon to successfully perform renal transplantation. Richard went on to get married and have two children before being overtaken by cardiac failure eight years later.[1] Ronald had no postoperative complications and lived a healthy life for 50 years after the surgery.[1] Dr. Murray wrote about the moment that stirred everyone's emotions in the O.R., "There was a collective hush in the operating room as blood began to flow into the implanted kidney and urine began to flow out of it. It as a moment I can never forget."[3]

While Dr. Murray had demonstrated that kidney transplant surgery was possible, it still did not solve the problem of immunologic incompatibility. He tried several techniques to prevent organ rejection in genetically, non-identical hosts including weakening the recipient's immune system by administering total body irradiation and the use of bone marrow replacement.[4] Bone marrow replacement realized some success in an operation on two non-genetically identical twins. In 1959, John Riteris presented with progressive kidney disease leading to kidney failure. He became the first recipient of a successful kidney transplant from a non-identical twin and lived another 20 years leading a rewarding career as an educator. However, the successful use of bone marrow replacement could not be consistently reproduced.[1]

The breakthrough occurred with the discovery and development of immunosuppressive drug therapy including 6-mercaptopurine that was used by Dr. Robert Schwartz and Dr. William Dameshek to prevent antibody production in rabbits against human serum albumin.[1] Next, in 1956 azathioprine was synthesized by Gertrude Elion, George Hitchings, and William Lange.[5] In 1961, Dr. Murray used the drug for the first time during a kidney transplant from a deceased donor to an unrelated recipient.[4] The transplanted kidney functioned, but the patient died from drug toxicity.[1] By the third patient, Dr. Murray had improved the protocols for the use of azathioprine and the 23 year old patient Mel Doucette survived for over a year establishing what is considered the first successful renal allograft.[1]

However, it became apparent to the medical community with Dr. Murray at the forefront that criteria needed to be developed for defining brain death. Harvard Medical School convened a committee that included Dr. Murray, and the result was the publication of the first modern neurological definition of brain death in 1968.[4]

Even with all his successes in transplantation, Dr. Murray's first love was still reconstructive surgery. He resigned as chief of transplant surgery at Peter Bent Brigham Hospital in 1971 to return to pediatric reconstructive surgery, becoming the chief of plastic surgery at the Boston Children's Hospital Medical Center. Just as with transplantation surgery, he is credited for developing procedures for treating pediatric patients suffering from burns and congenital facial deformities and treating diseases such as leprosy.[4]

In his Nobel autobiography he wrote, "My only wish would be to have ten more lives to live on this planet. If that were possible, I'd spend one lifetime each in embryology, genetics, physics, astronomy, and geology. The other lifetimes would be as a pianist, backwoodsman, tennis player, or writer for the *National Geographic*. If anyone has bothered to read this far, you would note that I still have one future lifetime unaccounted for. This because I'd like to keep open the option for another lifetime as a surgeon-scientist."[2]

References

1. Tan SY, Merchant J. Joseph Murray (1919 – 2012): first transplant surgeon. *Singapore Med J*. 2019. doi: 10.11622/smedj.2019032
2. Joseph E. Murray – Facts. NobelPrize.org. February 11, 2025. Accessed February 11, 2025. https://www.nobelprize.org/prizes/medicine/1990/murray/facts/
3. Murray JE. *Surgery of the soul: reflections on a curious career*. Science History Publications; 2001.
4. Snyder A. Joseph E. Murray. *The Lancet*. 2013; 381(9861): 110.
5. Azathioprine. DRUGBANK Online. June 13, 2005. Updated February 18, 2025. Accessed February 19, 2025. https://go.drugbank.com/drugs/DB00993

Study Reveals Higher UTI Risk in Patients Undergoing Minor Gynecologic Procedures

OF INTEREST IN THE MEDICAL ARENA

Study shows patients undergoing minor gynecologic procedures that are catheterized have a significantly higher proportion of urinary tract infections (UTI) as compared to non-catheterized patients. Of the 762 patients studied, 42.4% received routine single catheterization with no existing medical indication for it to be performed.

The retrospective cohort study was led by Salina Zhang, MD, Department of Ob/Gyn, Summa Health System, Akron, Ohio. The study was conducted at a tertiary care community hospital. The research team analyzed the records of 762 patients from January 1 to December 31 2021 who underwent procedures taking ≤ 45 minutes, including dilation and curettage, hysteroscopy, and loop electrosurgical excision. The age of the patients was from 19 to 89 years with a mean of 45.9 years.

Findings revealed a 42.4% (323 patients) catheterization rate. Of the 323 patients, 18 (5.6%) experienced a UTI, whereas, of the 439 patients who were not catheterized, 11 (2.5%) did not experience a UTI. The researchers acknowledged that postoperative patient follow-up data were not analyzed, thus possibly missing UTI cases.

The authors of the study wrote, "There is no consensus on the use of routine catheterization at the time of minor gynecologic surgeries such as hysteroscopy or loop electrosurgical excision procedure. Currently, placement of a catheter is guided by individual physician discretion. This study suggests that catheterization, unless medically necessary, should be avoided to reduce nosocomial infection risk. The results advocate for reconsidering current practices to enhance patient care and minimize preventable UTIs."

Reference

Zhang S, Ananth D, Haselton L, Byrnes J. Effects of routine catheterization on urinary tract infection rates after minor gynecologic surgeries. *Obstet Gynecol.* January 1, 2025. doi: 10.1097/AOG.0000000000005788

Study Finds No Genetic Causality Between Appendectomy and Gastrointestinal Cancers in European Population

A study conducted in 2024 found no causal association between appendectomy and the six gastrointestinal cancers (GC) based on the European population. The research involved two analyses (discovery cohort and replication cohort) combined with a meta-analysis to comprehensively assess the risk for patients who had undergone an appendectomy for acquiring a GC including colorectal cancer (CRC), esophageal cancer (EC), GC, liver cancer (LV), pancreatic cancer (PC), and small intestine cancer (SIC).[1]

The lifetime risk for developing appendicitis is estimated to be 7% - 8%.[2] Beginning in the early 1960s, studies showed an increased risk of cancer after appendectomy.[3,4] Dr. James R. McVay, Jr. first identified an association between appendectomy and CRC in 1964.[4] However, the link is inconsistent when taking into consideration geographic and demographic differences. Appendectomy has been shown to be a risk factor for CRC in Asian populations and Americans, but not causal relationship has been established in European populations.[1] There have been multiple studies focusing on the association between appendectomy and EC, GC, LC, PC, and SIC, but the results have also been inconsistent.[1]

The researchers obtained data from two resources – the UK Biobank study, a large-scale open database with thousands of individuals' genotype data paired with electronic health records and the FinnGen study that includes data on more than 300,000 Finnish individuals, combining genotype data from Finnish biobanks and electronic health record data from Finnish health registries. The researchers studied 78,706 cases obtained from the two databases (UK Biobank – 50,105 cases; FennGen study 28,601).[1]

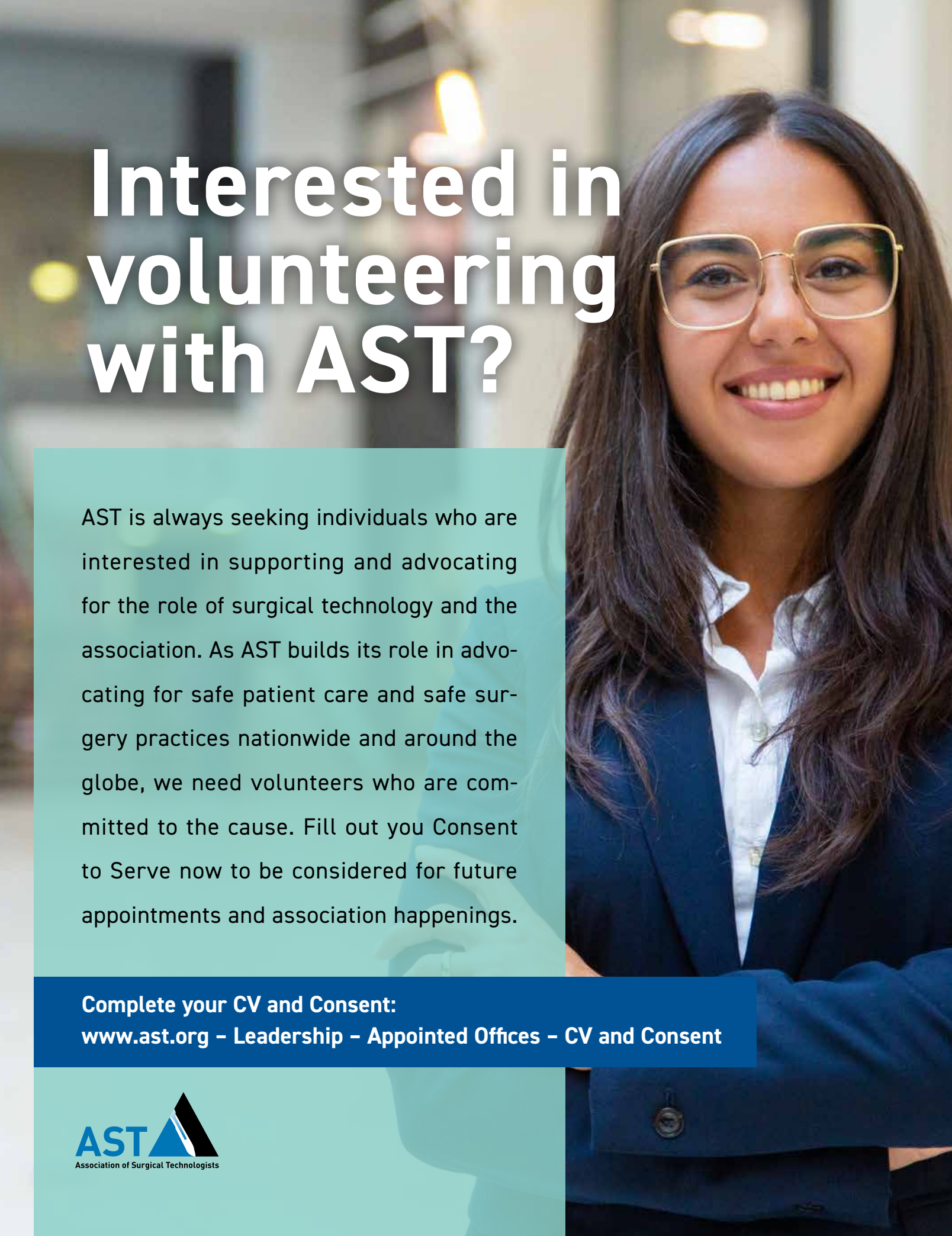
The results of both the discovery cohort and replication cohort as well as the meta-analysis showed no causal

relationship between appendectomy and the six cancers. The researchers wrote, "This is the first…study to assess the causal relationship between appendectomy and gastrointestinal cancers systematically…[W]e found no causal relationship between appendectomy and any of the six gastrointestinal cancers."[1] The research authors continued, "As the third most common cancer in the world, CRC, researchers have paid particular attention to the association between appendectomy and CRC. For Asian populations and Americans, numerous studies have found appendectomy to be a risk factor for cancer. However, it is very surprising that none of the studies on European populations have found such as association."[1]

The research team recognized the limitation of the study focusing on populations of European descent and the issue regarding non-European descent remains to be solved.[1] They shared that caution is needed when using their research results when studying populations of different ethnicities and races.[1] Additionally, due to data limitations, the research team could not complete subgroup analyses based on variables such as age, gender, and region.[1]

References

1. Wang S, Zhang T, Sun Y, et al. No genetic causality between appendectomy and gastrointestinal cancers: a Mendelian randomization study and meta-analysis in European population. *Scientific Reports*. October 24, 2024. doi: 10.1038/s41598-024-77600-6
2. Stewart B, Khanduri P, McCord C, et al. Global disease burden of conditions requiring emergency surgery. *Br J Surg*. January 2014. doi: 10.1002/bjs.9329
3. Robinson E. The incidence of appendectomies, tonsillectomies and adenoidectomies in cancer patients. *Br J Cancer*. 1968; 22(2): 250-252. doi: 10.1038/bjc.1968.32
4. McVay, JR Jr. The appendix in relation to neoplastic disease. *Cancer*. 1964; 17: 929-937.

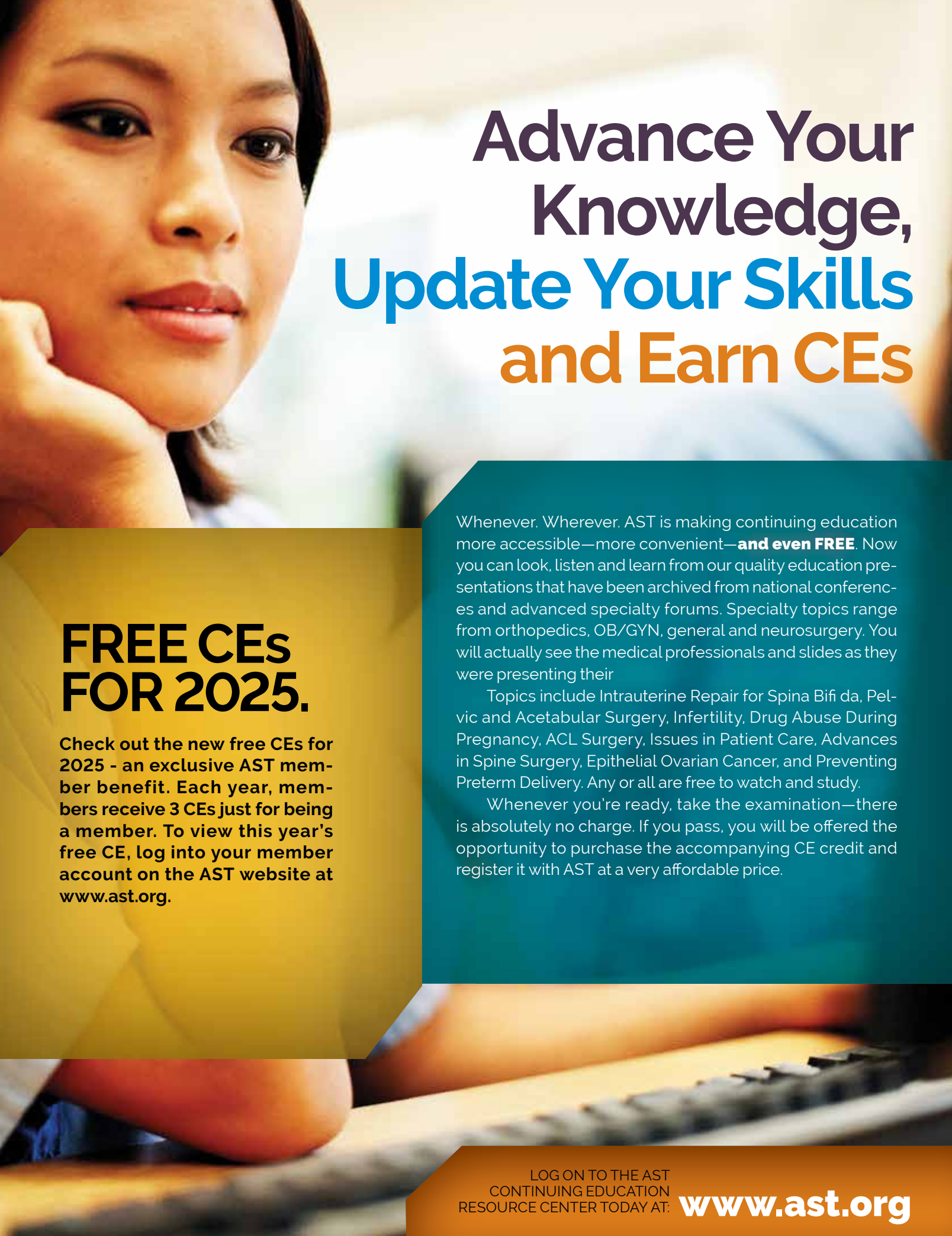


Interested in volunteering with AST?

AST is always seeking individuals who are interested in supporting and advocating for the role of surgical technology and the association. As AST builds its role in advocating for safe patient care and safe surgery practices nationwide and around the globe, we need volunteers who are committed to the cause. Fill out you Consent to Serve now to be considered for future appointments and association happenings.

Complete your CV and Consent:
www.ast.org – Leadership – Appointed Offices – CV and Consent

AST
Association of Surgical Technologists



Advance Your Knowledge, Update Your Skills and Earn CEs

FREE CEs FOR 2025.

Check out the new free CEs for 2025 - an exclusive AST member benefit. Each year, members receive 3 CEs just for being a member. To view this year's free CE, log into your member account on the AST website at www.ast.org.

Whenever. Wherever. AST is making continuing education more accessible—more convenient—**and even FREE**. Now you can look, listen and learn from our quality education presentations that have been archived from national conferences and advanced specialty forums. Specialty topics range from orthopedics, OB/GYN, general and neurosurgery. You will actually see the medical professionals and slides as they were presenting their

Topics include Intrauterine Repair for Spina Bifi da, Pelvic and Acetabular Surgery, Infertility, Drug Abuse During Pregnancy, ACL Surgery, Issues in Patient Care, Advances in Spine Surgery, Epithelial Ovarian Cancer, and Preventing Preterm Delivery. Any or all are free to watch and study.

Whenever you're ready, take the examination—there is absolutely no charge. If you pass, you will be offered the opportunity to purchase the accompanying CE credit and register it with AST at a very affordable price.

LOG ON TO THE AST CONTINUING EDUCATION RESOURCE CENTER TODAY AT: **www.ast.org**

UPCOMING PROGRAMS

AST MEMBERS: Keep your member profile updated to ensure that you receive the latest news and events from your state. As an AST member you can update your profile by using your login information at ***www.ast.org.*** You may also live chat at ***www.ast.org*** or contact Member Services at ***memserv@ast.org*** or call 1-800-637-7433. AST business hours are Monday-Friday, 8 am - 4:30 pm, MST.

ARKANSAS STATE ASSEMBLY

Program Type: Annual Meeting/Elections
Date: October 4, 2025
Title: Harvesting Credits: Reap Knowledge and Refine Skills
Registration: ar.ast.org
Location: Center for Economic Development-University of Arkansas Fort Smith (Bakery District), 70 S 7th St, Suite D, Fort Smith, AR 72901
Contact: Tamara Morgan, 479-414-6720, tamara.morgan@uafs.edu
CE Credits: 6

CALIFORNIA STATE ASSEMBLY

Program Type: Webinar (approved only for California State Assembly members)
Date: May 3, 2025
Title: Benefits of Stryker Spy-Phi for General Surgery
Contact: Wilmer Montes, 818-455-6642, ca.sastateassembly@gmail.com
CE Credits: 1Live

Program Type: Workshop
Date: July 12, 2025
Title: Northern Exposure III
Registration: ca-saofast.wixsite.com/casa/events/northern-exposure-iii
Location: Stanford Newark Campus, 7600 Gateway Blvd, Newark, CA 94560
Contact: Jessica Ramirez, 650-519-8429, ca.sastateassembly@gmail.com
CE Credits: 6

COLORADO/WYOMING STATE ASSEMBLY

Program Type: Webinar (approved only for Colorado/Wyoming State Assembly members)
Date: July 30, 2025
Title: Working Wednesday
Contact: Julie Beard, 720-256-5863, information@coloradoast.com
CE Credits: 2

Program Type: Annual Meeting/Elections
Date: September 27, 2025
Title: 2025 Business Meeting
Location: Denver Health, 777 Bannock St, Denver, CO 80204
Contact: Julie Beard, 720-256-5863, information@coloradoast.com
CE Credits: 5

GEORGIA STATE ASSEMBLY

Program Type: Workshop
Date: September 13, 2025
Title: September in the South
Registration: ast-gasa.com/fall-2025-meeting
Location: Southern Regional Technical College, 52 Tech Dr, Tifton, GA 31794
Contact: Susan Feltmann, PO Box 109, Auburn, GA 30011, 678-226-6676, gas-awebmaster@gmail.com
CE Credits: 9

Program Type: Annual Meeting/Elections
Date: March 14, 2026
Title: Spring Forward: Advancing Surgical Technology Education
Registration: ast-gasa.com/spring-2026-meeting
Location: Chattahoochee Technical College - North Metro Campus, 5198 Ross Road SE, Acworth, GA 30102
Contact: Erin Baggett, PO Box 109, Auburn, GA 30011, 678-226-6943, gas-awebmaster@gmail.com
CE Credits: 7

MAINE STATE ASSEMBLY

Program Type: Workshop
Date: May 10, 2025
Title: MESA Spring Conference
Location: MaineHealth Maine Medical Center Portland - Dana Center, 22 Bramhall St, Portland, ME 04102
Contact: Brittany Babb, 910-477-1559, brittany.babb@mainehealth.org
CE Credits: 6

MINNESOTA STATE ASSEMBLY

Program Type: Annual Meeting/Elections
Date: September 20, 2025
Title: MNSA 2025 Fall Workshop & Annual Business Meeting
Location: LifeSource, 2225 W River Road, Minneapolis, MN 55033
Contact: Lori Molus, PO Box 163, Becker, MN 55308, mnast2016@outlook.com
CE Credits: 6

NEW JERSEY STATE ASSEMBLY

Program Type: Annual Meeting/Elections
Date: September 20, 2025
Title: 2025 Fall Workshop & Business Meeting
Location: Morristown Memorial Hospital, 100 Madison Ave, Morristown, NJ 07960
Contact: Janee Flynn, PO Box 218, Ridgefield Park, NJ 07660, 201-658-9922, njast3@icloud.com
CE Credits: 6

NEW MEXICO STATE ASSEMBLY

Program Type: Workshop
Date: September 20, 2025
Title: Fall into Surgery Workshop
Location: UNM Domenici Center for Health Sciences Education, MSC09 5100, 1 University of New Mexico, Albuquerque, NM 87131
Contact: Ruth Borah, PO Box 66496, Albuquerque, NM 87193, 848-391-3661, ruth.kerrjusinski@gmail.com
CE Credits: 5

SOUTH CAROLINA STATE ASSEMBLY

Program Type: Annual Meeting/Elections
Date: November 1-2, 2025
Title: SCSA Fall Business Meeting and Workshop
Registration: scsaast.org
Location: Southeastern Institute of Manufacturing Technology (SIMT Building), 1951 Pisgah Road, Florence, SC 29501
Contact: Katrina Williams, 843-615-7454, katrinawilliams89@yahoo.com
CE Credits: 12

STATE ASSEMBLY ANNUAL BUSINESS MEETINGS

Members interested in the election of officers & the business issues of their state assembly should ensure their attendance at the following meetings.

ARKANSAS
Fort Smith
October 4, 2025
Annual Meeting
2025 BOD Elections
& 2026 Delegate
Elections

COLORADO/WYOMING
Denver
September 27, 2025
Annual Meeting
2025 BOD Elections
& 2026 Delegate
Elections

GEORGIA
Acworth
March 14, 2026
Annual Meeting
2026 BOD Elections
& 2026 Delegate
Elections

MINNESOTA
Minneapolis
September 20, 2025
Annual Meeting
2025 BOD Elections
& 2026 Delegate
Elections

NEW JERSEY
Morristown
September 20, 2025
Annual Meeting
2025 BOD Elections
& 2026 Delegate
Elections

SOUTH CAROLINA
Florence
November 1-2, 2025
Annual Meeting
2025 BOD Elections
& 2026 Delegate
Elections

Program Approvals: Submit the *State Assembly Program Date Request Form A1* no less than 120 days prior to the date(s) of the program for AST approval. The form must be received prior to first (1st) of the current month for program publication in the next month of the AST monthly journal *The Surgical Technologist*. The *Application for State Assembly CE Program Approval A2* must be received at least thirty (30) days prior to the date(s) of the program for continuing education credit approval. An application submitted post-program will not be accepted; no program is granted approval retroactively.

Contact stateassembly@ast.org or 800.637.7433, ext. 2547.

FOUNDATION *for* SURGICAL TECHNOLOGY

What is The Foundation for Surgical Technology?

The Foundation is a 501c3 organization comprised of representatives from the Association of Surgical Technologists (AST) and the National Board of Surgical Technology and Surgical Assisting (NBSTSA). This type of organization also means any donation you give to the Foundation is tax deductible.

Who does The Foundation support?

- The Foundation provides scholarships to the following:
- Students
- Educators
- Military personnel
- and CSTs who have helped others by serving on medical mission trips

When are the annual deadlines for the scholarships?

- Students scholarships - March 1
- Military scholarships - March 1
- Constellation (Eduscator) Awards - December 1
- Medical mission reimbursement - December 31

Learn more at www.ffst.org and give today!

ADVOCATE FOR YOURSELF.

AST
Association of Surgical Technologists

You advocate for your patients – no question. Now it's time to advocate for the critical role you play as a key member of the surgical team and how important your role is to patient safety.

AST developed a toolkit specifically for surgical technologists to use when you're explaining just how crucial is it that certified surgical technologists earn education from an accredited program thus making them eligible to sit for the national certifying exam and earn the distinguished CST credential. Scan the QR code to access documents, AST position statements and other resources you need to keep advocating for the profession.

- **The Workforce Shortage: A Message from AST**
- **CSTs Many Lifesaving Roles**
- **AST Encourages Healthcare Facility Leaders to Support Local, Accredited Surgical Technology Educational Programs**
- **Recommendations for CSTs, Program Directors, and State Assemblies when Addressing On-the-Job Training with a Healthcare Facility**

CONTINUING EDUCATION

Choose any nine articles and we will be happy to send them out free of charge. Return the answer sheets provided with the appropriate processing fee—only $6 per credit (not per test) for members, $10 per credit (not per test) for nonmembers. AST automatically records the returned CE credits for AST members.

Parotidectomy with Facial Nerve Dissection 1 CE

Radiostereometric Analysis in Orthopaedic Surgery 1 CE

The Modern-Day Caesarean Section 1.5 CEs

The Economic Argument for Using Safety Scalpels 2 CEs

Emergency Department Visits and the Public Health 2 CEs

Staged Rapid Source Control Laparotomy in Emergency General Surgery 1 CE

Functional Endoscopic Sinus Surgery with Image-Guided Navigation 1 CE

PJACT: Treating Articular Cartilage Defects 1 CE

AST has even more continuing education opportunities available in print and online. We will be adding more continuing education credits on a continual basis, and the lists that are published in the Journal will be rotating on a quarterly basis so that we can provide more CE credits in a range of specialties.

Other articles, as well as archived conference and forum presentations, are easily accessible on the AST Web site, http://ceonline.ast.org. And there are three free CE opportunities for AST members to earn continuing education credits online—be sure to check them out.

To order please visit: **http://ceonline.ast.org/articles/index.htm**
or contact Member Services at **memserv@ast.org** or fax requests to 303-694-9169
or call Member Services at 800-637-7433.

Returned CE tests cost:
Members $6 per CE
Nonmembers $10 per CE, plus $400 Nonmember Fee

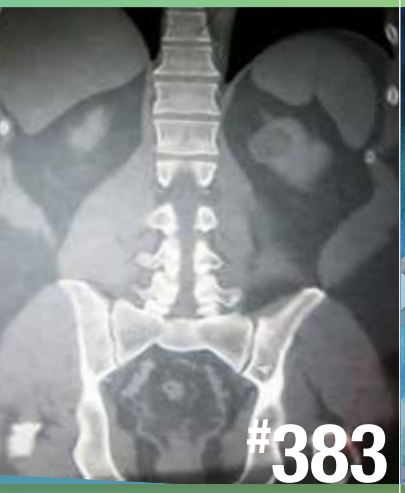
OPPORTUNITIES

Surgical Rib Fixation 1 CE

Butterfly Graft in Functional Rhinoplasty 1 CE

Micromotion at the Tibial Plateau in Total Knee Arthroplasty 1.5 CEs

Disc Battery Ingestion in Pediatric Patients



Partial Nephrectomy 2 CEs

Emotional Intelligence and the Surgical Technologist 2.5 CEs

Cervical Arthroplasty 1.5 CE

Treating Glioblastoma Multiforme 1 CE

ORDER FORM

❑ Member ❑ Nonmember

Membership No. _____

Name _____

Address _____

City _____ State _____ ZIP _____

Telephone _____

Test No.	Title (please print)	Test No.	Title (please print)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____		

JOIN AST

Now it pays even more to be a member of AST—especially for students.

Students - Your savings begin right away when you apply for the special student membership rate, $45 (a $35 savings). **Save** with the member discounted price of the examination study guide.

Enjoy the benefits of membership in the premier national professional organization for surgical technologists. Join online at *www.ast.org;* by phone at 800-637-7433; or by mail

Benefits include:

- ✔ scholarship opportunities
- ✔ access to the most up-to-date information about the profession
- ✔ insurance discounts
- ✔ education and employment opportunities
- ✔ access to resources that connects you to nearly 60,000 other surgical technology professionals
- ✔ student rate discounts

Apply

Become a member in minutes by completing the Join Form online at www.ast.org