

ASHP-HOPA guidelines on the roles and responsibilities of the pharmacy technician in ambulatory oncology pharmacy

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The roles and responsibilities of the pharmacy technician in ambulatory oncology practice have evolved considerably over the past several decades. Historically, technician roles consisted mainly of compounding and technical activities, but technicians in the ambulatory oncology setting currently serve in a variety of advanced roles.¹ A number of recent changes and initiatives, including the expansion of pharmacy services, an increase in the utilization of oral anti-cancer medications, greater focus on quality improvement, and the growing role of technology in pharmacy operations, have expanded the scope of the technician's role and created the need for advanced, well-trained technicians to support these functions.² Pharmacy technicians provide integral support to pharmacy staff, allowing for streamlined workflow and increased operational and technological oversight of pharmacy functions while maintaining high-quality patient care. The Hematology/Oncology Pharmacy Association (HOPA) and the American Society of Health-System Pharmacists (ASHP) have partnered to define the roles and responsibilities of pharmacy technicians in the ambulatory oncology setting to promote standardization and further advancement and expansion of ambulatory oncology pharmacy practice.

The ambulatory oncology setting is a complex care environment with a variety of models for the role of the pharmacy technician, and there is minimal guidance and evidence-based literature to support a particular practice model. For the purposes of these guidelines, the ambulatory setting is defined as an outpatient patient care setting, including community-based and academia-affiliated settings. Be-

cause the vast majority of cancer care is delivered in the ambulatory setting,³ it is particularly important to establish guidelines to promote pharmacy technicians as a readily available resource, with the goal of optimizing the delivery of pharmacy services in this environment.

Nationwide variations in the regulatory aspects of drug preparation and dispensing demonstrate a need for the universal adoption of standardized guidelines. In addition, rapidly changing practice standards, such as the anticipated impact of *United States Pharmacopeia (USP)* chapter 800⁴ on the handling of hazardous drugs, further emphasize the necessity of standardized recommendations. Nevertheless, although these guidelines are generally applicable, pharmacists and other healthcare professionals responsible for the selection, preparation, dispensing, and administration of drugs are urged to exercise professional judgment in interpreting and applying these guidelines to their specific circumstances, especially regarding compliance with applicable laws and regulations concerning the delegation of responsibilities to pharmacy technicians. Users of these guidelines are cautioned that the information provided is current as of publication and are urged to consult current editions of original sources (e.g., laws; regulations; applicable standards, including *USP* compendial standards) to ensure patient safety as well as legal and regulatory compliance.

The focus of these guidelines is to define the role and scope of the pharmacy technician in an ambulatory oncology pharmacy setting; however, the principles of this document may be applied to other areas in which technicians contribute to pharmacy

practice. It is intended to supplement documents such as the “ASHP Statement on the Roles of Pharmacy Technicians”⁵ and ASHP’s summary of the 2017 Pharmacy Technician Stakeholder Consensus Conference,⁶ which broadly covers the roles of technicians in all settings of pharmacy practice. The current document provides recommendations regarding a number of areas of technician practice within the ambulatory oncology setting, including education and training; medication compounding, dispensing, and distribution; patient care services; revenue cycle optimization; supply chain management; technology and informatics; and quality improvement.

Education and training

Education and training recommendations for pharmacy technicians have increased with the advancement of pharmacy technician roles. ASHP has advocated for advanced technician roles within the ASHP Practice Advancement Initiative. The components of this initiative address the need for pharmacy technicians to have appropriate training and credentials for medication preparation and distribution and for the performance of other functions not necessarily requiring a pharmacist’s professional judgment.⁷ Other countries, such as Canada, have a standardized accreditation process for pharmacy technician programs; only individuals completing the prescribed process are allowed to practice as technicians.⁸ While similar standardization of technician competency certification has been advocated for in the United States by pharmacy organization leadership, efforts are still in progress.^{6,9} ASHP and the Accreditation Council for Pharmacy Education established the Pharmacy Technician Accreditation Commission (PTAC) to advance the quality of technician education and training programs.¹⁰

The Pharmacy Technician Certification Board (PTCB) was created in 1995 with the goal of certifying technicians to support pharmacists and

patient care efforts in all practice settings.^{11,12} Technicians become certified by achieving a passing score on the Pharmacy Technician Certification Exam. However, certification is not regulated or standardized in the United States. As of 2015, 45 states registered or licensed pharmacy technicians; in 23 states, it may be necessary for technicians to be certified by PTCB to become licensed through the state board of pharmacy.¹³ Results from a cross-sectional study revealed that there are currently over 698 pharmacy technician training programs in the United States.¹² Of 216 programs that provided complete data, 29.6% were accredited by ASHP, 65.3% were affiliated with PTCB, and 24.5% were both accredited by ASHP and affiliated with PTCB.¹² Clearly, there is a need for standardized, accredited training of technicians; PTAC was created to address this deficiency.¹⁰

Given the complexity of the ambulatory oncology setting and varied roles of pharmacy technicians in the workplace, data regarding education and training are sparse. A survey specific to oncology pharmacy services was distributed to 41 U.S. institutions designated by the National Cancer Institute to assess their progress toward transforming pharmacy practice as recommended by the ASHP Practice Advancement Initiative.⁷ Results from half of the surveyed institutions indicated the existence of roles for technicians in the distribution and performance of other functions not necessarily requiring a pharmacist’s professional judgment. Only 39% indicated that technician preparation and distribution tasks were assigned in a manner that allowed pharmacists to provide more direct patient care.⁷ Standardized, accredited training of technicians in the manner proposed by PTAC will help ensure safe practices to patients and stakeholders and move the profession forward for pharmacists and technicians.

The appendix summarizes ASHP-HOPA recommendations regarding education and training, including

general and specialized training and certification, proof of competency, and compliance.

Medication compounding, dispensing, and distribution

Throughout the years, pharmacy technicians have played an essential role in the preparation, compounding, dispensing, and distribution of sterile and nonsterile hazardous medications in the ambulatory oncology setting. Pharmacy technicians are often vital to other pharmacy roles such as inventory management and oversight of automated dispensing machines. It is critical that technicians receive adequate education and training to follow safe practices ensuring patients receive quality medications and technicians, patients, and the public are protected from hazardous medication exposure. To ensure these safe practices are carried out, healthcare organizations must engage pharmacy technicians to incorporate safe medication preparation, handling, and distribution processes for hazardous medications, including disposal and documentation. The 2004 National Institute for Occupational Safety and Health (NIOSH) Alert initially warned healthcare workers about the risks of working with hazardous drugs and recommended methods and equipment for protecting their health.²⁰ Subsequent NIOSH updates have continued to encourage the identification and safe handling procedures of hazardous medications.²⁵⁻²⁷ *USP* chapter 797 has established standards for preparing medications, including some standards on safely handling hazardous medications.²⁸ *USP* chapter 800 further provides additional standards for frontline workers who handle hazardous medications.⁴ The “ASHP Guidelines on Handling Hazardous Drugs” provides guidance based on sources.²¹ Engaging pharmacy technicians to help operationalize workflow while adhering to regulations will help optimize processes for medication compounding, dispensing, and distribution.

The appendix summarizes ASHP-HOPA recommendations regarding pharmacy technicians' roles in medication compounding, dispensing, and distribution in ambulatory oncology settings, including drug preparation, handling of hazardous waste, documentation, and pump management.

Patient care services

Patients being treated in ambulatory oncology settings face many challenges related to the safe and effective use of medications. Pharmacy technicians have the skills and knowledge to help patients navigate many of these challenges. Patients who are receiving chemotherapy (i.v. or oral) are at high risk for experiencing medication errors and interactions; thus, it is important that an accurate medication history is recorded and subsequent reconciliation is performed.²⁹ Pharmacy technicians can assist in the collection of medication histories, including serving in a lead role for conducting patient interviews.^{5,30-33} During this interview, technicians should follow a standardized script to ensure that appropriate information is obtained. In addition, technicians can have an integral role in monitoring patients initiated or maintained on oral anticancer medications, using a standardized script to uncover toxicities that may benefit from pharmacist intervention and reinforcing the importance of adherence to medication regimens.

An additional barrier encountered by patients when obtaining oncology medications revolves around Food and Drug Administration (FDA) risk evaluation and mitigation strategy (REMS) programs. Each REMS program has a defined set of requirements; pharmacy technicians can assist with navigating the requirements and coordinating completion, such as ensuring distribution of medication guides and providing contact information and schedules for patient follow-up.

Finally, pharmacy technicians' responsibility for many investigational

medication procedures has become routine throughout healthcare. These individuals assist in the management of clinical investigational drug inventories, provide technical direction and assistance with clinical trial protocols, maintain information and record keeping required by study protocols, prepare investigational products for dispensing, and perform education and training of pharmacy team members pursuant to study protocol requirements.³⁴

The appendix summarizes ASHP-HOPA recommendations regarding pharmacy technicians' roles in providing patient care services in ambulatory oncology settings, including medication histories and reconciliation, oral anticancer medication patient outreach, REMS program requirements, and investigational drug management.

Revenue cycle optimization

Revenue cycle optimization has become a critical focus for the pharmacy enterprise. Pharmacy technicians, especially those with a background in finances and auditing, play a key role in the management of the business of pharmacy.⁵ Key aspects to ambulatory oncology pharmacy include prior authorization of clinic-administered medications and specialty pharmacy medications, validation of drug claims through revenue work queues (e.g., JW modifiers, Healthcare Common Procedure Coding System codes), and management of denied claims.

Healthcare organizations have undertaken efforts to optimize product selection when compounding infusion medications (e.g., dose vial rounding, maximizing vial selection) and minimizing waste for expensive chemotherapy and biologics. A pharmacy technician, under the supervision of a pharmacist, can work to minimize medication waste by participating on an interdisciplinary waste management team, monitoring compliance with policies and procedures, and optimizing drug use through scheduling coordination.³⁵

Technicians may oversee inventory management to avoid the use of products after their expiration dates, coordinate product replacement acquisition, and reverse distribution processes to minimize financial loss from unavoidable waste. As of January 1, 2017, claims for certain discarded drug or biologic amounts not administered to any patient have to be submitted using the JW modifier.³⁶ This creates an ongoing regulatory compliance issue, which would be an important function assigned to pharmacy technicians to ensure compliance from the point of dispensation to charge.³⁷

The process for obtaining expensive medications used to treat cancer patients has become increasingly complicated. As new oncology medications are approved, many require users to navigate the requirements of a limited distribution network, which can create barriers to medication access for patients and healthcare organizations. Pharmacy technicians, under the supervision of a pharmacist, can review financial claim requests and manage records to ensure that financial approval, including any necessary prior authorization, is obtained in advance of medication administration.³⁸ Technician involvement in these activities may improve patient care fragmentation, enhance advocacy and logistics support for patients and providers, and enhance top-of-license activities for other healthcare providers. For patients who cannot afford specific medications, pharmacy technicians can lead efforts to connect patients with financial assistance programs or receive medications from manufacturers.⁵

Finally, pharmacy technicians can play a key role in off-label medication use. Those practicing in the ambulatory oncology setting recognize the dynamic nature between clinical literature, the use of medications in off-label prescribing, and the timeline for guideline updating. Technicians are instrumental in completing paperwork and tracking drug replacement

acquired for off-label indications, providing billing support, and managing inventory across various access channels (e.g., traditional wholesaler, manufacturer, limited distribution network).

The appendix summarizes ASHP-HOPA recommendations regarding pharmacy technicians' roles in revenue cycle optimization in ambulatory oncology settings, including therapy authorization, patient financial assistance, and minimization of medication waste.

Supply chain management

Pharmacy technicians play a pivotal role in supply chain management of oncology and supportive care medications and supplies necessary to compound these drugs. Supply chain management responsibilities that may be led by pharmacy technicians include purchasing or procurement, inventory control, and drug shortage management.^{5,39}

Current chemotherapy medications often require complicated purchasing approaches, including navigation of complicated vendor, group purchasing organization, and manufacturer contracts across the outpatient and inpatient settings. Drug distribution models are often supported by pharmacy technicians responsible for purchasing products within cancer centers, including navigating potential challenges of high costs and accessibility.²

In addition to purchasing, technicians play a crucial role in inventory control with the storage and tracking of therapies for oncology treatment. An important inventory control consideration is product expiration dating; technicians should ensure that no expired product is stocked. Strategies to minimize expired products include calculation of inventory par levels based on medication turnover rates and consideration of length of product dating when ordering.⁴⁰ In addition to expiration dating, pharmacy technicians should promote adequate medication turn-

over by forecasting anticipated use and setting par levels accordingly. Lastly, when receiving any product, technicians should ensure that any products requiring special storage conditions, such as freezing or refrigeration, should be identified and stored properly.

Finally, pharmacy technicians play a critical role in the management of drug shortages.³⁹ Drug shortages are increasingly common, particularly with high-cost oncology medications.^{41,42} A 2011 survey revealed that both pharmacists and pharmacy technicians spend an average of 8–9 hours per week handling issues related to drug shortages.⁴³ Pharmacy technicians can help manage organizational approaches to shortages, including managing purchasing workflows and investigating alternative procurement strategies using ASHP and FDA resources.⁴⁴

The appendix summarizes ASHP-HOPA recommendations regarding pharmacy technicians' roles in supply chain management in ambulatory oncology settings, including purchasing, managing inventory control, and responding to drug shortages.

Technology and informatics

Informatics is a growing space within the national workforce and in pharmacy practice. In addition, pharmacy services have continued to see the increased utilization of technology, both software and hardware, throughout the pharmacy enterprise. Specialty-trained pharmacy technicians can assume roles in pharmacy informatics.²³ Domains may include automation and technology systems management, supervision of projects, policy and governance, customer service, charge integrity, reporting interface/database management, automation management, new technology assessment, workflow optimization, and end-user training and education.²³ These roles will be vital in the implementation and maintenance of technology systems management in the oncology setting. Examples

include i.v. workflow systems and interface/database management between the electronic health record and pharmacy automation.

Outside of large municipalities, healthcare organizations continue to struggle with sustainability and access to pharmacy services. As onsite pharmacy services might not be cost-effective for all entities, telepharmacy has become an important cost-effective alternative to allow the provision of some onsite pharmacy services. With the advent of technology and workflow solutions, pharmacy technicians now have the ability to prepare i.v. medications following *USP* guidelines pursuant to medication orders under the supervision of a remote pharmacist.

The appendix summarizes ASHP-HOPA recommendations regarding pharmacy technicians' roles in technology and informatics in ambulatory oncology settings, including automation and technology systems management and telepharmacy services.

Quality improvement

Healthcare delivery is a complex process involving many integrated and interdependent steps, each of which has the potential to fail. In all healthcare organizations, continuous monitoring of medical care processes, including medication management, is critical to the identification and prevention of errors. Pharmacists have often been one of the key point members of this process, but, with expanding roles, pharmacy technicians are also positioned to address quality review, improvement implementation, quality-assurance evaluations, and metrics implementation.⁵

In the oncology pharmacy setting, a variety of equipment is used for many different processes.²¹ Environmental monitoring is critical for compliance with *USP* chapters 797 and 800 for sterile i.v. compounding.^{4,28} Oncology pharmacy technicians are often at the forefront of monitoring and evaluating compliance of pharmacy equipment used in the oncology

setting. This responsibility includes monitoring engineering controls, environmental monitoring, monitoring the quality of sterile preparations, and equipment monitoring. Policies and procedures for the evaluation, selection, use, calibration, monitoring, and maintenance of these systems will be followed by pharmacy technicians based on applicable regulations and state board of pharmacy laws.⁴⁵⁻⁴⁷

The appendix summarizes ASHP-HOPA recommendations regarding pharmacy technicians' roles in quality improvement in ambulatory oncology settings, including error-prevention strategies and the monitoring of equipment and storage facility temperatures.

Conclusion

The role of pharmacy technicians in the ambulatory oncology setting has grown considerably in recent years to support increased operational needs, especially with implementation of USP chapters 797 and 800, as well as the growing need for pharmacy involvement with patient and caregiver services. To support technicians in this advanced role, education and training should include a structured pharmacy technician training program, certification by PTCB, and completion of formal oncology-specific job training. As the oncology environment has increased in complexity, the role of the pharmacy technician has expanded beyond traditional needs with medication compounding, dispensing, and distribution. Technicians can contribute to ambulatory oncology pharmacy practice through involvement in additional areas of pharmacy practice, including patient and caregiver education and services, financial aspects such as revenue cycle, technology and informatics, quality improvement, and inventory management. Activities outlined in these guidelines highlight the expanding technician role in the ambulatory oncology setting and depth of opportunity for technicians' contributions to the medication-use process.

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Additional information

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Appendix—ASHP-HOPA recommendations for pharmacy technician roles in ambulatory oncology settings^a

Education and training

General training and certification

1. All pharmacy technicians shall complete a pharmacy technician training program accredited by ASHP and the Accreditation Council for Pharmacy Education and earn and maintain PTCEB certification.^{12,13}
2. Technicians may attain the necessary knowledge base in a variety of ways, ranging from on-the-job training to online or publication-based training, employer-based structured didactic learning, and formalized study with programs that may or may not have proper professional accreditation status.
3. The importance of specialized training, including in the oncology setting, should be emphasized within these applicable training programs.
4. Education and training requirements must reflect the responsibilities the technicians will have in their daily activities.

Specialized training and certification

1. Technicians in the ambulatory oncology setting should receive training through a formalized process through either an internal or an external pharmacy technician education program.

2. An ideal, well-rounded technician training program should include elements of didactic and experiential education.
 - a. Oncology-specific training shall be a component of the program.
 - b. Technician competencies relevant for ambulatory oncology include mastery of pharmacy calculations and medical and pharmacy terminology.^{14,15}
 - c. Essential components of training for compounding roles are practicum experiences that address techniques in aseptic compounding and handling of hazardous drugs.
 - d. Technician should gain these experiences during training and receive evaluations that include feedback on technique.^{16,17}
 - e. Pharmacy technicians shall undergo site-specific training to the specific roles and responsibilities that they will perform.
 - f. Technicians and personnel involved in designing training programs should review updated resources related to compounding from regulatory bodies as regulations surrounding compounding continue to evolve as well as resources from ASHP, HOPA, and other authoritative organizations.
3. If PTCB designates for specialty certification any relevant practice area (e.g., compounding or oncology), technicians should successfully complete the appropriate certifications before practicing in that specialty area.

Proof of competency

Employers of pharmacy technicians should maintain pharmacy-technician-specific proof of initial and ongoing (e.g., annual) competency to ensure to stakeholders and the public that the technicians are practicing to the best of their abilities.

- a. Some resources for general continuing education include *Pharmacy Technician's Letter*¹⁸ and pharmacy technician continuing education provided by ASHP.¹⁹
- b. Quality measures should be employed to assess the accuracy of the pharmacy technician's performance.

Compliance

In a manner similar to pharmacists, pharmacy technicians must comply with state licensure and registration regulations and requirements, including those regarding education, training, and certification. It is the technician's responsibility to be familiar with and meet state requirements. PTCB has resources to assist with keeping track of these requirements.¹³

Medication compounding, dispensing, and distribution

Drug preparation

1. I.V. anticancer medications
 - a. Pharmacy technicians should share responsibility for ensuring safe preparation and dispensing of i.v. anticancer medications.
 - b. Technicians should practice correct usage of PPE, including compliance with regulatory requirements mandating PPE be donned across all aspects of hazardous drug handling.⁴
 - c. Pharmacy technicians should play a role in embracing CSTDs for preparation of anticancer medications, including involvement in the evaluation process and familiarity with regulatory standards.⁴
2. Oral anticancer medications
 - a. Technicians shall dispense oral anticancer medications according to best practice recommendations, including those of ASHP, NIOSH, and *USP* chapter 800, including use of disposable gloves and restricting product manipulation to performance within a PEC involving use of PPE.^{4,20-22}
 - b. Technicians shall be familiar with storage requirements, including separation of hazardous drugs from nonhazardous drugs, recommended by ASHP, NIOSH, and *USP* chapter 800.^{4,20,21}
 - c. Technicians should decontaminate or wash nondisposable materials as appropriate, including counting trays and tools exposed to oral anticancer medications thoroughly after use.²²

Handling of hazardous waste

1. Pharmacy technicians shall be fully trained in the storage, handling, and disposal of hazardous drugs per employer, state, and national guidelines; this training shall occur before preparing or handling hazardous preparations, and the effectiveness of the training should be verified by testing specific techniques.
 - a. All training should be documented, and competency should be reassessed and documented at least every 12 months.⁴
2. Technicians should be trained on hazardous drug exposure and spill control, including treatment of individuals accidentally exposed to hazardous medications and on the disposal of hazardous medications.^{4,21,22}
 - a. It is recommended that annual spill simulation exercises be conducted.²²

Documentation

1. An updated list of hazardous medications should be readily accessible to

all healthcare personnel involved in handling of hazardous medications.²²

2. If exposed to a hazardous drug spill, personnel should complete an incident report or exposure form and report to the designated emergency service for initial evaluation.⁴
3. Activities that shall be documented include but are not limited to the acquisition, preparation, and dispensing of a compounded hazardous drug, personnel training, and the use and maintenance of equipment and supplies.⁴

Pump management

1. Pharmacy technicians should assist in identifying pump libraries ensuring safe administration of chemotherapy in conjunction with pharmacists and nursing ensuring accuracy of pump libraries.
2. Pharmacy technicians may aid in CADD pump preparation upon demonstration of competency.

Patient care services

Medication histories and reconciliation

1. Pharmacy technicians should be involved in obtaining accurate medication histories for patients with cancer using a standardized script.
2. Medication history training should include patient interview skills and specific criteria to triage for pharmacist intervention.
3. Pharmacy technicians may participate in medication reconciliation processes under appropriate supervision to expand the healthcare organization's capacity to offer these services.

Oral anticancer medication patient outreach

1. Pharmacy technicians can be involved in monitoring adherence and toxicity of patients initiated and/or maintained on oral anticancer medications by using a standardized script.
2. Technicians should review medication adherence when completing medication histories; feedback regarding ways to improve adherence should be raised with pharmacist and remainder of healthcare team.

REMS program requirements

Pharmacy technicians should assist in compliance with REMS program requirements.

Investigational drug management

Pharmacy technicians should support multiple aspects of investigational drug management, including inventory, information and record keeping, and preparation of investigational products for dispensing.

Revenue cycle optimization**Therapy authorization**

1. Pharmacy technicians should be engaged in specific aspects of the revenue cycle, including authorization of high-cost medications, off-label medication workflows, and billing work queues.
2. Technicians should review financial review requests and manage records to ensure financial approval prior to therapy initiation.

Patient financial assistance

1. Pharmacy technicians may assist in discussing with patients out-of-pocket expenses associated with chemotherapy medications.
2. Pharmacy technicians may lead efforts to assist patients with securing copayment assistance or referring them to an appropriate financial counselor.
 - a. Assistance may include completion of required paperwork and financial information.
 - b. Pharmacy technicians may assist with enrollment for foundation assistance.

Minimizing medication waste

Pharmacy technicians should minimize medication waste through monitoring compliance with policies and procedures including dose rounding and optimizing drug use through schedule coordination.

Supply chain management**Purchasing**

1. Pharmacy technicians should assist with navigation of complicated vendor, group purchasing organization, and manufacturer contracts.

2. Technicians may carry out daily purchasing activities under pharmacist supervision.

Inventory control management

1. Pharmacy technicians should promote inventory control strategies, including minimization of expired product, promotion of adequate medication turnover, and alignment with product-line purchasing, to ensure inventory control management of high-cost items while reducing overall stock supplies.
2. When receiving products, pharmacy technicians should employ special precautions for hazardous substances and ensure fidelity of drug product specific shipping and handling requirements.

Drug shortages

Pharmacy technicians should contribute to drug shortage management, including managing purchasing strategies and investigating procurement of alternative products.

Technology and informatics**Automation and technology systems management**

Pharmacy technicians should work under the supervision of a pharmacist to leverage information technology resources to improve the quality and efficiency of the healthcare organization, including:

- a. Management of applicable interfaces between electronic health record and pharmacy automation,
- b. Placement, configuration, monitoring, maintenance, and troubleshooting of automation and technology systems,

- c. Preparation of reports from clinical and automation systems to facilitate organizational, departmental, and individual decision-making,
- d. End-user training and education, and
- e. Providing users and staff with consultative support.²³

Remote telepharmacy services

Pharmacy technicians may function in important roles at remote sites through telepharmacy services, including preparation of i.v. medications, under the supervision of a pharmacist.²⁴

Quality improvement**Error prevention strategies**

Oncology pharmacy technicians should be included in quality-improvement projects to address metrics for workflow evaluation for oncology care.

Equipment and storage facility temperature monitoring

Pharmacy technicians should evaluate monitoring for equipment and storage facilities based on current standard operating protocols for continued fidelity checks of equipment for medication storage, compounding, and delivery.

^aPPE = personal protective equipment, CSTD = closed-system transfer device, PEC = primary engineering control, CADD = continuous ambulatory delivery device.