

**ADVANCING MEDICATION
SAFETY THROUGH
TECHNOLOGY INNOVATIONS:**

FOCUS ON RADIO FREQUENCY IDENTIFICATION TECHNOLOGY





Imagine a pharmacy where the inventory count is always correct, it automatically increments as orders are received and decrements as orders are filled. What impacts would this have on the budget, inventory management, patient care and overall workload? Is pharmacy that far off from this futuristic state? This technology is already in practice at companies like Amazon, who implemented this concept in their no cashier grocery stores. Customers pick up what they need and exit without needing to check out. They are electronically charged for the items and the store's inventory is automatically updated.

What are the challenges and barriers for pharmacy to break into this new market? What are the other possibilities in pharmacy if this type of technology or concept was fully adopted?

These are the questions this report aims to explore in a user-friendly format to enhance awareness and stimulate discussion specifically around radio frequency identification (RFID) technology in medication use systems and processes. Use the report as a starting point for those at the initial phase of information gathering and evaluation or for those who have implemented and are looking to expand RFID in novel new ways.

This project of the ASHP Foundation and supported by Fresenius Kabi had the specific goals to increase understanding and dialogue around:

- Current trends and future opportunities of RFID technology in health care and health systems;
- Perceived facilitators and barriers to adoption in medication use systems;
- Pharmacy's adoption; and
- Post-implementation outcomes.

ADVISORY COMMITTEE

DAVID AGUERO, PharmD, MSTL, DPLA, St. Jude Children's Research Hospital, TN

ANGELA CASSANO, PharmD, Pharmfusion, LLC, VA

RYAN CELLO, PharmD, University of California, Davis, CA

DARREN FERER, BPharm, CPHIMS, Kaleida Health, NY

BARBARA B. NUSSBAUM, BPharm, PhD, ASHP Foundation, MD

ANTHONY SCOTT, PharmD, MBA, Emory University Hospital, GA

SARA WOLF, PharmD, MS, Cleveland Clinic, OH

ABOUT THE PROJECT PARTICIPANTS AND METHODS

A seven-member advisory committee composed of a project lead, pharmacy leaders with knowledge and experience with RFID technology, and ASHP Foundation staff designed and executed all aspects of the project. To achieve the project's goals, the advisory committee utilized sequential mixed methods that included a survey followed by a virtual research panel. Details about the methods can be found on page 7.

ABOUT THE SURVEY PARTICIPANTS

A total of 232 ASHP members completed the survey. Of those who completed the survey, 98% were pharmacists in current practice. Participants reported a lengthy history in pharmacy, with 73% having worked in the pharmacy profession for more than 10 years and 50% being in practice over 20 years.

Forty-five percent of participants were in leadership roles at the business unit or higher level, such as Assistant Director, Director of Pharmacy, or Chief Pharmacy Officer. Other typical participant roles, included: Manager/Supervisor (20%), Informatics/Technology Specialist (10%), Clinical Generalist/Specialist/Coordinator (4%), Medication Safety Officer/Specialist (4%), and Supply Chain Manager (4%).

The majority of respondents (81%) worked in hospitals and health systems with almost half (47%) in hospitals/health systems with 500 or more beds and only 14% with less than 200 beds.

ABOUT THE SURVEY PARTICIPANTS

232 Survey Respondents



YEARS IN PRACTICE



10 years or more



20 years or more

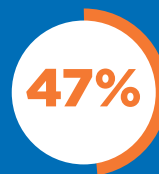
PHARMACY ROLES

Assistant Director, Director of Pharmacy, or Chief Pharmacy Officer	45%
Manager/Supervisor	20%
Informatics/Technology Specialist	10%
Clinical Generalist/Specialist/Coordinator	4%
Medication Safety Officer/Specialist	4%
Supply Chain Manager	4%

FACILITY TYPE



Work in hospitals and health systems



500 or more beds



Less than 200 beds

ABOUT RFID TECHNOLOGY



WHAT IS RFID?

RFID stands for **Radio Frequency Identification**. It is a proven technology that uses a system of tag readers to quickly and reliably identify items and capture information about them.

HOW DOES RFID WORK?



An interrogator emits a signal to the tag using an antenna. The tag responds with the information written within its memory bank. The interrogator will then transmit the read results to an RFID computer program.

WHAT ARE THE TYPES OF RFID TAGS?



Active Tags

Powered by an internal battery and are read or write.



Passive Tags

Operate without a separate power source and obtain operating power from the reader.

CURRENT STATE OF TECHNOLOGY IN MEDICATION USE SYSTEMS

Technology and automation solutions have become a standard in the medication use process, including automated dispensing cabinets, smart pumps, and high-capacity automated storage such as carousels. RFID is another established technology that is gaining momentum for use within healthcare and pharmacy. This technology is a wireless system made up of tags and readers that emits radio waves to transmit data. As a non-line of sight technology, RFID provides an effective way to record and track historical location of objects (e.g., medications) throughout a networked RFID system (e.g., health system). A trail of such recorded movements is the foundation for enabling traceability applications.¹

Survey respondents were in different stages of their RFID adoption journey. The largest group (40%) indicated they have implemented RFID. The next highest group (31%) was just beginning, indicating they have not evaluated RFID as a technology option but are interested in exploring (Figure 1). Respondents from either end of the innovation curve, from those who are exploring to those that have implemented this technology, are primarily looking to use it within pharmacy, compared to other areas like the emergency department or operating rooms (Figure 2).

For those who have implemented RFID into their practice (n=96), the results showed they are also routine utilizers of automated dispensing cabinets (98%), bar code medication administration (97%), smart infusion pumps (85%), carousel/high-capacity storage (78%), anesthesia workstations (74%), IV

workflow systems (63%), medication tracking systems (36%), and IV robotics (22%).

The most common current use of RFID technology in pharmacy is with code tray/code box management. Eighty-four percent of the survey respondents who have implemented an RFID solution have done so for code tray/box management (Figure 3). RFID allows for quick and reliable review of inventory content and more efficient tracking of these trays/boxes throughout the hospitals. For those who have implemented RFID, the least common areas include: hazardous medication (2%), patient specific medications (2%) and ambulatory medication adherence (1%), although these were selected as opportunities by those who are on a path to implementing.

FIGURE 1. STAGE OF ADOPTION OF SURVEY RESPONDENTS

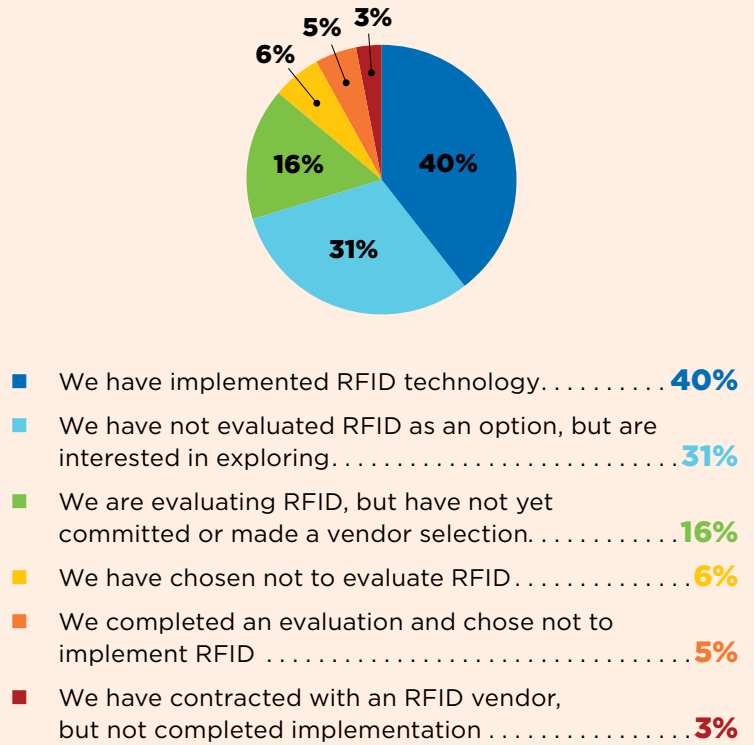
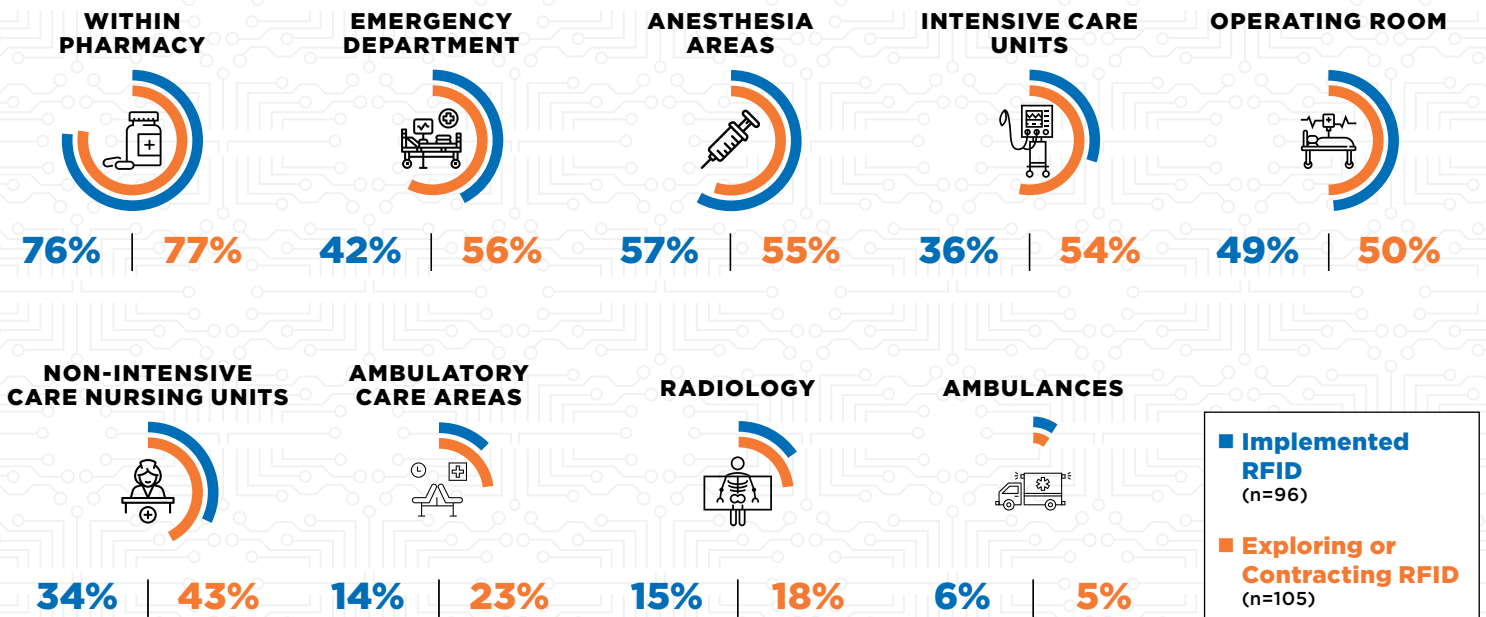


FIGURE 2. WHERE RFID IS IN USE IN HEALTH SYSTEMS



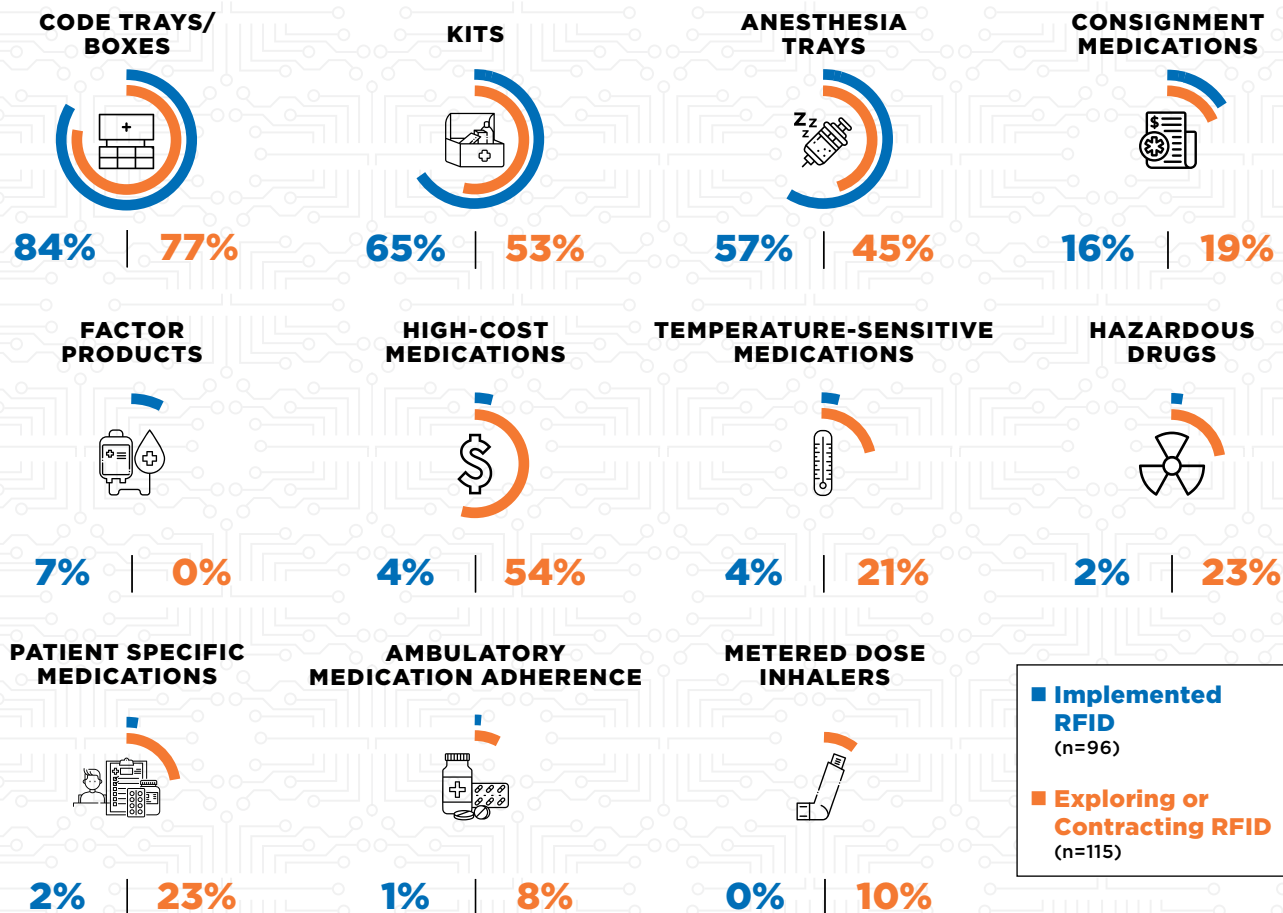
ADOPTION STIMULATORS

Pharmacy has only scratched the surface of the full potential that RFID technology could have on health care delivery. The impact remains to be seen and could have major effects on operations, inventory management, patient safety, and pharmacy practice in the future.

Whether exploring or having implemented, raising awareness of RFID technology use in medication systems may stimulate further adoption. Less than half (50/112) of those who have already implemented or completed an evaluation indicated they were either very or extremely knowledgeable about RFID. Although this is greater than the 8% (6/72) of those who are exploring RFID, it demonstrates the importance of increasing knowledge of RFID amongst both those already using it and those looking into it.

“I knew about RFID as far as medication tracking management but I’ve learned about so many other ways to use RFID just through this project. I think some of it may just be awareness of all the ways you can use it in the medication use process.”

FIGURE 3. HOW RFID TECHNOLOGY IS BEING USED



ABOUT THE METHODS

SURVEY

Participants of the survey were a clustered, random sample of ASHP active members who responded to a brief screening survey to confirm their interest to volunteer for the project, availability during the survey window, and the organization's stage of RFID adoption. A goal was to include a minimum of 30 participants in each stage of RFID adoption. All who responded in the affirmative received the online survey, conducted in April 2021.

Eighty-four participants of the survey indicated their interest in participating in the virtual focus group. This group was stratified by stage of adoption (e.g., exploring, implemented), organization-size/type (e.g., academic vs. smaller hospital), and RFID vendor selected.

After the advisory committee developed the survey, a pre-test review was completed to revise survey questions prior to distribution. The survey included primarily Likert-style with some free-response questions and was conducted online using Qualtrics (Qualtrics, Provo, UT).

A total of 350 ASHP members accepted the invitation and received the survey. Completed survey responses were received from 232 (a 66% completion rate).

VIRTUAL RESEARCH PANEL

From the survey responders 84 indicated their interest in participating in a virtual research panel. They were stratified by stage of adoption (e.g., exploring or contracting, implemented) and organization type (e.g., hospital, university). Participants who indicated that their organizations had implemented RFID were stratified by vendor as well.

Fifteen participants were invited and eight confirmed their ability to participate during the planned 10-day window in June 2021. Activities of the virtual research panel included a moderated discussion board and a moderated, live 90-minute virtual meeting.

Participant responses were de-identified and aggregated. No incentives were provided to participants. Survey results were summarized with descriptive statistics and virtual panel results were coded for key themes and illustrative quotes.

EVALUATING RFID TECHNOLOGY

Technology in use at survey respondents' practice sites shows that RFID is a technology that has been gaining traction in healthcare over the past decade. Almost half (47%) of survey respondents were in the process of, or interested in, evaluating RFID technology in the medication use process. During the evaluation phase of any new technology, there are key steps that start with determining the goals and priorities, key stakeholders, and the types of infrastructure needed to support said technology (Figure 4).

GOALS AND SCOPE OF RFID NEEDS

The goals will determine the scope of the project and drive all decisions. Nearly three-quarters (73%) of those evaluating or interested in RFID (n=110) cited inventory management as one of their top two reasons. Reinforced safety is another common goal. RFID allows for automatic reading of product identifier, lot number, and expiration date. While this can be accomplished with barcodes, it is a manual process that is

dependent on having the data embedded in the barcodes. Using RFID to improve inventory management should lead to cost savings which was also selected by respondents as a goal. Goals will be dependent on the areas where RFID will be implemented. There could be even greater cost savings when used for implementing consignment arrangements or internal tracking of high-cost items. Process standardization of code trays/boxes and anesthesia trays is also cited as a key goal. Last but certainly not least, recall management could be improved due to the nature of automatic capturing of data with RFID.

IMPORTANT FACTORS TO CONSIDER

Beyond the goals, three factors rated in the survey by the vast majority as very or extremely important were compatibility/interoperability with existing technology (84%), cost (83%), and technical support (82%) (Figure 5).

FIGURE 4. KEY ELEMENTS TO CONSIDER WHEN EVALUATING RFID TECHNOLOGY

- ☐ Goals of RFID technology implementation
- ☐ Intended locations for RFID implementation (e.g., pharmacy, ED, OR)
- ☐ Types of RFID technology solutions (e.g., trays, kits, boxes, tube stations)
- ☐ Stakeholders impacted by new technology
- ☐ Space needed to support RFID (e.g., equipment space, storage space for segregated drugs and trays, space for tags)
- ☐ Infrastructure needed (e.g., electrical, IT)
- ☐ Capital-both initial and ongoing
- ☐ Staffing needs
- ☐ Training needs (e.g., pharmacy, end users)
- ☐ Vendor support-both implementation and long term
- ☐ Availability of vendor integration with existing technologies
- ☐ Tag specific considerations (e.g., adhesive quality, cost structure, active vs. passive)
- ☐ Products being considered available as RFID enabled preparations from 503B outsourcing facilities and/or directly from manufacturers
- ☐ Analytics platform cost and capabilities

FIGURE 5. FACTORS IMPORTANT TO ORGANIZATIONS

● Not at all important ● Slightly important ● Moderately important ● Very important ● Extremely important

COMPATIBILITY/INTEROPERABILITY WITH EXISTING SYSTEMS



COST



TECHNICAL SUPPORT



HUMAN RESOURCES/STAFFING NEEDS



ANALYTICS



CUSTOMIZATION OF THE PRODUCT



CONTRACT FLEXIBILITY



OPPORTUNITIES FOR EXPANSION



REFERENCES/WORD OF MOUTH





Key Stakeholders

Key stakeholders to involve in project teams include, IT, pharmacy, end users of medications, purchasing, and finance. Survey responders indicated that pharmacy was the key player (98%) with IT (44%), purchasing (41%), and finance (36%) often at the table during the contracting stage (n=201). How and where RFID will be deployed impacts which end users to include on teams to provide input on workflows and processes that need to be updated. Will code trays or medication boxes be implemented? Will RFID be added to OR/anesthesia kits and/or trays? Operating room leadership and/or anesthesiology leadership should be brought to the table early in the process. Is a consignment vendor for factors or other high-cost products involved? Maybe tracking high-cost, patient-specific products internally is planned. Is vendor integration available, and will it provide added benefit? Answers to these questions may help determine which departments to include when developing the project team.



Tags and Tagging

Tag specific considerations cannot be underestimated. Make sure to consider size of tags and adhesive quality. Trying to place a tag on a small vial or ampule, while not covering any valuable information may present challenges. The adhesive should not alter the integrity of the product or device. On inhalation nebulers leaching is a reason many are embossed rather than printed. The adhesive quality should ensure that tags stay where they are placed. This is especially true with products that require specific temperature-sensitive storage like refrigeration or freezers. Humidity can also play a factor in certain regions. One downside to strong adhesives; removal may impact the integrity of the manufacturer label or the product itself. This is especially true when using for consignment purposes.

Active RFID tags require a power supply and are primarily used in non-medication asset management. Assets may include infusion

pumps, automated dispensing cabinets, or actual human staff that are moving around a healthcare facility. Active RFID likely involves more investment in infrastructure as the tags need to communicate with the local network, a receiving system to send data, and software to capture the data being sent. Medication inventory management solutions currently marketed typically incorporate passive tags, which require no power supply and are significantly cheaper, but with a much shorter transmission range.

Many challenges of passive RFID can be mitigated by purchasing products with embedded RFID tags. Sourcing of RFID tags does not currently follow a free-market system because RFID tags must be obtained by the system vendor or their approved supplier(s). Most current vendors charge in a price per tag structure. This can impact the project's scalability and be an additional challenge if vendors are switched in the future. It has yet to be seen how RFID system vendors will adapt their pricing structures as manufacturer embedded RFID tags gain market share, but these tags are expected to be a welcome change to all.



Staffing and Inventory Management Impacts

Similar to many other projects, vendors may mention FTE reduction or redistribution. While the amount of time required to check kits or trays will be reduced, there will be a workload shift to checking of manually tagged products prior to being placed in kits or trays. Do not underestimate the amount of time for manual tagging, maintaining RFID systems, inventory, and workflows (Figure 6). Much of this effort can be sourced by pharmacy technicians or student interns.

Inventory management was the top reason selected by survey respondents for implementing RFID. For implementation planning, be aware that additional space may be needed, or desired, for maintaining

separate inventory of RFID tagged medications. Consider a standardized template (or blueprint) of a kit or tray in designing the work space. Additionally, application maintenance of the master templates for kits and trays will need to be overseen by a team to ensure standardized processes and timely updates occur as shortages and template request updates are received. Think about how drug shortages can impact this element as well. Allocation is no longer as simple as adding a pre-printed card stating a drug or dosage form is unavailable in the supply chain, its replacement, or how to obtain from pharmacy. Dedicated staff will need to adjust the electronic build of the kit or tray by removing or replacing the unavailable product.



RFID Enabled Product Availability

RFID product availability is another key factor to consider during the evaluation phase. When this technology was first applied to the medication use process the only option was manually tagging products in-house.

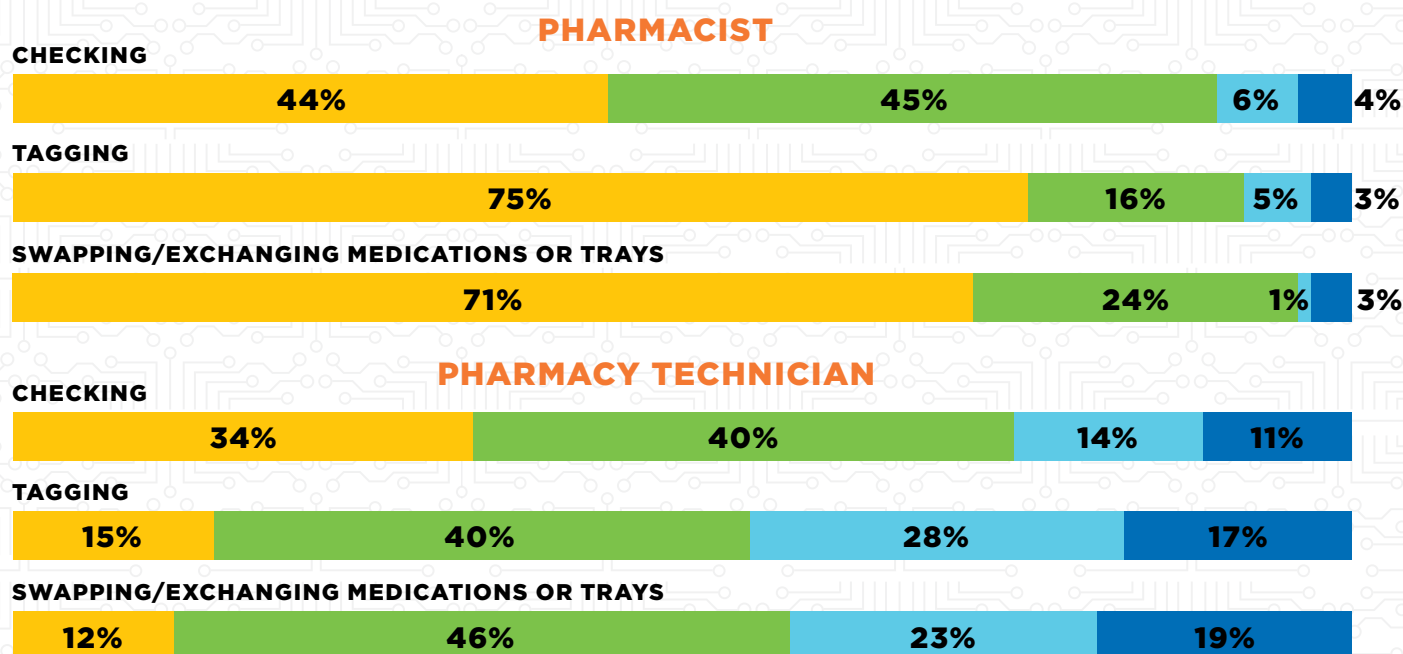
As RFID adoption has grown, third-party repackagers and 503b outsourcers have begun to offer these services. Recently, two manufacturers have begun supplying RFID enabled medications. The currently available product portfolio is small but there are plans for expansion. These growing options for obtaining RFID enabled medications should help reduce the manual in-house effort.

ADOPTION STIMULATORS

- ☑ Clarify goals and priority factors to consider
- ☑ Have the relevant key stakeholders around the table
- ☑ Tag specific considerations must be accounted for
- ☑ Realistically assess staffing needs for RFID-specific tasks
- ☑ Follow the checklist and leverage existing network of early adopters

FIGURE 6. TIME SPENT EACH DAY ON RFID OPERATIONS

● Less than 15 minutes ● 15-60 minutes ● 61-120 minutes ● Greater than 120 minutes



(n=91)



IMPLEMENTING RFID TECHNOLOGY

Following vendor selection and contracting, implementation can be reviewed, planned, and initiated.



CONTRACTING

A well-written and understood contract is the cornerstone of a good client/vendor relationship. Consider institution-specific contracting and legal requirements while following this defined process. Does the facility follow a centralized legal and/or contracting process, or is the pharmacy department able to begin contracting directly following a contract award? Give thought to the role the organization's legal department will play in negotiating the terms of the contract as well. Of respondents who either have contracted or implemented RFID (n=102), the majority (54%) suggested zero to six months from contract award to signature under

normal circumstances. This can be greatly influenced by both sourcing structure and strategic priorities as well as external pressures (e.g., the COVID-19 pandemic). Which service levels will be included in contract language and are these endorsed by legal counsel as defensible? Consider involving information security and/or risk management teams before final contract signature and understand how any software solutions associated with RFID will be accessed within the network infrastructure before the contract is finalized.



PROJECT SCOPING AND IMPLEMENTATION

When implementing, project managers should plan from a triple constraint perspective; that is, balancing scope, timeline, and resources.² Often one of these factors cannot be changed without impacting the

others and creating risk for the project. Therefore, project leads should manage risk judiciously.



WHERE AND WHAT

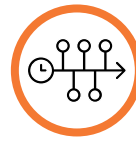
Perhaps the most important question in the implementation of RFID technology is where in the medication use process it will be applied, and if the technology itself is treated as a consumable, a solution, or both. For example, taking advantage of active RFID as part of real time location strategy for smart pumps is a very different project than planning for the technology to be applied to individual medication vials for inventory control of expensive pharmaceuticals. While facilities of all sizes have complex workflows, those with larger bed sizes may have more factors to consider in workflow planning—and most respondents came from hospitals of 500 beds or larger. That said, smaller facilities lacking 24/7 pharmacy services are likely to benefit from the inventory control capabilities of RFID technology.



WHO

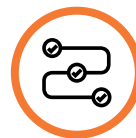
Define the resources for the project—that is, how many and from which departments will the project implementation team include? In the present day, consideration of the physical location of team members will be important as well. Typically, implementation team members will be on-site at each facility to set up and test all hardware and software based on decisions made during the planning phase. Who will sponsor and who will lead the effort—a staff member from pharmacy, information services, a centralized project manager, or a different department? An RFID project team may include a pharmacy executive as a sponsor alongside a centralized project manager, typically with vendor resources, and pharmacy operations resources and support from information services, usually for networking tasks and

credentialing. If project management resources aren't available, the major vendors in this field typically supply this resource.



WHEN


The timeline will vary depending on the institution. Familiarity with the technology will help with change management up front. Consider conducting 1:1 hands-on demonstration for the new automated RFID workflows and reviewing best practices with super users and other key pharmacy technicians and/or pharmacists during the workflow planning stage of the implementation. Besides the vendor, has anyone on the project team implemented this technology previously? If the answer is no, the executive sponsor may consider hiring a consulting team with appropriate experience implementing this technology effectively or putting team in contact with another comparable site that has implemented in a similar fashion to help keep the project in line with the executive sponsor's intent. However, ensuring users are engaged who will use the product continuously once operational is just as important.



HOW

Appropriate workflow mapping using process management tools can provide a visual medium for honest dialogue about current and future-state process design. Getting agreement and buy-in related to process changes will be important to the technology being well-adopted and limiting process waste. Changes in staffing may be needed to accommodate updated workflows. For example, repackaging and tagging inventory for trays occurring during night shift “downtime” may result in additional staff hours being freed for clinical care during day shift hours.

While resourcing and timeline calibration present significant opportunity and risk,



“Pharmacy has been the primary champion for RFID involving medications.”

technology implementations are probably most empowered (and conversely, imperiled) when change management is handled effectively. Changes like those above require strong communication, and agreement from operations staff for successful adoption. All-the-better if the project sponsor is a pharmacy executive who can provide the direction to department staff in support of an operational supervisor or manager who will support the use of the technology post-go-live.

Level and depth of training will greatly affect the project team’s ability to effect change as a result of the deployed solution. Will the vendor supply training materials and will they help customize any materials to the site? If not, plan to allocate some resources to this area with the help of pharmacy technicians, residents, or students. Pharmacy student interns are a great resource in training development. How will training resources be provided, and what will be the plan for ongoing training post go-live? Depending on the size of the institution and scope of the project, actual training resources may be made available to the project team, or this need may have to be resourced from the department, which does have benefits in supporting post go-live workflow optimizations.

Last and certainly not least, culture trumps strategy, and each department has its own communication methodology and style. Consider the existing channels when designing a communication strategy to introduce and reinforce change effectively. Communicate early, and often in any project. For example, in use of RFID, tagged inventory will need to be maintained, but that shifted effort will give staff more control of their time for patient care activities. If staff are just learning about the technology and additional tasks expected of them during training, they may not buy into the changes that are required. Staff buy-in should be treated and managed as a critical resource; if the project team does not accumulate enough buy-in for a solution, it is unlikely to be successful in meeting its intended purpose.

Keep in mind additional resources may be needed during the actual implementation go-live, though likely only for a period of days to weeks. Depending on the need being filled by the technology, RFID technology supported process changes reap benefits fairly quickly.³

IMPLEMENTATION STIMULATORS:

- ☑ Culture trumps strategy—pay attention to existing relationships and communication channels.
- ☑ Brush up on change management strategies.
- ☑ Implementation plan needs to build from the 4 W’s—Where, What, Who, and When.
- ☑ “How” matters when managing the change.

USING ANALYTICS AND MEASURING OUTCOMES OF RFID

RFID technology is often described as a reliable medication inventory management solution for pharmacy departments in the hospital setting. The tracking of medications with an RFID tag can improve many steps in the medication review and distribution process operationally. There was evidence of this in the survey responses.

The use of analytics software and monitoring outcomes are crucial components towards helping with the management of ongoing drug inventory needs and other identified goals for RFID implementation. The utilization of tags on both medications and trays from regular use within the pharmacy department generates data that can support the review of metrics intended to drive strategic decisions on how to optimize the use of inventory for efficiency and cost management. However, the need and adoption of the data collection tool varies based on each organization's individual need, perceived value of the analytics platform, and the evaluated usefulness of the data collected by the software of choice.

Pharmacy based analytic platforms that provide real time data management come primarily in the form of electronic dashboards that provide the end user with real time information about the usage and distribution of the RFID tagged medication inventory tracked within the system of choice. The goal of increasing the levels of automation in the inventory management process and providing full visibility into the value of adding RFID tracked medications is a driver for the adoption of RFID technology and can be used to create a business case for the return on investment of implementing the technology. Analytic software can deliver real time monitoring of expiration date tracking of medication stocked in trays or kits, utilization

rates of both fast moving and slow-moving medication, and par level recommendations for medications located within a tagged kit or tray.

From the initial evaluation of RFID, 74% of the survey respondents listed the availability of an analytics platform as at least very important to consider for RFID or selecting to proceed with the implementation of RFID within the pharmacy department (Figure 5). Under half (46%) reported utilizing the analytics component of the RFID technology as part of their implementation (n=93). Time required for running (66%) and review (51%) of reports were the most frequent reasons that analytics were not being done (n=68).

The justification for the use of an RFID analytics platform showed some variation based on the departmental needs reviewed by the pharmacy leaders in addition to the contributions of the multidisciplinary team. Of the 43 respondents utilizing analytics in Figure 7, the most frequent use of the data provided by the analytics platform are tray and kit utilization rates for the distribution of the medications being tagged and scanned by the RFID inventory hardware.

“Tracking medication trays allowed for decreased waste by moving medications from trays to areas of high use.”

FIGURE 7. ANALYTICS IN USE TO EVALUATE RFID



The majority of respondents who implemented RFID reported benefits in the medication use process (Figure 8). Benefits were reported by over twice as many survey responders (n=95) as those who use the RFID platform analytics (n=43).

Analytics were used to customize tray and kits (73%) and any other tagged carriers of medications. Patterns of medication usage and expirations give the end user important insight into how kits and trays are being used routinely within the workspace. These data points contribute to determining whether a medication should be added to a tray, removed from a tray, or have the par level adjusted to accommodate for variations in the rate of utilization in a specified area. An analysis of these data can contribute to a more efficiently managed inventory system through waste reduction and improved par level management.

Improved inventory tracking (82%) was the most common benefit reported by those who have implemented RFID. As patient safety improvements remain a selling point for RFID technology, a routine review of analytics data from the RFID platform supports best practices to manage tray restocking workflows and review activity by technician and pharmacist end users. Reports that log restocking activity can identify the rate of stocking errors caught at the individual drug level after a tray is scanned to identify trends and establish the effectiveness of a particular workflow that standardizes second checks and even tech-check-tech routines. Lastly, end users can review dashboards and reports from analytics to determine if service expansions or reductions are needed in a particular clinical area. Data showing the frequency of medications used or not used can go a long way towards establishing more investments in decentralized medication inventory stocking and planning for future changes within the department that meet provider demands and internal growth strategies.

“Decreased inventory of back-up trays. We went from 16 to 4.”

Drug recalls are also a routine occurrence that present unpredictable safety challenges for

pharmacy departments. The use of an analytics system to track medication specific details down to the lot number and expiration date can drastically reduce the amount of time needed to identify and remove recalled inventory from distribution out in the patient care areas. Tracking reports run for medication recalls can isolate the recalled medications and also inform the end user which specific tray or kit to find the items that needs to be quarantined or returned to the manufacturer if appropriate.

64% who implemented used the technology to manage drug recalls (Figure 8)

Some of the benefits of accessing and reviewing analytics data are well established and vary based on how the technology is used within the organization and the most significant

departmental needs prioritized by the pharmacy

leader. Labor utilization rates associated with using and maintaining the RFID technology is a useful marker to evaluate the human resources needed to run and oversee the system as a whole (Figure 7). For example, many RFID vendors highlight that the systems are intended to free up time and resources of pharmacist and technician staff based on faster turnaround of tray and kit restocking times. Organizations can also use analytics to measure the amount of time spent on these activities, while reviewing the amount of time needed to place tags on medication inventory and program each individual drug into the tracking database to maintain patient safety standards and accuracy.

ADDITIONAL CONSIDERATIONS

The implications of RFID analytics can also present some challenges and hurdles for pharmacy departments which must be accounted for and evaluated as thoroughly as the benefits.

Access to the Data: A primary hurdle for overall adoption centers around cost and the financial commitments needed to access the data generated from the RFID hardware solutions. The access to analytics data varies based on the RFID vendor, with some requiring an additional add-on subscription cost separate from the tag fees and maintenance contracts for the system.

- Leaders evaluating the impact of adding more overhead cost to an RFID program rollout should be aware of the budgeted impact and balance this against the potential

FIGURE 8. BENEFITS REPORTED FROM IMPLEMENTING RFID



82%

**IMPROVED
INVENTORY TRACKING**



73%

**DATA TO OPTIMIZE KIT
OR TRAY CONTENTS**



72%

**DECREASE IN EXPIRED
MEDICATIONS**



64%

**TRACKING FOR
PURPOSES OF DRUG
RECALLS**



46%

**TRACKING DURING
DRUG SHORTAGES**



15%

**RETURN ON
INVESTMENT**



13%

OTHER

(n=95)

return on investment of the analytic capabilities through the aforementioned cost savings and waste reduction opportunities.

- Site-specific decisions can be made after a complete assessment of the types of data available from the RFID vendor and specific applications to each area within the department using the technology.
- Important considerations of the usefulness of the data and applicability to the operational workflows can allow leaders to determine if the additional expenses are justified.
- Predictive analytics is also a cutting-edge resource that can allow end-users to gain a better understanding of data patterns and proactively manage change for any involved stakeholders.

Dedicated Resources: Pharmacy leaders are also faced with identifying the availability of dedicated resources assigned to review the RFID analytics data and make outcomes-based decisions.

- Initial validation and ongoing review of reports and virtual dashboards takes time. Comprehensive super user training must be included to ensure the proper conclusions are determined based on the accurate review of data and the needs of the organization.
- Time committed to daily, weekly, and monthly reviews must be accounted for, despite the prevalence of automated reports and other visual indicators highlighting areas of concern or waste.
- Troubleshooting analytic platforms may be a service offered by the RFID vendor that must be considered through contracting and general maintenance agreements. Technical support needs are often unexpected and unpredictable, so end users are challenged to identify the best staffing resources

to support the system regardless of the frequency of occurrence.

- The size and scope of the organization implementing the technology will play a key role in determining how to delegate RFID support responsibilities. While some groups may be in the fortunate position to have adequate support from internal pharmacy information technology or information systems departments, choosing the department that has the bandwidth and capacity to help with routine and unexpected needs must be mapped out and planned with diligence.

Supply and Demand: Limitations in the volume of RFID medications used daily may also reduce the functionality of analytics solutions.

- End users tracking usage rates for a limited medication formulary or a minimal number of trays may have a hard time justifying the additional expenses related to analytics due to a lack of return on investment if the RFID vendor carves out access to the analytics platform separate in the contractual obligations. Larger organizations may be able to avoid these pitfalls by increasing the scale of use for RFID-tagged medications, but smaller sites may not actualize the benefit or establish the internal need to pursue this option as a long-term strategy tied to the use of RFID technology.

ADVANCED USES AND INNOVATIONS

At the time of the survey, less than half of respondents had incorporated RFID into their pharmacy practice setting. There were several themes that influenced respondents' decisions to include RFID as part of their medication use management strategy, with cost and compatibility/interoperability with existing systems being ranked by over 80% of respondents as being very to extremely important (Figure 5). This section explores areas that are important for RFID to gain further acceptance in health care settings in the short- and long-term future (Figure 9). Furthermore, this section examines what benefits an investment in RFID infrastructure could provide to help automate many manual processes and free up time for clinicians to focus on the care of their patients.



TAGS AND TAGGING

Project participants were using and/or evaluating several different vendors for their RFID-enabled medication use process. Many of the vendors use a fee per tag model for their pricing, and at the time of study, there was not an agreed-upon standard that would allow for interoperability among tags between systems. Of the organizations who had implemented RFID (n=92), 43% reported having medications tagged by 503B or third-party vendors. To further explore this trend, several panel members shared their similar processes. Panelists described receiving tagged items from 503B companies that came with tags that were specific for different RFID systems, and while these tags provided some benefit over tagging themselves the supply was not always consistent and the number of line items available as pre-tagged still led to them having to tag several items internally.

Standardization is essential. One of the first steps in getting to wider RFID adoption discussed by the panel through online posts centers on agreeing to a standard for RFID similar to how GS1 standardizes format and what info is included in 1D & 2D barcodes. Once this industry standard has been set, the consensus of the panel is it will lead to companies and pharmacies feeling comfortable with further adoption into technologies utilizing RFID and lead to more competition. This competition in the RFID space has the potential to drive down cost leading to further adoption.



SUPPLY OF MANUFACTURED PRE-TAGGED

An expansion of line items pre-tagged for use in all major RFID systems by pharmaceutical manufacturers could have several major impacts on the medication use process and lead to further adoption of RFID. Manufacturers and wholesalers having inventory that include RFID was discussed during the live panel session as being a means for these companies to better automate inventory tracking through the production and distribution process as required by the Drug Supply Chain Security Act. If this expansion of manufactured tagged items comes with increased costs and no additional perceived benefit, the likelihood of broader adoption is in question based on results of the survey showing additional cost being a strong factor behind the decision of those who evaluated RFID (Figure 5).

For pharmacies that currently utilize RFID but are having to keep a segregated inventory of tagged products, having the option to consolidate to one pre-tagged line item that did not significantly increase dollars spent would eliminate the need to have two

separate inventories for the same line item. This improvement in inventory management provides pharmacies with clear visibility into usable inventory on hand and allows them to utilize medications where they are needed in times of supply disruptions without having to worry about cost they have already invested in tagging items.



COMPATIBILITY AND INTEROPERABILITY

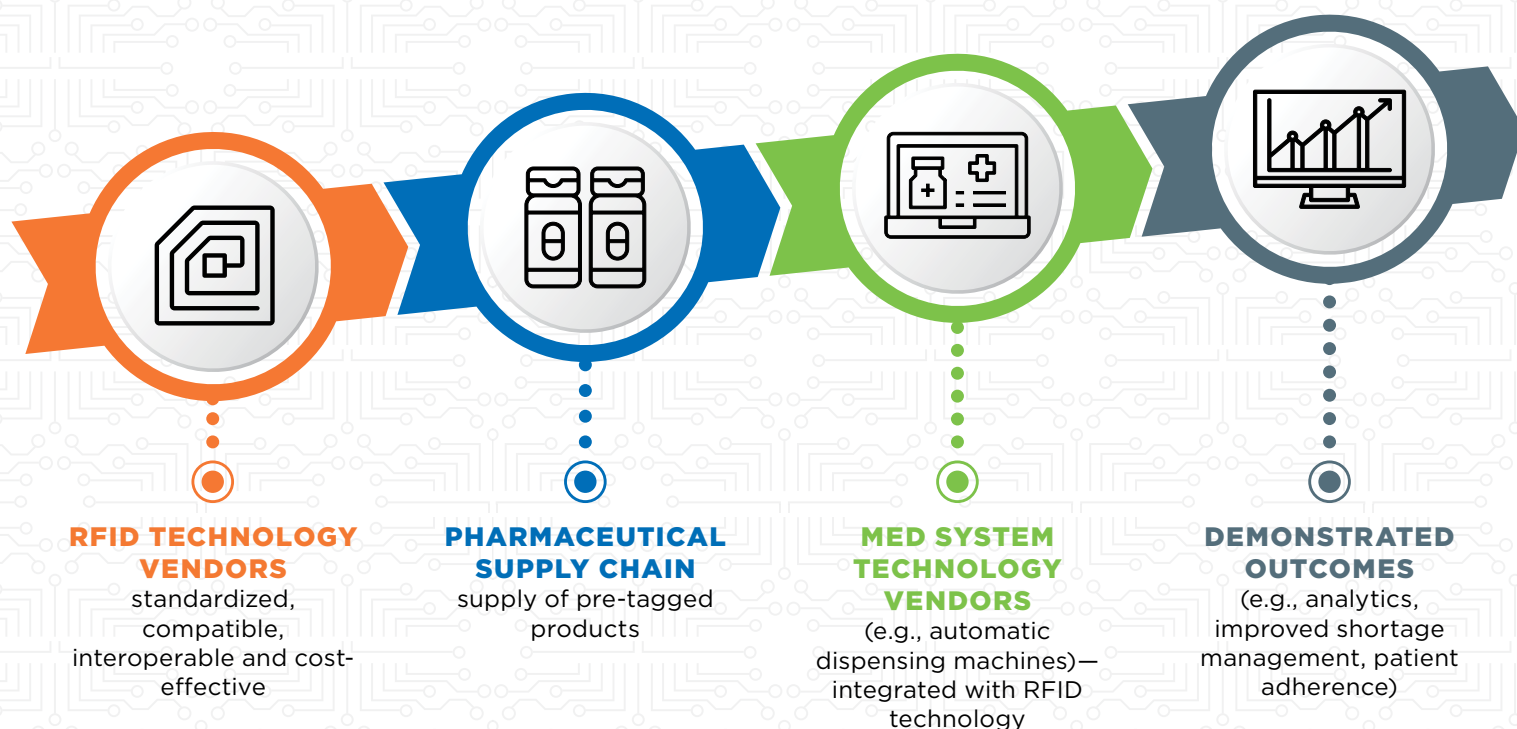
Survey respondents indicated that compatibility and interoperability with existing technology was an important factor for RFID adoption (Figure 5). The virtual panel delved into this around current and future use.

During the live meeting, panel members asserted that it would likely take pharmaceutical manufacturers adopting RFID first before other pharmacy vendors, such as automated dispensing machine (ADM) makers, would invest in the technology as they would want to be sure that their RFID reading technology would work across RFID vendors

tags. This emphasizes the importance of standardization with agreed upon interoperable standards for tags.

Increased availability of pre-tagged products would likely lead to ADM customers requesting the ability to utilize the RFID tags to better manage their inventories. RFID integrated into ADMs and other pharmacy automated storage solutions would enable a real time accurate inventory throughout the pharmacy even when electronic counts do not match physical counts in each storage location. In an ADM with RFID capabilities, the technician could refill a medication without having to perform a count or enter any expiration dates as the reader in the ADM would capture all of this information accurately leading to less time spent at the machines and less risk that medications will not be available or expired medications will be given to a patient. The improvements in inventory management would likely trigger ADM and other technology vendors to look to incorporate RFID into future technology product lines, including those that connect to our patients.

FIGURE 9. A PATH TO FUTURE ADOPTION AND INNOVATIONS





ANALYTICS AND RETURN ON INVESTMENT (ROI)

The panel discussed that adoption of RFID could be enhanced with an agreed upon ROI formula that was validated by end users and measurable across different systems. Pharmacy would have the needed data to advocate to leadership the benefits of RFID. In addition to an ROI on initial go-live, if there were standardized analytics that could be applied when looking at opportunities to expand RFID operations, it would help the pharmacy understand the impact of expansion and if the benefit was worth the cost in tags and labor. Currently, many of the panel report that vendors supplied an ROI equation that was potentially used to help at contracting and implementation of a system but was not applied for any future expansion. Panel recommendations of important metrics and analytics to support implementation, evaluation, and expansion, include:

- Ability to quickly analyze potential decrease in waste if RFID incorporated into an area as means to justify the additional cost of tags
- Metrics showing time saved for pharmacists and technicians by going from a highly manual process to an automated process and could be applied across RFID systems
- Agreed upon safety metrics
- Key Performance Indicators measuring processing time of trays and kits and staff involved to help evaluate the impact
- Metrics supporting the use of tech-check-tech process including success rate, kits processed and rework percentage leading to state and national standards to help advance acceptance of process.



ADVANCING PRACTICE AND SAFETY

The survey captured the time being spent by technicians and pharmacists for sites using RFID and only 12% (n=96) of respondents who had adopted RFID allowed technicians to do a final check. The panel believed having validated safety metrics when RFID is incorporated into the medication use process would help further adoption of a tech-check-tech process to free up pharmacist time to provide patient care activities. Standardized metrics that are integrated into the enterprise data warehouse could allow key stakeholders beyond pharmacy to benefit from the investment in RFID.

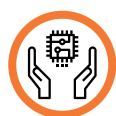
An additional area the panel felt would be valuable for further adoption centered on RFID integration with electronic medical record (EMR) vendors. Possible scenarios included vendors capturing lot, item number and expiration each time medication was scanned or passing this information from ADM to EMR when medication is removed by anesthesia providers where there is no barcoding. Accessible data removes manual documentation, assists with recalls, and helps track the pedigree of each medication down to the patient level. With many EMR vendors providing tracking options, having the ability to incorporate RFID tracking of medications through systems such as pneumatic tubes and real time location services (RTLS) and automatically integrating into EMR would bring visibility and trackability the use process.

Finally, highlighting the importance of medication safety as a factor for RFID, panel members suggested that including RFID medication tracking as a national safety objective would promote adoption.



PREPARING THE WORKFORCE FOR RFID TECHNOLOGY

As the profession looks to the highly integrated health care system of the future, the panel explored how to educate pharmacy personnel about the uses of RFID in the medication use process outside of the current established areas such as code tray, kits and anesthesia tray management (Figure 3). The panel's recommendations included conducting and supporting research and sharing the results through webinars, publications and professional networking opportunities.



THE FUTURE OF RFID

In a fully integrated health care system with RFID as a component of the medication use process, imagine a scenario where every patient, staff, piece of equipment and medication is tracked throughout the health system by RFID scanners at every door of the pharmacy, medication room, OR suites, and hospital entrance. The data would integrate

into the EMR to provide real-time visibility into all key components of the healthcare network (Figure 10). All of this information would be captured allowing teams to analyze how to quickly address any issues that arise, act on signals indicating change in use patterns and utilize machine learning algorithms to optimize care.

One scenario discussed during the live panel was that of a patient who is coding on the floor which requires opening a crash cart. Opening the crash cart would trigger central processing to send up a new cart, which could be delivered via a robot that is also able to return the used cart for replenishment. The medications taken out of the cart and administered would flow into the EMR on scan indicating specific lot and expiration date as well as individualized serial number of each product. The medications used would be captured in the pharmacy inventory management system and if indicated automatically place order with wholesaler to replenish pharmacy supply. As the patient was wheeled up to the ICU from the floor, their location would update based on actual location and update dispense logic in EMR and ADM.

FIGURE 10. CONNECTED CARE

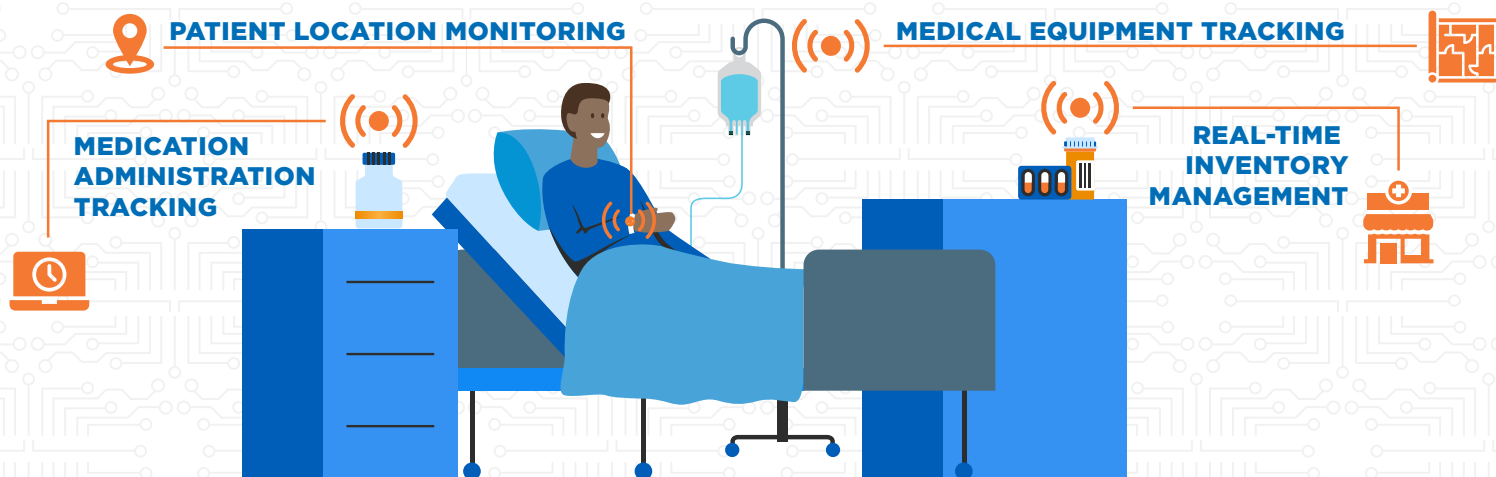


FIGURE 11. OPPORTUNITIES FOR EXPANSION OF RFID

- ✓ Pneumatic tube tracking with RFID leading to decrease in waste.
- ✓ Integrating RTLS tracking into tracking of kits and trays to decrease time spent finding recalled and expired medications throughout health system.
- ✓ RTLS tracking of essential equipment by materials management such as infusion pumps and ventilators to ensure equipment needed is in the correct location to meet needs of patients.
- ✓ Tracking of patients as they travel through health system with this info updating into EMR in real time.
- ✓ Tracking of lab specimens such as biopsies.
- ✓ Embedded into patient specific labels for specific types of medications allowing for real time tracking of high-cost patient medications and patient specific controlled substances as branch of diversion detection program.
- ✓ Automated PAR level communication leading to real time accurate inventories and less labor to manage.

SUMMARY

There are many opportunities for incorporating RFID into the healthcare landscape (Figure 11). The data generated through the survey and virtual research panel highlight the current trends, anticipated goals and acknowledge the current barriers. Throughout the report potential stimulators have been identified to enhance the adoption of RFID. RFID provides an important opportunity for pharmacy to lead the transformation to an integrated health system to optimize safety, outcomes and value. Pharmacy leaders should continue to educate the pharmacy workforce and other disciplines on the potential of RFID and advocate to vendors and manufacturers to continue to invest in future enhancements that will improve operations and patient care with less manual inputs and more autonomous workflows.

REFERENCES

1. Wu Y, Ranasinghe DC, Sheng QZ, Zeadally S, Yu J. RFID enabled traceability networks: A survey. *Distrib Parallel Databases*. 2011;29:397-443.
2. Baratta, A. (2006). The triple constraint: a triple illusion. Paper presented at PMI® Global Congress 2006—North America, Seattle, WA. Newtown Square, PA: Project Management Institute.
3. Ajami S, Rajabzadeh A. Radio Frequency Identification (RFID) technology and patient safety. *J Res Med Sci*. 2013;18(9):809-813.

ACKNOWLEDGEMENTS

This research was supported by Fresenius Kabi.

This report is a product of the advisory committee and could not have been created without the support and expertise from the staff at ASHP.



About the ASHP Foundation

The ASHP Foundation was established in 1968 by ASHP as a nonprofit, tax-exempt organization. As the philanthropic arm of ASHP, the Foundation shares ASHP's vision that medication use will be optimal, safe, and effective for all people all of the time. Our mission is to support ASHP by advancing the professional practice of pharmacists and the pharmacy workforce by funding research and education that improves health outcomes through optimal, safe, and effective medication use. To learn more about the Foundation's programs, visit ashpfoundation.org.

4500 East-West Highway, Suite 900
Bethesda, Maryland 20814

ashpfoundation.org

 @ASHPFoundation

 @ASHPFoundation

The ASHP Foundation is a 501(c)3 nonprofit organization, and all contributions are tax deductible to the extent allowed by law.