Roadblocks and successes in preparing COVID-19 vaccination clinics: Perspectives from pharmacy residents

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Purpose. To outline logistics challenges, barriers, and successes in the development of separate programs for mass COVID-19 vaccine distribution and administration to healthcare employees and community members.

Summary. In the face of the global coronavirus disease 2019 (COVID-19) pandemic, COVID-19 vaccine development and distribution became a worldwide priority. AdventHealth Orlando was selected as the central hub for vaccination efforts for central Florida. There was a need to quickly evaluate literature, patient safety, and institutional resources and logistics to coordinate the development of employee and community vaccination clinics. These efforts were driven by postgraduate year 2 residents in health-system pharmacy administration and leadership, medication-use safety and policy, and informatics. Clinic development focused on 4 key areas: vaccine quality control, secure inventory movement, safe preparation and administration, and consolidation of inventory. Healthcare worker vaccinations were administered on the health system's main campus, and community vaccination events were carried out at temporary clinic facilities set up in the parking lot of Orlando International Airport.

Conclusion. In a mass COVID-19 vaccination initiative directed by the pharmacy enterprise leadership of a large Florida health system, postgraduate year 2 pharmacy residents played a key role in developing and implementing vaccination clinics targeting healthcare worker and community populations. During multiple vaccination events, a total of more than 50,000 COVID-19 vaccine doses were administered, with minimal to no vaccine wastage.

Keywords: health system, pandemic, pharmacy, residents, vaccines

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In March 2020, the World Health Organization announced the global coronavirus disease 2019 (COVID-19) pandemic. As quickly as the pandemic began, the pharmaceutical industry shifted focus towards vaccine development. The Pfizer-BioNTech COVID-19 vaccine was the first to receive emergency use authorization (EUA) from the Food and Drug Administration (FDA) in December 2020, quickly followed by approval of the Moderna COVID-19 vaccine. Nationally, hospitals were tasked to develop safe and efficient workflows for vaccine distribution.

AdventHealth's Central Florida Division is an 8-campus community hospital enterprise with approximately 3,400 licensed beds. At the time of writing this included the AdventHealth Orlando campus, a 1,400-bed quaternary community hospital, which was one of the 5 central COVID-19 vaccination hubs selected by the state of Florida. These hospitals were tasked with vaccinating over 50,000 frontline healthcare workers and community members with the Pfizer-BioNTech and Moderna COVID-19 vaccines within central Florida. To carry this out, the

AdventHealth Central Florida Division enterprise leadership partnered with postgraduate year 2 (PGY2) pharmacy residents specializing in health-system pharmacy administration and leadership, medication-use safety and policy, and informatics. These PGY2 pharmacy residents had the support of the pharmacy department, which included operational and clinical leaders, pharmacists, pharmacy residents (16 postgraduate year 1 and 11 PGY2 residents), pharmacy Interns, and pharmacy technicians. The clinic structure (Figure 1) created by our team then served as a model for the AdventHealth multistate enterprise, which spans 5 regions comprising 36 campuses across 8 states. The 4 principal areas of development for vaccine administration are vaccine quality control, secure inventory movement, safe preparation and administration, and consolidation of inventory. This article recounts our experiences and perspectives as pharmacy residents in staging and managing employee and community COVID-19 vaccination efforts.

Employee vaccinations

Being one of the 5 hospitals selected, AdventHealth Orlando developed a COVID-19 vaccine task force including executive leaders in nursing, medicine, security, transportation, and pharmacy to design the workflows and mitigate challenges of vaccine distribution. The taskforce divided the received allocation of vaccines to 2 hospitals in the AdventHealth Central Florida Division: AdventHealth Orlando Hospital and AdventHealth Celebration Hospital. Criteria for determining the healthcare personnel qualified to receive the vaccine were based on the Centers for Disease Control and Prevention (CDC) Class 1A recommendations.^{1,2}

Roadblocks and interventions.

There was minimal guidance and direction from federal and professional organizations to assist with planning clinic operations prior to the Pfizer-BioNTech vaccine EUA. Consistent communication with Pfizer's vaccine regional medical director was

KEY POINTS

- AdventHealth Orlando Pharmacy was the central hub for vaccine storage and administration during early vaccination efforts involving use of both the Pfizer-BioNTech and Moderna COVID-19 vaccines.
- The vaccination initiative hinged on success in 4 key areas: vaccine quality control, secure inventory movement, safe preparation and administration, and consolidation of inventory.
- Early vaccination efforts, driven by pharmacy residents, laid out a foundation for successful mass vaccinations of central Florida healthcare employees and community members.

necessary to gather information about vaccine trial design, mechanism of action, storage, handling, and reconstitution. We collated this material into a workflow presentation and presented it to pharmacy operational leaders and all pharmacy staff members at the 2 identified AdventHealth hospitals. Presentations included handling precautions, vaccine preparation and manipulation, storage requirements, and methods of retrieving and tracking inventory.

Even with the latest information, vaccine stability still presented a great challenge within the operational design. The Pfizer-BioNTech COVID-19 vaccine is unique in that temperatures of approximately -80°C are required to maintain long-term stability.² The vaccine arrived in a container capable of holding dry ice, which necessitated adequate training of and handling by staff members. To minimize the number of personnel handling dry ice, we created one centralized hub near AdventHealth Orlando staff by a select team trained

on how to safely move the vaccine from the dry ice to the ultra-cold freezer. In the centralized facility, the vaccine was moved to an area with high ventilation, dry ice storage, and thermal gloves. Due to the handling concerns posed by ultra-cold temperatures, any vaccine movement away from the centralized facility occurred at refrigerated temperatures, thus requiring a beyond-use date (BUD) of 5 days. With the collaboration of supply chain leaders, coolers and ice packs were collected at the storage facility to be sent with the vaccine to the clinic sites (Figure 2). Vaccine that was reconstituted and drawn up into a syringe received a BUD of 1 hour per *United States Pharmacopeia* chapter 797 standards¹; see Table 2. Communication was essential to ensure adequate tracking of inventory movement both internally and externally to surrounding hospitals. Receiving the vaccine from the manufacturer and transferring it between hospital sites also required the creation of numerous destination sites within the inventory management system as well as continual assessments of urgent system builds, changes, and updates. Using a commercial inventory management system customized by our informatics resident, we were able to set up a remote location that housed vaccine inventory (measured in numbers of vials) and worked with executive administration to determine the best operational processes that would ensure accurate transactions between sites. Prior to the first day of vaccination clinic operations, which was scheduled for 4 days after the approval of the Pfizer-BioNTech COVID-19 vaccine EUA, a 1-day trial was executed at the campuses to practice the planned workflows with the frontline workers. The onsite trials revealed challenges not even the most detailed planning could anticipate. For example, our initial plan assigned nurses to reconstitute and draw unit doses from vaccine vials, given the high production of vaccinations planned (eg, 1,000-1,500 doses per clinic day running from 7:00 AM to 5:00 PM). Although this workflow

Figure 1. Vaccine flow outline. BUD indicates beyond-use date. “Pfizer-BioNTech” and “Moderna” refer to the companies’ respective COVID-19 vaccine products.

was carefully orchestrated by nursing and pharmacy leaders, during the first scheduled trial run nurses were concerned with the potential reconstitution errors that might occur. Therefore, the process was rapidly changed so that pharmacy personnel had control over vaccine preparation. Education sheets initially formatted for nursing staff were adjusted to fit the needs of the pharmacy preparation station as illustrated in Figure 3. Educational information was formatted into a single page with detailed instructions and images on how to dilute the vaccine, pull up unit dose syringes, and store and date the product in the vaccine clinic. This change in pharmacy role required our quick communication with pharmacy

operational leaders at Celebration Hospital and Orlando Hospital to recruit staff members to work the vaccine stations in this capacity.

Within the clinic, there were 4 principal areas to which personnel were assigned: registration, vaccination station, vaccine preparation station, and patient observation. Nurses were assigned at the entryway to verify online registration and go through the vaccination fact sheet with patients. From there patients were guided to the vaccination station. At the vaccination station a nurse went over vaccine adverse effects, verified patient information, and administered the vaccine. In the beginning of each vaccination day, all nurses were given a card with

the lot, manufacturer, and expiration of the vaccine selected for the clinic. To simplify fulfillment of clinic needs, only 1 lot of vaccine was utilized during a clinic day. The vaccine information was filled within the patient portal created for documentation. The pharmacy team reconstituted vaccine vials and drew unit doses into syringes. The doses prepared from a single vial were placed within a bin that was labeled with the “best used by” date. The vaccine was kept in coolers surrounded by ice packs to maintain a refrigerated environment. A PGY2 resident pharmacist-in-charge (PIC) supervised the pharmacy staff and monitored the vaccination stations for vaccine supply and refill needs. After patients were vaccinated, they

Figure 2. Community vaccination tent setup (large scale).

went to the observation room, where nursing staff observed them for any potential adverse reactions.

Coordination with the multidisciplinary team required consistent communication to minimize vaccine waste. Clinic days were scheduled using an internal scheduling portal for employees that provided estimated supply demand throughout the day. By the end of a clinic day, beginning 1 hour before closing, a vial was open only if we had the number of patients required to administer its full contents. In the event of available extra doses, a verbal notification of vaccine availability on a first-come, first-served basis was sent to clinical areas with qualifying personnel who met the CDC Class 1a criteria.

As the clinics began, it was essential to redesign the workflow to match vaccine information that evolved daily. Initially, the Pfizer-BioNTech COVID-19 vaccine was approved for administration of only 5 doses per vial. Eventually, CDC and FDA cleared vaccination sites to draw every obtainable full dose from a vaccine vial, but this led to unanticipated supply issues. The state supply allocation was created to accommodate preparation of exactly 5 doses from each vial.² With the approval

of a potential sixth dose per vial, more needles, syringes, and vaccination cards were required. Pharmacy leaders creatively developed methods to navigate the shortage by obtaining the template for the vaccination cards so that more could be printed. We also worked with the supply chain management leaders to share needle supply from other care areas and set orders to prevent future shortages. Additionally, the Pfizer-BioNTech COVID-19 vaccine requires reconstitution with 0.9% sodium chloride injection; that not only required more specific staff training but also required that we navigate a shortage of 2-mL vials of 0.9% sodium chloride injection that had been provided by the government (the shortage was largely due to handling errors) by sequestering 10-mL vials from the local pharmacy inventory to reconstitute the vaccines and educating staff to not use a single vial of 0.9% sodium chloride for multiple vaccine vials.

Another challenge faced by the pharmacy leadership team was vaccine inventory tracking. A Web-based remote order form was created and provided to designated internal sites to facilitate access to the designated vaccine storage location without compromising

security. Specific workflow processes were outlined for the operations and vaccination teams to ensure minimal data scrubbing prior to reporting out transactions and/or inventory. In collaboration with the clinical analytics team, we built a system to track the vaccine inventory, movement, and distribution for all internal sites within the AdventHealth Central Florida Division in addition to external (non-Central Florida Division) sites. The overarching goal was to have an automated process that allowed for real-time data updates to help supplement multistate dashboards built within Power BI (Microsoft Corporation, Redmond, WA) displaying vaccine information for executive teams.

Positive highlights. There were various complications each clinic day, but our team successfully adapted the workflow and had zero vaccine waste thanks to consistent communication across all levels of the pharmacy leadership. Multistate leaders coordinated daily afternoon meetings to discuss limitations across the country, while local leaders discussed in detail challenges of clinic operations. Safety huddles were coordinated at the start of each clinic day to facilitate discussion of

Figure 3. Employee vaccination station layout. PIC indicates pharmacist-in-charge.

the latest changes and concerns of the staff members. The division pharmacy leadership team passed information from these meetings to the local leaders at the selected AdventHealth hospital sites to maintain the loops of communication. The team also provided onsite support during external vaccination clinics and community vaccination clinics. Real-time vaccine quantities on hand after vaccination events were frequently communicated to executive leaders for future planning, and transactional reports of vaccine distribution were conveyed to enable audits. The expectation of effective communication established from the start of the clinics helped in developing a solid foundation for an expanded scope of

vaccination efforts after approval of the Moderna COVID-19 vaccine.

Community vaccinations

After successful execution of the employee vaccination pods and the arrival of the Moderna COVID-19 vaccine, we shifted our vaccination services to the community, administering vaccinations in the Orlando International Airport parking lot. Leaders followed the State of Florida recommendations to target people at least 65 years of age and healthcare employees outside of hospital settings.

Prior to the start of community clinics, centralization of supplies of Moderna COVID-19 vaccine from all regional AdventHealth hospitals to

the AdventHealth Orlando site was required. The centralization of vaccine supplies allowed for streamlined inventory management. On a given day, any remaining vaccines from what was originally brought to the airport event were returned to AdventHealth Orlando. Once all supplies of Moderna COVID-19 vaccines were received, we were able to use the inventory to schedule roughly 1,500 appointments per clinic day over a week.

AdventHealth utilized Web links to issue appointment slots to community members' emails for easy sign-up. This was communicated on the direct AdventHealth website. Additionally, AdventHealth partnered with local media outlets and hotlines (eg, HQ

Virus hotline) to disperse alerts for appointment sign-up. Internally, appointments were managed by AdventHealth informational technology (IT) staff via Salesforce software (Salesforce.com, Inc., San Francisco, CA). As pharmacy resident leaders, we managed the pharmacy service within the entire clinic and provided cosupport to multidisciplinary leaders.

The clinic was set up in a “field medicine” fashion, with 3 main tents (Figure 2). The center tent was the administrative tent, which housed computers for charting purposes, IT personnel on standby, and a privacy bay with 3 hospital beds to support faint/fall-risk patients. The 2 tents

on the side of the center tent housed vaccination processes and mirroring monitoring areas where vaccinated patients were observed for 15 to 30 minutes by nurses with epinephrine kits (provided by the pharmacy department), with a physician readily available. Thankfully, there were no major adverse events.

For emergencies, there was an open path leading from the opening of the general parking lot area up to the front of the 3 tents to allow emergency medical services or fire department personnel to have easy access to the area. The pharmacy team had a section at the back of each vaccine tent dedicated to vaccine storage, preparation,

and dispensing. There was at least 1 pharmacy operational leader on-site to handle any higher-level troubleshooting. There was a PIC who was dedicated to managing vaccine supply. There was a minimum of 2 people drawing up doses from vaccine vials according to the estimated need/volume for the day. Lastly, there were at least 2 or 3 additional “flex” individuals who served in triage positions to get vaccine doses from the pharmacy station to nurses. These same individuals also helped assemble syringes and needles as needed; the full supply list is outlined in Table 1. It is important to note that this core pharmacy operational team was different from the cadre of

Table 1. Supplies Used in Vaccination Initiative

Category	Item	Amount
Vaccine station	Deep divider bins	4-5
	Hand sanitizer	3-4 bottles
	Compounding mats	4-5
	70% isopropyl alcohol spray bottles	2
	Sharps container	1
	Tape	1 roll
	Scissors	2
	Gloves (various sizes)	1 box of each
	Blank labels	1 roll
	Gauze	3 packs
	Marker/pen	2
Vaccine supplies	Syringes (1-3 mL) ^a	
	Needles (23 and 25 gauge) ^a	
	Red bin (for prepped vaccine)	1
	Small delivery bins	10-20
	Alcohol pads ^a	
	Sterile water for injection (for use with Pfizer-BioNTech vaccine only) ^a	
	CDC vaccination cards ^a	
Safety measures	Vaccine storage unit (cooler/fridge) ^a	
	Anaphylaxis kit (1-mL epinephrine vial, 1-mL syringe, 23-gauge x 1-inch needle, 20-gauge blunt needle, weight-based dosing card)	At least 1
	Lot and expiration labels ^a	
	Inventory decrement template	1 shared Excel package

Abbreviation: CDC, Centers for Disease Control and Prevention. Excel is a registered trademark of Microsoft Corporation, Redmond, WA.

^aAmount varied with vaccines administered.

Table 2. “Best Used By” Dating Per Manufacturer and Setting

Setting	Pfizer-BioNTech COVID-19 Vaccine	Moderna COVID-19 Vaccine
Cooler/fridge	5 days	30 days
Room temperature (nonpunctured vial)	6 hours	12 hours
Punctured vial	6 hours	6 hours
Immediate-use unit dose syringe	1 hour	1 hour

additional pharmacists who served as vaccinators alongside nurses during the clinic events.

Roadblocks and interventions.

Serving the community brought along its own set of challenges. Although all vaccine supplies had been centralized to AdventHealth Orlando, the need for a secondary resource hub located outside of the AdventHealth system created difficulties with obtaining facility resources and other supply items on short notice. The only AdventHealth facility that was within decent proximity was only 20 to 25 minutes away from the airport and served as a secondary resource hub. The pharmacy team at this site supported the community clinic with additional supplies for vaccine preparation and generated labels listing the manufacturer, lot, and expiration to adhere to vaccination cards.

A major challenge with the Moderna COVID-19 vaccine versus the Pfizer-BioNTech COVID-19 vaccine was that the Moderna vaccine vials did not list expiration dates; this required visiting the Moderna vaccine manufacturer's website, typing in the lot number, and manually noting the expiration date that would go on the labels. Moreover, Moderna vials had multiple distinct types of lot numbers to keep track of, as opposed to Pfizer-BioNTech vials, whose lot numbers were mostly consistent, with only a small handful of differing lots. This required an added level of attention to detail to ensure that the correct labeling information was recorded per vaccine administered.

The workflow of the community clinic presented another challenge.

Due to variability in crowd management at the registration tent, one vaccination tent received higher traffic than the other. The unbalanced patient movement between the tents caused pharmacy staff to have to upscale dose production in one tent versus the other. To balance the workflow between the vaccination tents, we coordinated with operational executive leaders to stratify attendees by last name. Redesigning the workflow allowed pharmacy personnel to maintain a predictable balance of inventory and anticipate needs per tent prior to depletion.

Along with vaccines, the pharmacy department also supplied 6 anaphylaxis kits to the observation nurses for use in case of an anaphylactic event. The anaphylaxis kits were to be collected by a pharmacy representative, but with the constant movement within the clinic it was difficult to determine where the kits were located at the end of the day. To maintain accountability for the kits, we created a sign-out process to track dispenses and returns of said kits. Another challenge for our PIC in keeping track of vials used, doses sent out, and vials left, was keeping dose counts as accurate as possible. This became true especially for the Moderna COVID-19 vaccine vials, from which we were able to draw 11 doses instead of the originally approved 10 doses. At the time of this community vaccination event, FDA had approved administration of 11 doses per Moderna COVID-19 vaccine vial; however, depending on factors like technique used to draw up the dose and the needle and syringe used, the ability to obtain an 11th dose was variable.³ Nonetheless, we kept separate trackers for all 11 doses

achieved per vial and added it to the tally of total doses produced for the day to have an accurate final count.

Another inventory challenge was the dwindling supply of syringes and needles as the volume of appointments increased during the weeklong event. To address a potential shortage of supplies, we first determined the complete inventory of remaining needles and syringes. We then compared the inventory values with the number of appointments for the remainder of the vaccination event. To fill the anticipated gap in supplies, we coordinated with materials management leaders to order more supplies based on our calculations. Our ability to proactively assess utilization of supplies allowed for the inventory needed to be sent prior to the end of clinic operations, thereby circumventing shortages.

Following the successful execution of the community Moderna COVID-19 vaccine event, AdventHealth was asked to partner with the Orange County Department of Health to host a community Pfizer-BioNTech COVID-19 vaccine community event. Logistically, while the handling of the Pfizer-BioNTech COVID-19 vaccine remained the same, at the community level the target was to serve an exponentially larger clinic volume (over 3,500 individuals) per day. To meet the demand, we recruited additional pharmacists and pharmacy technicians with prior intravenous room training to ensure steady production at the event. Due to the limited availability of personnel to deliver vaccinations, an unpredictable flux of walk-in appointments, and the vaccine's short BUD once thawed, a strategy was required to maintain a

stable inventory on-site. Thus, the total vial inventory needed was calculated according to the number of appointments scheduled, with the addition of an extra 10% as a buffer. Of the total inventory required, we kept 75% of the vials at a refrigerated temperature for first use and stored the remaining vials on dry ice in containers on-site. This innovative practice resulted in zero waste.

Positive highlights. Using a consistent pharmacy team throughout the week, we were able to establish an ease of workflow and troubleshoot problems that arose quickly. No single vaccination event involved simultaneous utilization of both Pfizer-BioNTech and Moderna COVID-19 vaccines; this added to our ability to maintain patient safety and best practices. Our pharmacy team valued new and innovative ideas, which exponentially improved the process and streamlined the production of the vaccine doses. Such ideas included improvements to our inventory tracking sheet and dose documentation sheet—both of which made final counts more readily available for physician leads. At the end of day 2 of the community Moderna COVID-19 vaccine event, some of the physician and operations leads wanted to increase the number of daily appointment slots by 300 to 500 in accordance with our remaining supply of vaccine. From our perspective, so long as we had the supply of vaccines and labor we could accommodate added patient volume at the 2 tents without getting overwhelmed. By the last day of the weeklong event, we had executed over 7,600 vaccinations with zero waste. We believe this success resulted in a significant improvement in pharmacy and physician relationships. Undoubtedly, physicians saw what we as a profession could do in the face of a pandemic, and we believe their respect, esteem, and regard for us as equal practitioners grew.

Final takeaways

Our facilitation of the clinics resulted in over 50,000 vaccine doses being administered in central Florida.

Although many teachings occurred in these clinics, there are a few final takeaways worth mentioning:

1. Never assume your team members know the details you know. During the employee and community clinics, each of our team members received pieces of information through interactions with event leaders. Such details included last-minute clinic walk-ins or cancellations and clinic hour changes. To ensure that our pharmacy team was all on the same page and had all necessary details, we established daily check-ins for each member to share information learned and determine necessary workflow adjustments.
2. Never be afraid to ask for help. Vaccinating employees of a large health system and over 7,600 community members requires substantial interdisciplinary partnership. Although we were the subject matter experts for drug information, we required the help of our courier services to ensure safe and reliable transportation between sites and asked our nursing counterparts to assist with some elements of daily operations.
3. Review all proposed ideas and strategies aloud and with other people to catch any potential downstream glitches. While all thoughts, ideas, and perspectives are welcomed, it is important to make sure that those ideas are implementable by the frontline staff who will be directly impacted. Confer with your local leaders to verify that the suggested workflow is safe and feasible given the available team resources.
4. Encourage team members to keep up-to-date with the literature. When integrating a new pharmaceutical product into a health system's services, it is important to remain abreast of current updates in FDA approvals, EUA criteria (if applicable), pertinent CDC stipulations, and announcements from other governing bodies. Staff should be ready and willing to adjust the workflow to suit current recommendations.
5. Assess your workflow for its ability to maintain just culture. We established safety huddles prior to vaccination

events to discuss any concerns of our employees. "Close calls" and lapses were discussed openly to encourage a system of ongoing modification. These steps promoted a culture of safety and allowed standardization of redundancies to prevent employee and patient harm.

Conclusion

In a mass COVID-19 vaccination initiative directed by the pharmacy enterprise leadership of a large Florida health system, PGY2 pharmacy residents played a key role in developing and implementing vaccination clinics targeting healthcare worker and community populations. During multiple vaccination events, more than 50,000 COVID-19 vaccine doses were administered, with minimal to no vaccine wastage.

Disclosures

The authors have declared no potential conflicts of interest.

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