

## ARTICLE

# The Evolution of a Hospital-Based Covid-19 Vaccination Program for Inpatients

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The Priscilla Chan and Mark Zuckerberg San Francisco General Hospital and Trauma Center was the first hospital in San Francisco and one of the first in California to successfully operationalize the administration of Covid-19 vaccines to hospitalized patients. Between February and July of 2021, inpatient clinicians administered 526 Covid-19 vaccines with zero wasted doses. More than 80% of enrolled patients were fully vaccinated by the Inpatient Vaccine Program (IP Program) while admitted or after discharge. The IP Program identified and mitigated 12 workflow considerations to ensure a sustainable system. The infrastructure remains flexible enough to adapt to evolving vaccination eligibility, including supplemental and booster dose indications. Covid-19 vaccination in an academic, safety-net hospital provides an opportunity to mitigate vaccination disparities and access vulnerable, unvaccinated populations.

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Establishing substantial immunity can protect against Covid-19 surges within unimmunized populations.<sup>1,2</sup> While toolkits from the Centers for Disease Control and Prevention (CDC) exist to guide community vaccination program implementation, limited guidance exists for the hospital setting.<sup>3</sup> Inpatient operational complexities are quite distinct from community barriers. Despite challenges, hospitalizations remain a prime opportunity to address vaccine misinformation and offer vaccination to patients at risk for severe Covid-19 illness.<sup>4</sup>

The rationale for inpatient vaccination efforts against other respiratory illnesses applies to inpatient Covid-19 vaccination programs.<sup>5,6</sup> Up to two-thirds of deaths attributable to pneumonia and influenza-like illness occur in the populations hospitalized during influenza season.<sup>5</sup>

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Additionally, inpatients who are unvaccinated against influenza prior to hospital discharge tend to remain unvaccinated.<sup>7</sup> With respect to Covid-19, safety-net patients are likely to have demographic, socioeconomic, and medical comorbidity risk factors for severe Covid-19.<sup>8,9</sup> Furthermore, due to the special handling and vaccination series requirements, Covid-19 vaccines pose a special inpatient operational challenge. Improving vaccine access and addressing misinformation can increase vaccination rates for the most vulnerable inpatients, making the effort to overcome operational barriers worth the investment.

## Program Development

In less than 2 weeks, a dedicated team developed an inpatient vaccination program using rapid small-scale Plan-Do-Study Act (PDSA) cycles and a multiphase implementation plan.

### *Planning Principles*

An interdisciplinary task force, including performance improvement (PI), pharmacy, infection control, nursing, and hospital medicine leaders, stayed abreast of evolving vaccination regulations and agreed on three guiding program principles. First, a single messenger ribonucleic acid (mRNA) vaccine dose is beneficial even in situations with second-dose uncertainty.<sup>1,10</sup> Second, the task force hypothesized that if a Covid-19 vaccine was offered and explained, patients would be inclined to accept vaccination while hospitalized. Third, the team agreed to launch a pilot study to optimize the workflows prior to expanding efforts more broadly.

The task force's goal was to increase vaccine access, including second-dose arrangements, without increasing length of stay (LOS) or interfering with medical treatment. System improvement tools used included PDSA cycles and the Toyota Lean Production and Management system tools (e.g., standard work, swim lanes, and unit huddles).

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“ *The IP Program administered a total of 526 vaccine doses to 486 patients with zero wasted doses over the study period from February 18, 2021, to July 14, 2021.*”

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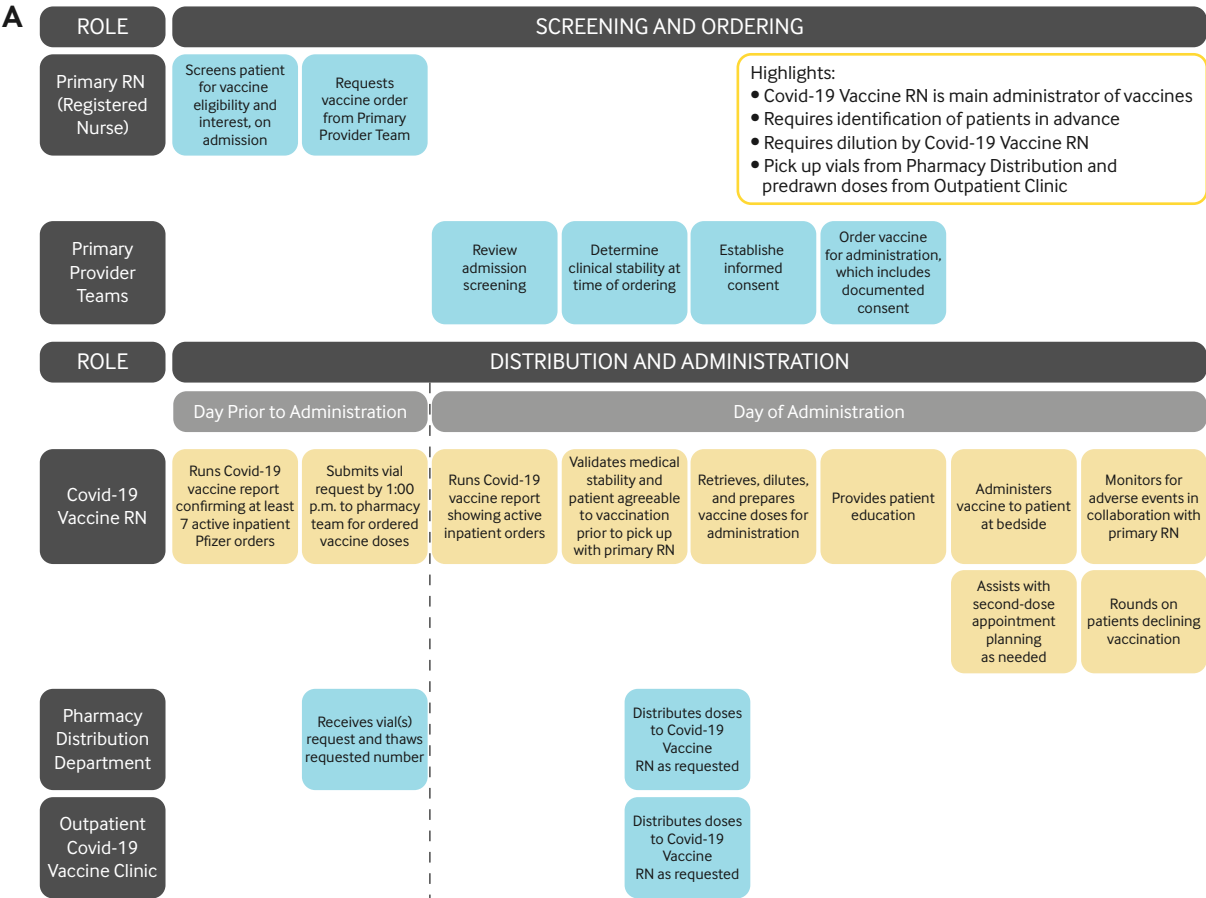
### *Implementation Phase 1: Unit-Based PDSA*

A designated 32-bed nursing unit performed rapid PDSA cycles to test screening and administration workflows, led by a certified nurse specialist, a unit-based medical doctor champion, and a designated vaccination registered nurse (RN). This phase defined staff roles using swim lane maps and standard work (Figure 1a). Over time, as we addressed hurdles, the program evolved through several viable workflow iterations in response to staffing and other operational changes (Figures 1b and 1c). An accompanying Appendix includes a detailed PDSA table ([Appendix Exhibit A](#)).

FIGURE 1A

# Inpatient Covid-19 Vaccination Program Model with Covid-19 Vaccination RN (February 2021–April 2021)

The Inpatient Vaccine Program’s (IP Program) first iteration required staffing a Covid-19 vaccine registered nurse (RN) to identify eligible patients 1 day prior to administration. The Covid-19 vaccine RN completed screening, dose preparation and administration, and monitoring for reaction management. The primary provider secured consent, confirmed medical stability, and ordered the vaccine.



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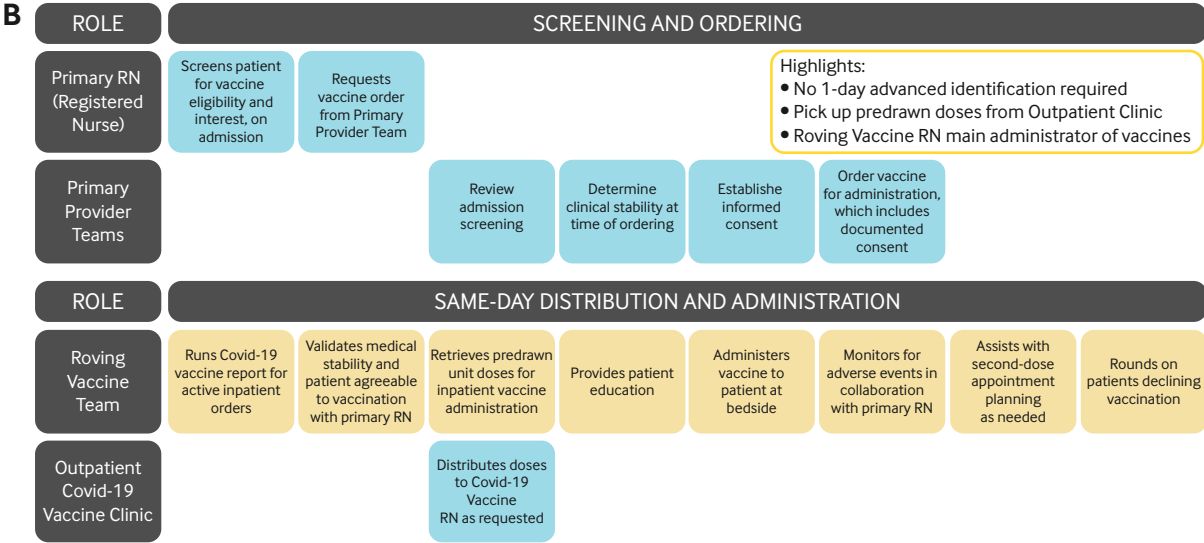
## Implementation Phase 2: Department-wide Spread

After addressing initial barriers, the task force expanded the program to the 184-bed medical-surgical department in March 2021. Program success depended on multimodal educational campaigning (Figure 2).

FIGURE 1B

# Inpatient Covid-19 Vaccination Program Model with Dedicated Roving Vaccination Team (May 2021–September 2021)

The Inpatient Vaccine Program’s (IP Program) second iteration utilized a nurse-based roving vaccination service to administer same-day vaccinations and consult with patients refusing vaccination. Outpatient Covid-19 vaccine clinic (outpatient clinic) resources staffed the roving service and distributed on-demand vaccine doses to inpatients. A centralized nurse-based service allowed for just-in-time dissemination of education to provider teams and mistake-proofing of the workflow. RN = registered nurse.



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## Implementation Phase 3: Hospital-wide Spread

In April 2021, the IP Program expanded to the intensive care, pediatric, labor and delivery, and postpartum units. Leaders replicated similar strategies to disseminate workflows throughout these respective units ([Appendix Exhibit B](#)).

### Hurdles

Twelve IP Program barriers were identified and mitigated (Table 1).

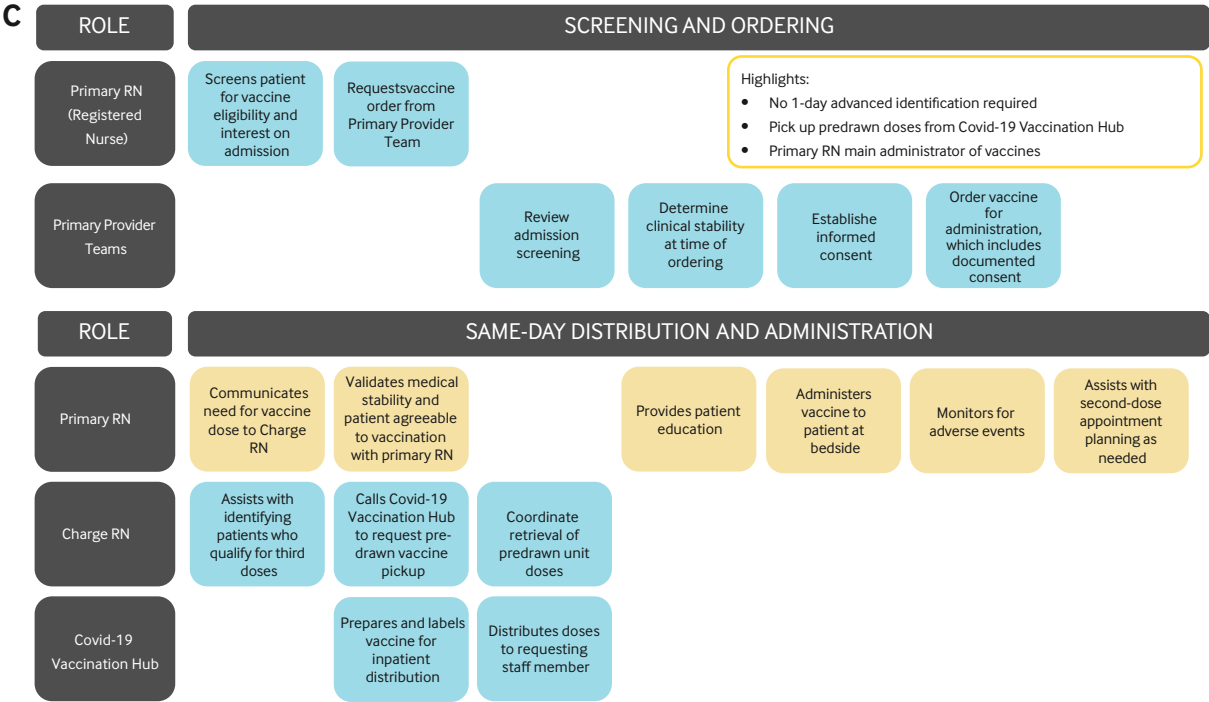
#### Hurdle 1: Clinical Considerations — Eligibility and Timing of Administration

IP Program patient eligibility considerations included the following: verifying vaccination status, confirming no contraindications or allergies toward vaccine products, deeming the patient medically stable by the inpatient provider, and determining that the patient is eligible under existing public

FIGURE 1C

# Inpatient Covid-19 Vaccination Program Model: Decentralization Plan (October 2021–Present, as of December 2021)

The Inpatient Vaccine Program’s (IP Program) third iteration decentralized screening, vaccine administration, and patient monitoring responsibilities from the dedicated nurse-based roving team to the patient’s primary bedside registered nurse (RN). A Covid-19 vaccination hub distributed predrawn syringes to allow for efficient same-day distribution and administration.



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health orders. Stable chronic conditions were not a contraindication to vaccination. To mistake-proof the workflow, guidance was built into the electronic health record (EHR) vaccine order, and nursing staff reconfirmed medical stability with the primary team immediately prior to administration.

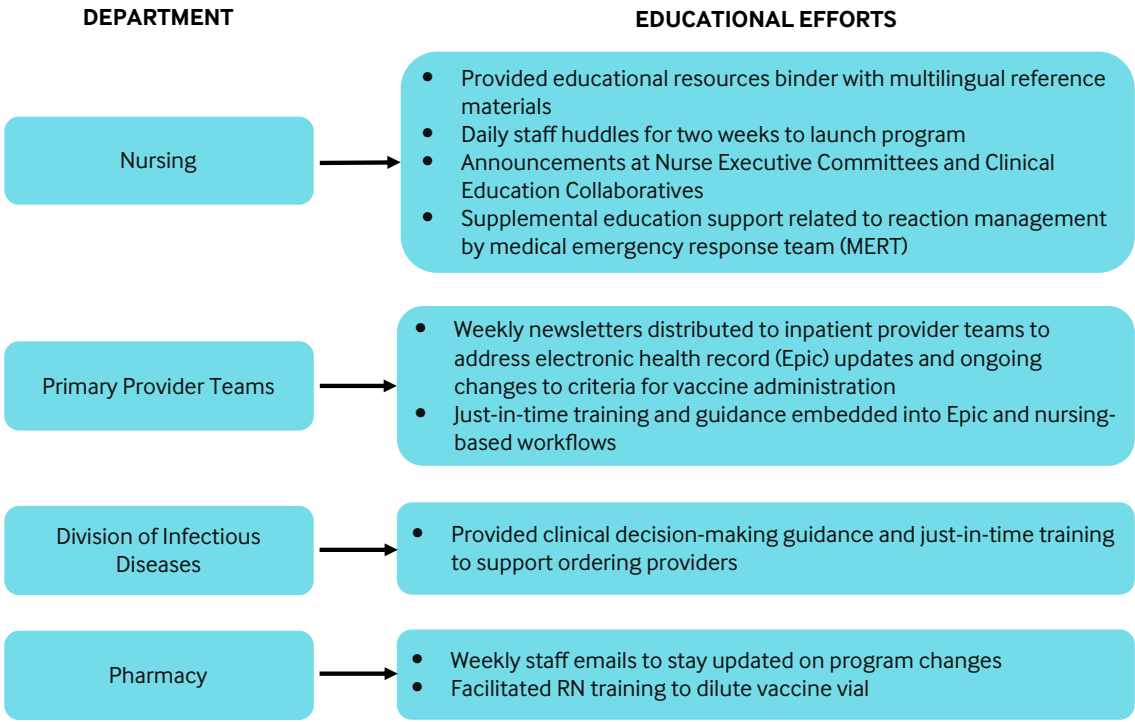
## *Hurdle 2: Pharmaceutical Considerations – Unstable Inventory, Lack of Unit Dose Distribution, Thawing, and Zero-Waste Requirement*

The IP Program aspired to offer all vaccine brands to inpatients to accommodate patient preferences. A 1-month vaccine supply of any approved vaccine brand was a prerequisite for program launch. The Priscilla Chan and Mark Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG) secured an adequate supply of BNT162b2 vaccine (Pfizer–BioNTech) and a limited supply of mRNA-1273 vaccine (Moderna) by February 2021. Note that the Ad26.COV2.S vaccine (Janssen–Johnson &

FIGURE 2

## Educational Efforts to Expand the Covid-19 Vaccination Program

Various modalities were utilized to share workflow updates with stakeholders, including department leaders and frontline staff. RN = registered nurse.



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Johnson) supply was allocated to inpatients in May 2021. To conserve mRNA-1273 vaccine doses and optimize dose sharing with the ZSFG Outpatient Clinic, the EHR restricted mRNA-1273 vaccines to second-dose, once-weekly administrations until an adequate supply was secured.

“ *The zero-waste mandate presented challenges because approximately 15% of patients initially consenting either changed their decision or experienced a change in medical condition disqualifying them from vaccination.* ”

Due to inherent workflows, the pharmacy dispensed entire BNT162b2 vaccine vials, while the outpatient clinic dispensed predrawn unit doses to inpatients. To support the dual workflows, pharmacy staff trained medical-surgical nurse champions in preparation techniques for BNT162b2 vaccine vials. In terms of convenience, unit dose dispensing was certainly the more favorable workflow.

**Table 1. Covid-19 Inpatient Vaccination Program Operational Barriers and Countermeasures**

Category	Barrier	Countermeasures
Pharmaceutical considerations	Zero waste required	<ul style="list-style-type: none"> <li>Identify seven or more patients prior to requesting a BNT162b2 vaccine (Pfizer–BioNTech) vial</li> <li>Partner with the outpatient clinic for unused dose sharing</li> </ul>
	Unstable inpatient vaccine inventory	<ul style="list-style-type: none"> <li>Restrict ordering to only first doses of BNT162b2 vaccine</li> <li>Restrict ordering mRNA-1273 vaccine (Moderna) doses to select provider champions</li> <li>Limit mRNA-1273 vaccine administration to Tuesdays in partnership with the outpatient clinic</li> <li>Proactively assess inventory shortages</li> </ul>
	Safe vaccine storage: thawing required	<ul style="list-style-type: none"> <li>Request vials by 1:00 p.m. for next-day administration</li> </ul>
	Unit doses unavailable for distribution	<ul style="list-style-type: none"> <li>Train medical-surgical RNs in dose preparation</li> <li>Utilize vaccine logs to track doses administered per vial</li> <li>Outpatient clinic to distribute predrawn doses to inpatients</li> </ul>
Clinical considerations	Undefined eligibility criteria and timing of administration	<ul style="list-style-type: none"> <li>All admitted patients' eligibility determined according to health orders by screening and medical stability</li> <li>Division of Infectious Diseases to define order guidance and add language to the EHR order set</li> <li>RN to validate medical stability prior to administration</li> <li>Order scheduled vaccine without set administration time in MAR to accommodate for flexibility in patient condition, preference, and dose availability</li> </ul>
Workflow considerations	Duplicate work: screening, monitoring, and order tracking	<ul style="list-style-type: none"> <li>Standard work defined for all roles and iterations of vaccine program models</li> <li>Responsibility of consent owned by ordering provider, with documentation of it being obtained required within vaccine order set and then displayed on the MAR</li> <li>Electronic report to show a list of patients with active vaccine orders</li> </ul>
	Nonstandard reaction management workflows across campus	<ul style="list-style-type: none"> <li>Add reaction management panel to the electronic order</li> <li>Ensure emergent medications, such as epinephrine, are readily available in the unit's medication dispensing system</li> <li>Partner with the Medical Emergency Response Team or institution's rapid response team to support reaction management</li> </ul>
	Staff training	<ul style="list-style-type: none"> <li>Use a multimodal education approach: staff huddles, Covid-19 resource binder, and emails</li> </ul>
	Staffing	<ul style="list-style-type: none"> <li>Utilize support staff (e.g., performance improvement, educators, and certified nurse specialists) to cover shifts</li> <li>Leverage underutilized staff resources from other care areas</li> </ul>
Supply considerations	Limited inpatient inventory of administration materials	<ul style="list-style-type: none"> <li>Outpatient clinic to provide weekly supplies of materials (syringes, needles, and vaccination cards)</li> <li>Nurse educators to create and maintain multilingual patient education materials</li> </ul>
Patient experience considerations	Vaccine hesitancy	<ul style="list-style-type: none"> <li>Educate staff to humbly address vaccination questions (e.g., "truth sandwich" technique<sup>11</sup>) according to CDC best practices and talking points<sup>12</sup></li> <li>Provide multilingual patient education materials addressing vaccine facts and community resources</li> <li>Offer all vaccine brands to honor preferences, supply permitting</li> <li>Engage with the Covid-19 equity subcommittee for idea generation</li> <li>Partner with the spiritual care team to address vaccination mistruths</li> </ul>
	Second-dose planning	<ul style="list-style-type: none"> <li>Providers to enter second-dose referrals with an appointment reminder</li> <li>Partner with receiving facilities to facilitate second-dose follow-up</li> </ul>

RN = registered nurse, EHR = electronic health record, MAR = medication administration record, CDC = Centers for Disease Control and Prevention. Source: The authors.

The zero-waste mandate presented challenges because approximately 15% of patients initially consenting either changed their decision or experienced a change in medical condition disqualifying them from vaccination. Countermeasures against this drop-off evolved with IP Program iterations. Initially, the Covid-19 vaccine RN identified more patients (n = 7) than doses available per BNT162b2 vaccine vial (n = 6), and vials were requested prior to 1:00 p.m. the day before administration for thawing. Later, program advancements allowed for same-day administration with dose distribution from the outpatient clinic. Infrequently, the outpatient clinic absorbed extra inpatient doses. Once ordered, the vaccine remained on the hospital medication administration record (MAR), but without a set administration time, to permit for flexibility based on clinical presentation, patient preference, and dose availability.

*Hurdle 3: Patient Experience Considerations — Vaccine Hesitancy and Second-Dose Follow-up*

Debunking Covid-19 vaccine misinformation represented a significant barrier. By mid-June 2021, approximately 90% of unvaccinated patients refused vaccination (Figure 3).

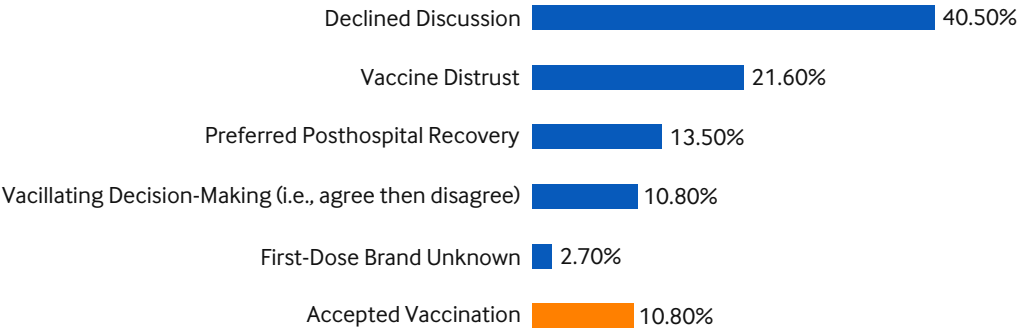
Patients expressed distrust in vaccination due to at least one of the following mistruths: (1) experts failed to sufficiently study the Covid-19 vaccines; (2) Covid-19 vaccinations do not work; (3) vaccination inserts tracking chips; or (4) if hospitalized with Covid-19, vaccination is believed to be unnecessary.

To address misperceptions early, Covid-19 vaccine screening occurred during the admission process. All clinical team members, ranging from spiritual care services to nursing leadership, were encouraged to engage in humble conversations with unvaccinated inpatients.<sup>13</sup> When

FIGURE 3

**Stratification of Reasons for Vaccine Declination by Eligible Patients**

Discussions with patients (n = 37) declining Covid-19 vaccination revealed that 40.5% of patients refused to engage in a dialogue around vaccination, precluding exact determination of refusal. Nearly a quarter of unvaccinated patients expressed vaccine distrust, while 10.8% declined vaccination after initially agreeing, despite health care teams engaging in informative discussions.



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possible, the Covid-19 vaccine RN rounded on patients declining vaccination with a conversion success rate of approximately 10%. Engaging in meaningful dialogue averaged 20–30 minutes, with the greatest success among patients expressing a willingness to learn, along with family member support and engagement. By May 2021, ZSFG offered all vaccine brands to be able to honor patient preferences, removing this as a barrier to successful vaccination.

ZSFG guaranteed series completion for all patients, regardless of insurance, if they were able to return to a clinic. Clinicians placed second-dose order referrals and provided patients educational materials with the follow-up date and location details. When patients were discharged out of network, providers coordinated follow-up directly with out-of-network receiving facilities.

#### *Hurdle 4: Workflow Considerations — Duplicate Work, Undefined Roles, and Staffing*

Observations early after project launch noted duplicate efforts in vaccine screening, obtaining consent, and patient monitoring. To minimize overprocessing, the MAR displayed patient consent documented by the provider. PI staff set up a report to see all active Covid-19 inpatient vaccine orders and secured a vaccination phone line to streamline communications. Standard work was defined at the end of phase 1 and refined with program spread to explicitly lay out the roles of each team member (Figures 1a, 1b, and 1c).

Nurse staffing shortages have plagued hospitals nationally throughout the pandemic, and ZSFG is no exception. The IP Program prescheduled a Covid-19 RN on only 65% of available shifts. PI and nurse educators reprioritized existing responsibilities to fill uncovered shifts. Limited bandwidth existed for exhausted frontline staff to learn new standard work. By April 2021, medical-surgical department screening and order placement compliance was only 70% and 75%, respectively. As the outpatient demand for vaccines decreased, staffing resources shifted to create a dedicated inpatient nurse-based roving vaccination service (Figure 1b). This service provided a centralized “owner” and “mistake proofer” of the IP Program to ensure 100% screening and vaccination compliance. State Covid-19 funds temporarily financed this role. As funding priorities shifted, the decentralized workflow was implemented (Figure 1c), removing the need to staff this extra role.

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#### *Hurdle 5: Supply Considerations — Vaccination Cards, Syringes, and Patient Education Handouts*

The outpatient clinic allocated weekly supplies of vaccine administration materials, such as syringes and vaccination cards, for the IP Program. Nurse educators ensured Emergency Use Authorization information materials were available on each unit.

## Metrics

To assess the value of the program, we considered both cost and efficacy metrics.

### *Doses Administered and Program Efficacy*

The IP Program administered a total of 526 vaccine doses to 486 patients with zero wasted doses over the study period from February 18, 2021, to July 14, 2021 (Figure 4a).

Of the 526 doses administered during the study period, 400 (76%) were the BNT162b2 vaccine, 89 (16.9%) were the Ad26.COV2.S vaccine, and 37 (7%) were the mRNA-1273 vaccine. Of the 437 mRNA vaccine doses administered, approximately 297 (68%) were first doses. Table 2 provides details of the patient vaccination cohort.

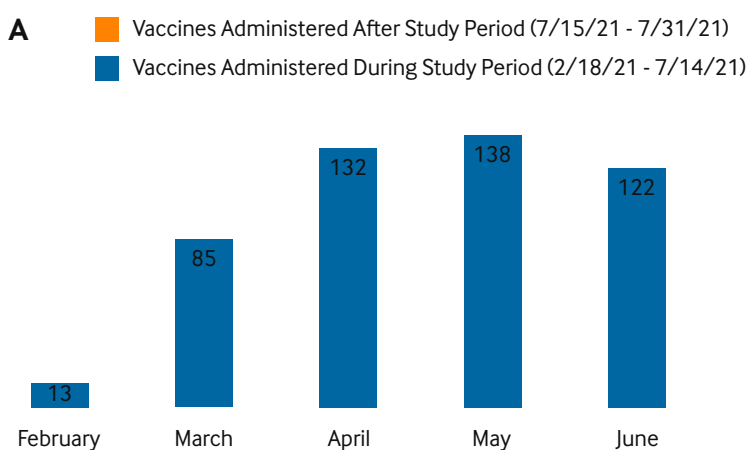
Notably, 395 patients (81%) vaccinated by the IP Program completed their vaccination series (Figure 4b).

At least 247 (47%) doses were administered to individuals living in zip codes with disproportionately low vaccination rates. An increased LOS due to postvaccination fever was

FIGURE 4A

### Inpatient Covid-19 Vaccines Administered by Month (February 18, 2021–July 14, 2021)

The Priscilla Chan and Mark Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG) began vaccinating hospitalized patients as part of health department efforts less than a month after regulatory authorization, per tiered eligibility criteria. Shortly after all adults were eligible for vaccination in April 2021, the number of hospitalized patients successfully vaccinated by the Inpatient Vaccine Program (IP Program) peaked. By July 2021, the number of hospitalized patients vaccinated decreased and plateaued as community vaccination rates climbed.



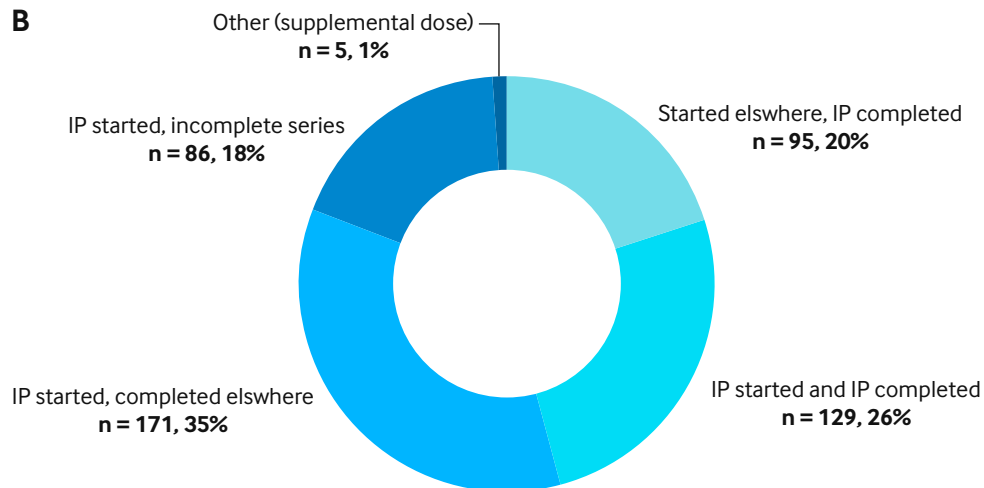
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FIGURE 4B

## Vaccine Series Completion Status for Patients Vaccinated as Part of the Inpatient Vaccine Program

A total of 395 patients successfully completed their vaccination series through the Inpatient Vaccine Program (IP Program), representing more than 80% of the total patients enrolled in the program. Of that group, 46% of enrolled patients completed their vaccination series while hospitalized, whereas 35% achieved completion after hospital discharge. Note: Fully vaccinated patients include individuals with two doses of a messenger ribonucleic acid (mRNA) vaccine (BNT162b2 [Pfizer–BioNTech] or mRNA-1273 [Moderna]) or one dose of the Ad26.COV2.S vaccine (Janssen–Johnson & Johnson) administered.



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observed in two patients. Total daily vaccine administrations ranged from 5 to 10, with a maximum of 17. Average cycle time per administration was approximately 1 hour from screening to the end of monitoring.

“*The IP Program resulted in a successful and flexible model, and vaccinations continue to be administered to our hospitalized patients. Program flexibility will be important for future responses to variants of concern as well as for changes to approved vaccine schedules.*”

The volume of vaccines administered peaked in May 2021 and trended downward as community vaccination rates increased, averaging about 6.7% of all patients discharged over the study period (Figure 4a). The majority of patients in the intensive care, pediatric, labor and delivery, and

**Table 2. Patient Vaccination Cohort**

Demographics	Vaccine cohort (n = 486 patients)	Hospital discharge population (n = 7,259 patients)
Age, yr		
16–18	5 (1.0)	72 (1.0)
19–64	338 (69.5)	4,987 (68.7)
65 or older	143 (29.4)	2,199 (30.3)
Legal sex		
Male	306 (62.9)	4,138 (57.0)
Female	180 (36.9)	3,114 (42.9)
Race and ethnicity		
Latino/Hispanic or Spanish origin	135 (27.6)	2,156 (29.7)
White	119 (25.4)	1,764 (24.3)
Black/African American	117 (24.1)	1,538 (21.2)
Asian	66 (13.6)	1,263 (17.4)
Native Hawaiian/other Pacific Islander	13 (2.7)	123 (1.7)
Other race and ethnicity	37 (7.6)	414 (5.7)
Primary English speakers	254 (52.2)	4,878 (67.2)
Length of stay, (LOS)	14.2	5.8
Homeless	111 (23.0)	N/A

Values are presented as No. of patients (%) unless otherwise indicated. Demographic data are based on the number of patients who received the vaccine as part of the inpatient program compared with the total number of hospital discharges from participating departments during the same time frame (February 2021 to mid-July 2021). Participating departments include the following units: medical-surgical, intensive care, pediatrics, labor and delivery, and postpartum. The vaccine cohort included patients with a longer length of stay, as this likely allowed patient to be identified, engaged in discussions, and enrolled for vaccination. N/A = not available. Source: The authors.

postpartum units did not qualify for vaccination based on medical instability and health department eligibility requirements. Administration of third doses to immunocompromised patients started near the end of the study period. The IP Program resulted in a successful and flexible model, and vaccinations continue to be administered to our hospitalized patients. Program flexibility will be important for future responses to variants of concern as well as for changes to approved vaccine schedules. Highlighting the importance of this flexibility, booster doses were strategically incorporated into the program in November 2021.

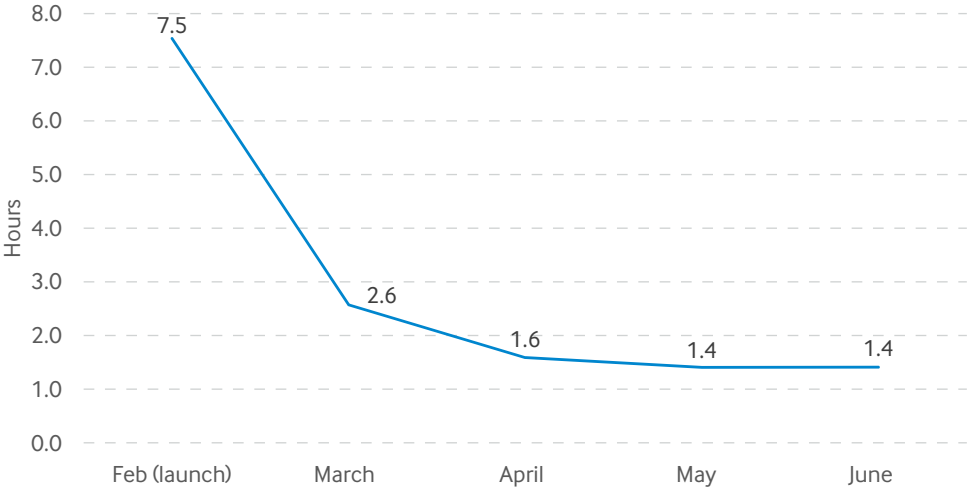
### *Cost: Effort Versus Impact*

Given that the federal government provided the Covid-19 vaccines and ancillary administration supplies at no charge, the program expenses were primarily a function of labor costs. The first 2 months of the program required initial investments in strategic planning, project management, and staff training. The labor required per administration decreased over time and will continue to improve as Covid-19 vaccines become part of routine patient care (Figure 5).

FIGURE 5

## Total IP Program Labor Hours Required per Covid-19 Vaccine Dose Administered over Time (February 2021–June 2021)

Launching the Inpatient Vaccine Program (IP Program) required vital commitments to project planning, mitigating hurdles, and staff training with an observed low volume of vaccinations administered to start. As a result, initial labor hours per vaccine dose administration averaged more than 7 hours. Over time, as vaccine administration increased with streamlined standard work and removal of overprocessing workflow steps, labor hours decreased to 1.4 hours per dose administered.



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The full benefit of vaccinating 486 underserved community members in the City of San Francisco is difficult to measure. According to the CDC, unvaccinated persons are 5 times more likely to be infected and 10 times more likely to be hospitalized and die from Covid-19.<sup>14</sup> San Francisco has observed similar numbers, suggesting large cost savings from preventable hospitalizations, morbidity, and mortality. The task force believes the value of the inpatient vaccination program (preventable admissions, limitation of community spread, mortality, etc.) was worth the investment on behalf of ZSFG.

### Next Steps

ZSFG intends to sustain a decentralized, adaptable Covid-19 inpatient vaccination program indefinitely (Figure 1c). Given the rapidly evolving eligibility criteria and vaccine science (including which patients benefit from additional doses), patient identification workflows currently lag. Leveraging features within the EHR remains a work in progress and a means to enhance workflow compliance.

ZSFG serves as a case study for how an academic, safety-net hospital can harness rapid PDSA cycles in combination with committed interdisciplinary leaders to provide a value-added service and address vaccine hesitancy in underserved communities during a pandemic. Given that safety-net settings disproportionately serve vulnerable communities with lower vaccination rates, hospital-based vaccination programs can help address health disparities.<sup>14</sup> A committed team can roll out a timely (within 2 weeks), safe (two patients with increased LOS), effective (526 vaccinations administered), and sustainable IP Program. Patients expressed gratitude for the ease of access to vaccines, especially those receiving a second dose for series completion. Clinical staff leveraging rapport and expertise engaged in meaningful dialogues with patients refusing vaccination, and, in this regard, hospitalization offers a unique means of dispelling false information. Inpatient staff, especially those on Covid-19 care units, expressed empowerment by contributing to the prevention of harm that they bear witness to daily. Hospitals and regulatory agencies should consider inpatient care areas as essential hubs for Covid-19 vaccination.

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# Appendix

[Exhibit A: Pilot Unit PDSA Document. Exhibit B: Inpatient Vaccination Program Timeline](#)

## Acknowledgments

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*Disclosures: Dana Freiser, Merjo Roca, Tony Chung, Tanvi Bhakta, Lisa G. Winston, and Gabriel M. Ortiz have nothing to disclose.*

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