Healthcare Economics of a Coronavirus Disease 2019 Pop-Up Vaccination Center

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Introduction: Creation of pop-up vaccination sites at trusted community locations has been encouraged to address vaccine hesitancy and provide equitable access to COVID-19 vaccination in minority communities. This study sought to study the healthcare economics of a community-based COVID-19 pop-up vaccination center in terms of the following: costs associated with operating the vaccination center, analysis of billing data from patients who received the Moderna COVID-19 vaccine, and costs of hospitalization for COVID-19 which may be avoided with widespread vaccination. Methods: The pop-up vaccination center was located in Port Jefferson Station, NY, USA. Costs associated with operation of the COVID-19 pop-up vaccination center were quantified, itemized, and tabulated. Current Procedural Technology codes were used to identify patients who received the Moderna COVID-19 vaccine. Billing data were quantified for the cohort as well as per each patient to receive the vaccine. Costs associated with provision of urgent care, emergency, and hospital services to patients with COVID-19 were obtained. Results: The total cost to operate the vaccination center was $25,880. The vaccination center administered the initial dose of the Moderna COVID-19 vaccine to $=251 patients between March and May, 2021. The standard hospital costs for patients admitted to the medical ICU due to COVID-19 ranged from $8,913 to $190,714, per patient. Conclusion: Since the Moderna COVID-19 vaccine series is effective in preventing hospitalization for 93% of patients, this community-based vaccination center’s administration of the vaccine series to 240 patients meant aversion of hospitalization due to COVID-19 related morbidity for 223 patients. Therefore, the true impact of this vaccination center, measured in averted hospital costs, ranges from $1,987,599 to $42,529,222.

INTRODUCTION

Three vaccines are currently approved by the United States Food and Drug Administration for prevention of coronavirus disease 2019 (COVID-19): Pfizer-BioNTech’s BNT162b2 (mRNA), Moderna (mRNA), and Johnson & Johnson/Janssen Pharmaceuticals’ JNJ-78436735 (viral vector). The Pfizer-BioNTech and Moderna vaccines are administered as part of a two-dose series, 21 and 28 days apart respectively, whereas the Johnson & Johnson/Janssen vaccine is administered as a single dose. Additional doses are available for immuno-

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Abbreviations: CDC, Centers for Disease Control and Prevention; COVID-19, coronavirus disease 2019; CPT, Current Procedural Technology®; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit; NY, New York; PPE, personal protective equipment.

Keywords: coronavirus disease 2019, coronavirus disease 2019 vaccine, SARS-CoV-2, vaccination, vaccines

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compromised patients or individuals in high-risk settings (eg, healthcare workers). The Pfizer-BioNTech vaccine is now widely available for patients ages 5+ years; however, the Moderna and Johnson & Johnson/Janssen vaccines are currently recommended only for patients age 18+ years [1].

When the effectiveness of these vaccines in preventing COVID-19 hospitalizations were compared among adults without immunocompromising conditions, the Moderna vaccine had the greatest effectiveness (93%) followed by the Pfizer-BioNTech (88%) and lastly by the Johnson & Johnson vaccine (71%) [2]. Achieving public vaccination rates above 75% are crucial to promoting public health through “herd immunity” and in preventing avoidable morbidity and mortality resulting from COVID-19. According to the World Health Organization, there have been nearly 60 million confirmed cases of COVID-19 and over 830,000 deaths attributable to the COVID-19 pandemic [3]. Minority communities have been disproportionately affected by the pandemic [4], whereby racial and ethnic disparities in the incidence of COVID-19 are well-documented [5].

The creation of pop-up vaccination sites at trusted community locations has been encouraged to address vaccine hesitancy and provide equitable access to COVID-19 vaccination in minority communities [6]. There is, however, a paucity of literature available regarding the economic impact of such pop-up vaccination centers. This study sought to investigate the healthcare economics of a community-based COVID-19 pop-up vaccination center in Port Jefferson Station, NY, USA, in terms of the following: 1) costs associated with operating the vaccination center, 2) analysis of billing data from a cohort of patients who received the Moderna COVID-19 vaccine, and 3) costs of hospitalization for COVID-19 which may be avoided with widespread vaccination.

**METHODS**

**Operating Costs**

Costs associated with operation of the COVID-19 pop-up vaccination center were quantified, itemized, and tabulated directly from practice expenditure reports. These included costs of medical supplies and storage (eg, Panasonic High-Performance Manual Defrost Biomedical Freezer; CliniCool© Silver Series Pharmacy/Vaccine Refrigerator and Freezer; Excursion-Trac Refrigerator/Freezer Datalogging Traceable Thermometer (cloud-based system for continuous temperature monitoring)); personal protective equipment (PPE), wipes, sanitizer, and office equipment to document patient health information and distribute vaccine safety information as well as costs associated with the rendering of medical services (eg, administration of vaccine doses followed by supervision for vaccine-related adverse effects by medical and nursing personnel). Personnel employed by the vaccination center included one board-certified pulmonology-critical care specialty physician, two registered nurses, and several volunteer medical assistants. Doses
of the Moderna COVID-19 vaccine were provided to the vaccination center at no cost.

Based on the current rate of reimbursement to employees for business use of personal vehicles established by the Internal Revenue Service and United States General Services Administration for the state in which the vaccination center was located (ie, $0.560 United States dollars per mile traveled), the costs of travel mileage associated with transportation of the vaccine and other medical supplies to the vaccination center were determined [7].

Table 1. Itemized Costs of Medical Supplies and Services Required to Operate a COVID-19 Pop-up Vaccination Center

| Category                                                                 | Total Cost | Percentage |
|--------------------------------------------------------------------------|------------|------------|
| Total cost of medical supplies, services, and storage                    | $26,880    | 100.0%     |
| Panasonic High-Performance Manual Defrost Biomedical Freezer 24.4 Cu. Ft.| $11,852    | 44.1%      |
| CliniCool© Silver Series PRIME 16 Cu. Ft. Pharmacy/Vaccine Refrigerator and Freezer | $5,407     | 20.1%      |
| Rent for equipment storage ($1500/month)                                 | $4,500     | 16.7%      |
| Medical and nursing personnel                                            | $3,456     | 12.9%      |
| PPE, gloves, wipes, sanitizer, and office equipment                      | $600       | 2.2%       |
| Electronic health record ($200/month)                                    | $600       | 2.2%       |
| Travel mileage ($0.560/mile)                                             | $323       | 1.2%       |
| Excursion-Trac Refrigerator/Freezer Datalogging Traceable Thermometer    | $142       | 0.5%       |

$USD=United States dollars; PPE=personal protective equipment.

These billing data were then quantified for the entire cohort as well as per each patient to receive the vaccine, with distinction made between billing data corresponding to each dose of the two-part vaccine series. Per patient billing data were characterized using descriptive statistics: mean, standard deviation (SD), median, interquartile range (IQR), and range. For insurance plan-based contractual adjustment, negative valuation is used to indicate the difference between the charge to the patient’s insurance plan and the reimbursement payment received by the COVID-19 vaccination center.

Study Sample and Billing Data

Current Procedural Technology® (CPT) codes 0011A and 0012A were used to identify patients who received doses 1 and 2, respectively, of the Moderna COVID-19 vaccine series (ModernaTX, Inc., MA). This vaccination center did not administer either the Pfizer-BioNTech vaccine or Johnson & Johnson/Janssen vaccine. This study included only patients with age ≥18 years—the population for which the Moderna COVID-19 vaccine is currently approved—who received at least one dose of the vaccine series. Finally, since this analysis relies on the availability of billing data, patients for whom billing information was unavailable were excluded from the study cohort. These eligibility criteria are summarized and displayed as a consort diagram in Figure 1.

Electronic health records were reviewed retrospectively, and billing data were deidentified and anonymously coded. Billing data abstracted included the charge to each patient’s insurance plan for administration of each vaccine dose, insurance plan-based contractual adjustment (ie, the difference between the initial amount billed by the vaccination center to the patient insurance plan(s) and the reimbursement to the center for vaccine administration), and reimbursement (ie, payment from insurance plan to the COVID-19 vaccination center for medical services rendered).

Estimation of Urgent Care, Emergency, and Hospital Costs

Costs associated with provision of urgent care, emergency, and hospital services to patients with COVID-19 were obtained from established costs from urgent care centers [8], a local ambulance corporation, and a local hospital and standard costs determined per patient to model the full range of possible scenarios which may follow from onset of COVID-19, from quarantine in self-isolation to seeking emergency medical care (eg, emergency department visit) and admission to the medical intensive care unit (ICU).

In order to accurately capture costs associated with emergency services and hospitalization, “local” in the context of “local ambulance corporation” indicates that the ambulance corporation from which cost data were captured was the same corporation responsible for transportation and provision of emergency services en route to the local hospital from which costs were obtained. Hospital costs were fixed quantities derived directly from hospital billing data that scaled to the level of care required, ranging from the cost of visiting the emergency department to ICU admission requiring use of extracorporeal membrane oxygenation or tracheostomy with prolonged (>96 hours) of mechanical ventilation and major oral procedures.
The COVID-19 pop-up vaccination center administered the initial dose of the Moderna COVID-19 vaccine to N=251 patients between March and May, 2021, with the majority of initial dose administrations occurring in April 2021—144/251, 57.4% (Table 2). Patients were evenly distributed in terms of age with the exception of patients aged 79-88 and 89-98 years, which accounted for 6 (2.4%) and 1 (0.4%) patients, respectively. More patients to receive the vaccine were female than male: 141 (56.2%) vs. 110 (43.8%). The most common insurance plan types among patients in the study cohort were commercial (154/251, 61.4%) followed by Medicare (46/251, 18.3%). Patients in the cohort completed the vaccine series at a rate of 95.6% (240/251), with 238 (94.8%) patients having 28 days between doses—two patients had 31 days between doses.

A total of $12,550.00 was charged to insurance plans for administration of the first dose in the Moderna COVID-19 vaccine series to the entire cohort (Table 3). Following insurance plan-based contractual adjustment (-$5259.54), the reimbursement for administration of the first dose to the entire study cohort was $7,290.46. Similarly, for the 240 patients who received the second dose (ie, completed the Moderna COVID-19 vaccine series), a total of $12,000.00 was billed to insurance plans, resulting in net reimbursement to the vaccination center of $8,775.16 after contractual adjustment (-$3,224.84).

On average, the net payment (reimbursement) to the vaccination center per patient was $29.05 (SD=$15.84) and $36.56 (SD=$10.68) for the first and second doses of the Moderna COVID-19 vaccine series, respectively. Notably, the average insurance plan-based contractual adjustment for the second dose, -$13.44 (SD=$10.68), differed from that of the first dose, -$20.95 (SD=$15.84), while the charge (amount billed to insurance plans) remained constant. The median net payment to the vaccination center for administration of the first and second doses were $16.94 (IQR: [$16.94, $47.64]) and $40.00 (IQR: [$28.39, $47.64]), respectively. The range in net payment was the same for doses 1 and 2 of the series: [$13.23, $50.00].

Itemized analysis of medical supply and services costs associated with operation of the COVID-19 popup vaccination center is summarized in Table 1. The total cost to operate the vaccination center was $25,880 USD. The greatest operating cost corresponded to purchase of a Panasonic High-Performance Manual Defrost Biomedical Freezer for storage of the Moderna COVID-19 vaccine at 30°C: $11,852, accounting for 44.1% of operating costs. Notably, the rent for equipment storage, was $4,500 (16.7%), and cost to utilize an electronic health record, $600 (2.2%), corresponded to the costs incurred for a single-physician, community-based private practice medical center from March to June, 2021.

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but rather quarantine in self-isolation; thus, these patients were assumed to incur negligible costs. Notably, this does not include costs associated with long-term complications of infection with the novel coronavirus (post-COVID conditions), which may only cause patients to seek care months to years after acute infection [9].

Three methods of seeking emergency care, as well as associated costs, were identified as follows: 1) the patient may drive to the emergency room ($0), 2) visit an urgent care medical center ($150), or 3) an ambulance may be called by or on behalf of the patient to transport the patient to a hospital emergency department ($800-$1,200).

If a patient were to visit an urgent care center without visiting a hospital emergency department, the total cost associated with this pathway would be $150, an average tabulated from local urgent care centers for costs associated with a visit for suspected COVID-19.

The remainder of this algorithmic approach to diagnosis and management of patients with COVID-19 proceeds sequentially with costs quantified cumulatively. For example, if a patient were to visit an urgent care center ($150) and be referred for a visit in the emergency department, the patient could drive ($0) or be transported to the emergency department by ambulance ($800-$1,200). From the emergency department ($635), the pathway branches into three options algorithmically considered to be mutually exclusive: admission to the clinical decision unit ($1,274), admission to the medical ICU, and discharge home ($0). Admission to the clinical decision unit, however, does not preclude transfer to the medical ICU should an escalation in medical care be indicated.

Several common outcomes were identified for patients admitted to the medical ICU. The outcome associated with the lowest cost was admission to the medical ICU for respiratory infections and inflammatory reactions without complication or comorbidity: $8,913. The ICU...
complete the vaccine series in order to recoup these operating costs; however, this is likely an underestimation, as the administration of additional vaccination doses would incur additional expenses associated with the medical supplies and services to administer these additional doses as previously outlined in Table 1.

Moreover, since the Moderna COVID-19 vaccine series is effective in preventing hospitalization for 93% of patients, this community-based vaccination center’s administration of the vaccine series to 240 patients means abatement of hospitalization due to COVID-19 related morbidity for 223 patients [2]. To accurately estimate the hospital costs averted in the community, the New York State Statewide COVID-19 Testing for Suffolk County, New York [10]—the location of the vaccination center and study cohort—was used to calculate the percent positivity rate for the months over which the Moderna COVID-19 vaccine series was initiated. That is, the mean % positivity rate for COVID-19, measured as the quotient of daily new positives and total number of tests performed, was 2.87% (SD=1.57%). Therefore, incorporating percent positivity rate in the community, the true impact of the vaccination center, in averted hospital costs is estimated to range from $57,032 to $1,220,328.

While quantitation of costs averted is one important metric regarding the impact of the vaccination clinic, achievement of herd immunity through vaccination should be a collaborative effort among vaccination centers at all levels of care. Furthermore, when individual preferences for COVID-19 vaccination in China were assessed, Leng et al. found that the most important factors that influenced individuals’ decisions to receive vaccination were vaccine effectiveness, side-effects, and the proportion of acquaintances vaccinated. Although this group also found that higher local vaccine coverage created altruistic herd incentives for individuals to receive the vaccine, the researchers also found that vaccine administration in

### DISCUSSION

The total cost to operate a COVID-19 pop-up vaccination center in New York between March and June 2021 was $26,880.00. This does not include the cost of Moderna COVID-19 vaccine doses, which were made available to the vaccination center free of charge. During its operation, the vaccination center administered a complete series to 240 of 251 patients who received the first dose. The net payment to the vaccination center corresponding to administration of vaccines to this cohort was $7,290.46 and $8,775.16, respectively, totaling $16,065.62 in reimbursement for services rendered by the vaccination center. This meant the vaccination center was unable to recoup $10,814.38 in operating costs corresponding to medical supplies and services rendered in the administration of vaccines to this cohort.

On average, the net payment to the vaccination center per patient for administration of the first and second doses were $29.05 and $36.56, respectively. Hence, the average total reimbursement to the vaccination center was $65.61 per patient completing the Moderna COVID-19 vaccine series. Given the total cost to operate the vaccination clinic was $26,880.00, 410 patients would have had to

| Total | Mean (SD) | Median [IQR] | Range |
|-------|-----------|--------------|-------|
| Total | $12,550.00 | $50.00 ($0.00) | $50.00 [$50.00, $50.00] |
| Contract adjustment | -$5,259.54 | -$20.95 ($15.84) | -$33.06 [-$2.36, -$33.06] |
| Net payment | $7,290.46 | $29.05 ($15.84) | $16.94 [$16.94, $47.64] |

| Total | Mean (SD) | Median [IQR] | Range |
|-------|-----------|--------------|-------|
| Charge | $12,000.00 | $50.00 ($0.00) | $50.00 [$50.00, $50.00] |
| Contract adjustment | -$3,224.84 | -$13.44 ($10.68) | -$10.00 [-$2.36, -$21.61] |
| Net payment | $8,775.16 | $36.56 ($10.68) | $40.00 [$28.39, $47.64] |

IQR= interquartile range; SD= standard deviation
the hospital setting was preferred to vaccination at the township/community health centers and village clinic or community health stations [11]. Arguably, however, the latter types of vaccination centers enhance herd immunity by increasing local vaccine coverage.

Strengths of this research are its use of operating costs and billing data directly from expenditure reports from a COVID-19 vaccination center. The sample size (N=251) was appropriately powered to collect a representative sample for billing data—charges to insurance plans, insurance plan-based contractual adjustments, and net payments (reimbursements to the vaccination center). Another strength of this paper was its use of costs obtained from urgent care centers, ambulance corps, and a local hospital to model costs associated with various outcomes following infection with the novel coronavirus.

This research has several limitations. Foremost, this study reports the operating costs of a single COVID-19 vaccination center that administered the Moderna COVID-19 vaccination and was in operation from March through June of 2021. COVID-19 vaccination centers that administered other versions of the COVID-19 vaccine will understand have different costs related to the storage of the vaccine. Additionally, a COVID-19 vaccination center located in a different state or country than the one whose operating costs are presented here will likely have different rates for medical supplies and services. The model for patient outcomes following infection with the novel coronavirus only encompasses cost data from one hospital, limiting generalizability of the cost-savings. Finally, we acknowledge that there are many permutations to the model depicted in Figure 2 (eg, polymerase chain reaction and rapid antigen testing).

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