**Introduction**

At the end of May 2022, 3 billion COVID-19 vaccine doses have been given in China, which posed an unprecedented challenge to the health care system.\(^1\)\(^2\) Our hospital is a tertiary grade A hospital in Shenzhen, a city with 17.6 million people. Starting on December 15, 2020, this hospital was the first in Shenzhen authorized for emergency use of the COVID-19 vaccine for high-risk populations, with a daily vaccination rate of around 150. Four months later, this hospital was the designated hospital serving foreign visitors in addition to residents. Due to the waning immunity after vaccination, we realized the perpetual nature of COVID-19 vaccination efforts.\(^3\) Subsequently, we developed a 600 m\(^2\) vaccination center in August 2021 to accomplish 1200 vaccinations daily.

This report describes our tactical strategies to endeavor the challenges by incorporating the core policies in setting up a mass vaccination center. With a 3 × 3 matrix of human factors, spatial layout design, and logistics planning, we addressed the issues of infection control, vaccination safety, and efficiency improvement (Table 1). We believe this framework may serve as a template for future planning and managing mass vaccination centers.

**Planning**

**Human Factors**

On the administrative level, the hospital director led the decision-making team involving nursing, public health, infection control, medical affairs, and public relations departments. The vaccination coordinators consisted of a head nurse and a senior public health physician responsible for overall program development and implementation.

For all frontline medical staff, national COVID-19 vaccination certificates were mandatory. Through online modules, hands-on practice, and testing, the training program covered the areas of vaccine eligibility, vaccine storage, handling, injection techniques, and the management of adverse reactions. Because of the novelty of COVID-19 vaccines and their expedited uses, concerns have been raised about the potential adverse reactions. Therefore, the national guidance addressed this issue by setting up federal, provisional, and regional multidisciplinary specialists to manage Adverse Events Following Immunization (AEFI).\(^4\) All vaccination centers allocated sufficient resources and developed an infrastructure for regular simulation exercises to minimize knowledge gaps and optimize team coordination.

**Spatial Layout**

Our mass vaccination center is located in the hospital but separated from other clinical areas to reduce cross-contamination. Its direct access to the Emergency Department permitted rapid response to AEFI.\(^5\) Following the provincial guidelines, the center incorporated five functional zones: triage and reception, assessment, injection, observation, and administration, directing the people flow in a unidirectional path with egress points for ineligible individuals.\(^6\) A scalable modular layout accommodated dynamic sizing based on fluctuated vaccination demands. In addition, the hourly inoculation capacity determined the size of the 30-minute observation area allowing at least 1-meter interpersonal distance. Accessibility and convenience factors translated into service quality and client satisfaction.

**Administering**

Managing administrative risks involved discipline and scrutiny. Vaccination coordinators were responsible for the staff’s compliance with the standard operating procedure (Table 2).
Table 1. Matrix Table for Strategic Planning and Implementation of COVID-19 Mass Vaccination Center.

| Issues                  | Human factors                                                                 | Spatial layout                                                                 | Administering                                                                 |
|-------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Infection control       | • Multidisciplinary administration team, including infection control specialist<br>• No COVID-19 nucleic acid amplification testing for inoculators or recipients within 48 hours post-immunization | • Separate entrance and exit<br>• Triage station for epidemiological surveillance<br>• Zonal division for crowd segregation<br>• Unidirectional public path, with egress points for ineligible individuals<br>• Sufficient space allowing 1-meter social distance<br>• Air-conditioning with diluting ventilation | • Balancing accessibility and overcrowding with online booking<br>• Level I PPE for inoculators (avoid false positivity in COVID-19 testing) with proper donning and doffing<br>• Proper hand hygiene<br>• Working area cleaning with 1000 mg/L chlorine-containing disinfectants<br>• Computer equipment cleaning with 75% ethanol<br>• Natural ventilation and UV-C germicidal irradiation after service hours<br>• Prevention of vaccine aerosol and management of vaccine spill<br>• Regular environmental surveillance with COVID-19 nucleic acid amplification test<br>• Biohazard waste management for vaccine materials |
| Safe vaccination        | • Strategic medical staff recruitment<br>• Systematic staff training with national certification<br>• Designated vaccine coordinators<br>• Regular preparedness drills | • Immediate access to the emergency department or resuscitation cart<br>• Post-vaccination observation area to monitor immediate adverse reactions | • Strict identity checking<br>• Eligibility assessment and vaccine prescription by physicians<br>• Mandatory consent with a disclaimer<br>• Cross-checking by inoculators and recipients<br>• Standard operating procedures for the use of multidose vials<br>• Software with error-checking prompts<br>• Mandatory management protocol for AEFI<br>• Education materials for AEFI, including pamphlets and videos<br>• Follow-up and reporting procedures for AEFI<br>• Daily review and audit by the vaccination coordinator for continuous quality improvement |
| Efficiency improvement  | • Optimized physician-to-inoculator ratio<br>• Supporting staff to triage and manage people flow<br>• Translator for effective communication | • Temporary vaccine storage with a tableside fridge in the inoculation room<br>• Conveniently located restrooms<br>• Disabled and wheelchair-friendly design<br>• Explicit signages with large fonts | • Recording time sequences of vaccination for continuous improvement initiatives<br>• User-friendly software<br>• Information technology contingency planning |

Abbreviations: AEFI = Adverse Events Following Immunization; PPE = personal protective equipment.

Daily huddles to brief changes based on the feedback or recent Government updates. Vigilant, periodic quality control through audit/feedback, analysis, planning, and action cycles were the cornerstones of risk mitigation. Besides the stewardship of new staff, the coordinator also performed regular competency assessments. Online appointment booking platforms and electronic vaccine information systems centrally maintained by the health bureau avoid human errors and reduce overcrowding.

**Ethical Approval**

Our institutional research ethics committee has approved this study and publication (code: [2022]130).

**Results**

From December 15, 2020, to May 31, 2022, 79,462 vaccines were administered to 11,502 foreigners, 45,910 Hong Kong residents, 299 Macau residents, 4,083 Taiwanese, and 17,668 mainland residents. Among those, 37,871 (47.7%) completed the first dose of inactivated vaccines, 31,435 (39.6%) the second dose, but only 10,190 (12.8%) had the third dose. All 19 (0.024%) AEFI were managed as outpatients. Four of these 19 reactions were delayed >30 minutes after immunization, including eyelid swelling at 14 hours post-vaccination, right ptosis at two days, low-grade fever 24 hours after, and a local skin reaction. Of the remaining 15 patients, 14 developed mild allergic reactions <30 minutes after vaccination but all resolved after a dose of dexamethasone or antihistamine.
Two of the 19 patients had low-grade fever (<38.5°C) first noticed during the 30-minute observation, but none had confirmed infection. In addition, 39 (0.049%) patients had a vasovagal response, and two (0.0025%) complained of self-limiting headache, which is not considered AEFI. Due to a mismatch between the recipients’ information and the vaccination registry, the inoculating nurses caught two (0.0025%) near-miss events before the injections. One (0.0013%) actual adverse incident was due to imprecise vaccine dosing. During this period, the vaccination has never been reported to be the contact source for any confirmed COVID-19 cases.

**Discussion**

Mass vaccination of COVID-19 in a constrained timeframe posed a unique challenge in modern Medicine entailing vigilant risk management. In contrast to other mass immunization, the COVID-19 campaign had specific ramifications for infection control. Due to assemblage midst the pandemic, preventing infection spread was crucial. Moreover, the vaccines themselves might cause false-positive results in COVID-19 testing.

Because of the high mortality of COVID-19, the vaccines were released for early, compassionate use. Thus, in addition to mandatory participants’ written consent and disclaimer, a dual assessment by a physician and an inoculator set a higher safety standard, but at the expense of efficiency. Vigilant surveillance of adverse events and immediate medical intervention minimized the risks and alleviated vaccine hesitancy.

The efficiency of mass vaccination centers determines their sustainable and long-term roles in disease control. The staffing shortage was relieved through systematic training and certification of vaccination staff. Although pharmacists in China might assist in ordering and storing the vaccines, the legislation did not allow them to be inoculators. Now eligible for COVID-19 vaccination, populations older than three require different preparedness. Finally, in contrast to other countries, China does not accept drive-through immunization clinics.

**Conclusion**

This report highlights the scheme of a $3 \times 3$ matrix in the infrastructure planning of a COVID-19 mass vaccination center. Our stringent risk management practices included risk prediction and risk mitigation. To the best of our

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**Table 2. Inoculator’s Operating Procedures for COVID-19 Intramuscular-administered Vaccines.**

| Check the following information of the recipient |
|-----------------------------------------------|
| • Recipient’s identity                        |
| • Medical and health conditions               |
| • Vaccination record                         |
| • Allergy history                            |
| • Non-fasting status                         |
| • Recipient’s signatures in the forms         |
| • Physician’s medical order                   |
| • Recipient’s signed consent                  |

| Vaccine preparation                          |
|-----------------------------------------------|
| • Remove the vaccines from the refrigerator and check the storage temperature. |
| • Check vaccine name, manufacturer, dose, log number, serial number, and expiration date. |
| • Draw up the vaccines with syringes and needle size under the aseptic technique. |
| • Avoid aerosol vaccine spills.              |
| • Mark the date and time, with signature, when opening a multidose vial. The remaining vaccine may be temporarily stored in a table refrigerator in compliance with the cold-chain management protocol. |
| • All needles and syringes for intramuscular vaccine injection are disposable after use. |

| Vaccine administration                       |
|-----------------------------------------------|
| • Hand hygiene with hand rub sanitizer before each injection. |
| • Correctly locate the anatomic landmarks for deltoid. |
| • Prepare the injection site with an alcohol wipe twice in a circular motion from the center outward and allow sufficient dry time. |
| • Insert needle quickly at 90° intramuscularly and then inject the content steadily. |
| • Withdraw the needle at the same angle of insertion. |
| • Dispose of the syringe and needle properly into a “sharps” container. Then, dispose of the vaccine vials as biohazard waste. |
| • Document the vaccination in the local immunization registry. |
| • Guide the recipients to the observation area and hand out the vaccine information sheet. Remind the recipients to watch for possible adverse reactions. Advise recipients to avoid foods or drugs that may induce allergic reactions. Provide a hotline for counseling over the phone. |
| • Help the recipient to set up the next vaccination date if applicable. |
knowledge, this is the first report reviewing the planning and administrating of a COVID-19 mass vaccination center in China.

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