



Emergency medical response at a COVID-19 vaccination centre in a tertiary hospital: a protocol

Zeenathnisa Mougammadou Aribou¹, Joel Ming Chiew¹, Geraldine Pei Yun Lim²,
Elena Binte Mohamed Ayob², Wee Hoe Gan^{1,3,4}, John Wah Lim^{1,3,4}, Limin Wijaya⁵, Hei Man Wong^{3,5}

¹Department of Occupational and Environmental Medicine, Singapore General Hospital, Singapore, Singapore; ²Division of Nursing, Singapore General Hospital, Singapore, Singapore; ³Duke-NUS Medical School, Singapore, Singapore; ⁴Saw Swee Hock School of Public Health, National University of Singapore, Singapore, Singapore; ⁵Department of Infectious Diseases, Singapore General Hospital, Singapore, Singapore

Correspondence to: Zeenathnisa Mougammadou Aribou MBBS, MPH. Department Occupational and Environmental Medicine, Singapore General Hospital, Outram Road, Singapore 169608, Singapore. Email: zeenathnisamougammadou.aribou@mohh.com.sg.

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As of 19 April 2022, the COVID-19 pandemic has infected close to 504 million people and resulted in approximately 6.2 million deaths globally (1). The Delta variant has shown to be more transmissible than the previous variants, while preliminary data suggested that the mutations identified in Omicron, the prevailing SARS-CoV2 Variant of Concern, could confer increased infectivity and higher re-infection risk (2,3). With the emergence of the Deltacron variant that contains elements of the Delta and Omicron, controlling the pandemic will require pharmacotherapies and vaccines that prevent viral spread. This paper will outline the importance of COVID 19 vaccination, the need to ensure swift and effective emergency medical response at a COVID-19 vaccination centre and the key steps taken at the vaccination centre in a large tertiary hospital in Singapore.

The need for effective COVID-19 vaccinations and hence the vaccination programme

The spectrum of pharmacotherapy to treat COVID-19 is evolving rapidly after 2 years into the pandemic. Anti-inflammatory medication (i.e., Dexamethasone, Baricitinib and Tocilizumab), anti-viral agents (i.e., Remdesivir, Paxlovid and Molnupiravir) and anti-SARS-CoV-2 monoclonal antibodies (i.e., Sotrovimab and Regeneron) are recommended in major management guidelines for the treatment of COVID-19. However, they do not directly prevent onward transmission of the virus which is

responsible for the relentless global spread (4).

Studies have shown that mass vaccination, however, is effective in both mitigating disease severity and curbing onward transmission (5). In Singapore, a study showed that those who were fully vaccinated and above the age of 50 years did not require high dependency or intensive care compared to 10.6% of those who were unvaccinated or partially vaccinated in the same age group (6). Similarly, Arbel *et al.* concluded that vaccinated participants who received a booster dose after at least 5 months from the 2nd dose had 90% lower mortality due to COVID-19 than those who did not (7). Furthermore, it is evident that vaccination reduces transmission in the community and in a hospital setting (8). Global mass vaccination programme is therefore a crucial tool in managing this pandemic.

Following the implementation of mass vaccination, however, severe allergic and anaphylactic reactions, though rare, have been reported. The COVID-19 Citizen Science Study, an online cohort study reported that allergic reactions or anaphylaxis was reported in 0.3% of participants after 1 dose of the Pfizer-BioNTech or Moderna vaccine, and 0.2% of participants after 2 doses of the Pfizer-BioNTech or Moderna vaccine (9). Such reactions, though rare, can have a negative rippling effect on vaccination uptake, thus hindering the progress of the vaccination exercise. Hence, it is essential to ensure prompt medical response at the vaccination centres for patient safety and to gain staff and public's confidence.

Allergic and anaphylactic reactions related to COVID-19 vaccinations in Singapore

The national vaccination campaign in Singapore commenced on 14 December 2020, and as of 15 April 2022, 92% of Singapore's total population (approximately 5.93 million) are fully vaccinated against COVID-19 and 73% have received a booster vaccination (10). The country's COVID-19 related death rate remains one of the lowest in the world. Under the National COVID-19 vaccination programme, Pfizer-BioNTech and Moderna vaccines were the first to become available, followed by the Sinovac-Coronovac and Sinopharm vaccines. Pfizer-BioNTech and Moderna are messenger ribonucleic acid (mRNA) vaccines which contain the genetic material from the SARS-CoV-2. After its inoculation, such material will signal the body to make a protein that triggers a protective immune response against COVID-19. On the other hand, Sinovac-Coronovac and Sinopharm are inactivated vaccines that utilise unreactive SARS-CoV-2 particles to stimulate the immune system to make antibodies against the virus (11).

As of 28 February 2022, the local incidence rate of anaphylaxis reported with mRNA vaccines in Singapore was estimated at 0.67 per 100,000 doses administered. On the other hand, there had been anaphylaxis amongst 0.003% of Sinovac doses administered and serious adverse events amongst 0.007% of Sinopharm doses administered. Inactivated COVID-19 vaccines have only been administered to 3% of the population who are ineligible for the mRNA vaccines due to medical reasons (12).

Implementation of a vaccination centre in the largest tertiary hospital in Singapore and our results

Singapore General Hospital (SGH) is one of the largest hospitals in Singapore with 1,785 beds and a 11,479-strong workforce. The COVID-19 staff vaccination centre at SGH began its operations in early January 2021, approximately 1 month after the Pfizer-BioNTech vaccine was approved by the Health Science Authority of Singapore. Anticipating the need to stay resilient during the COVID-19 pandemic, this staff vaccination centre was set up to vaccinate 400–500 healthcare workers from our institution per day to better protect them.

Manpower and training

There were a total of 11 nurses, 2 doctors and 10 administrative

staff funded by our institution's Staff Vaccination Programme under the support and guidance from Singapore's Ministry of Health (MOH) COVID-19 Vaccination Taskforce. These staff were deployed to the vaccination centre full-time to ensure smooth running of the operation. A nurse clinician was appointed to oversee the vaccine workflow and tally the stock. 11 nurses (including 2 nurse clinicians) who are familiar with vaccination procedures were deployed from the travel clinic and other departments. In addition, the doctors were residents from the Division of Medicine competent of performing medical resuscitation. Administrative staff were temporary staff recruited by the institution for this vaccination programme to aid with administrative work.

Training sessions relevant to the staff's job scope were provided prior to the centre's operational date, and practical assessments were also held to ensure their competency e.g., dilution and administration of the vaccines by the nurses and resuscitation procedures by the on-site medical team, which was evaluated by the hospital wide multi-disciplinary resuscitation team throughout the duration of this vaccination programme.

Screening for vaccinee's eligibility and contraindications and risk stratification

Vaccinees were screened for their eligibility to the vaccines according to the guidelines released by MOH. Whilst MOH has guidance on the management of anaphylaxis and severe allergic reactions, each vaccination centre had to operationalise it according to the institution's unique set up. Screening allows vaccination providers to ascertain the eligibility and contraindications of the vaccination. It enabled us to stratify vaccinees for their risk of allergic reactions and hence deciding on the need for closer monitoring during the mandatory 30-minute post-vaccination observation period. As per the current recommendations, any history of allergic, anaphylactic or severe reaction to a previous COVID-19 vaccine or any component of the vaccine is an absolute contraindication of the same type of COVID-19 vaccine. Patients with a history of atopy or a history of allergic reactions to any drug or vaccine were classified to be at a higher risk of developing allergic reactions post-vaccination. This screening process was done by 2–3 nurses or doctors rostered on that day with the use of a screening form at the screening stations.

Prospective vaccinees without contraindication who were eligible to be vaccinated but deemed to be at a higher risk of developing adverse or allergic reactions were asked to sit

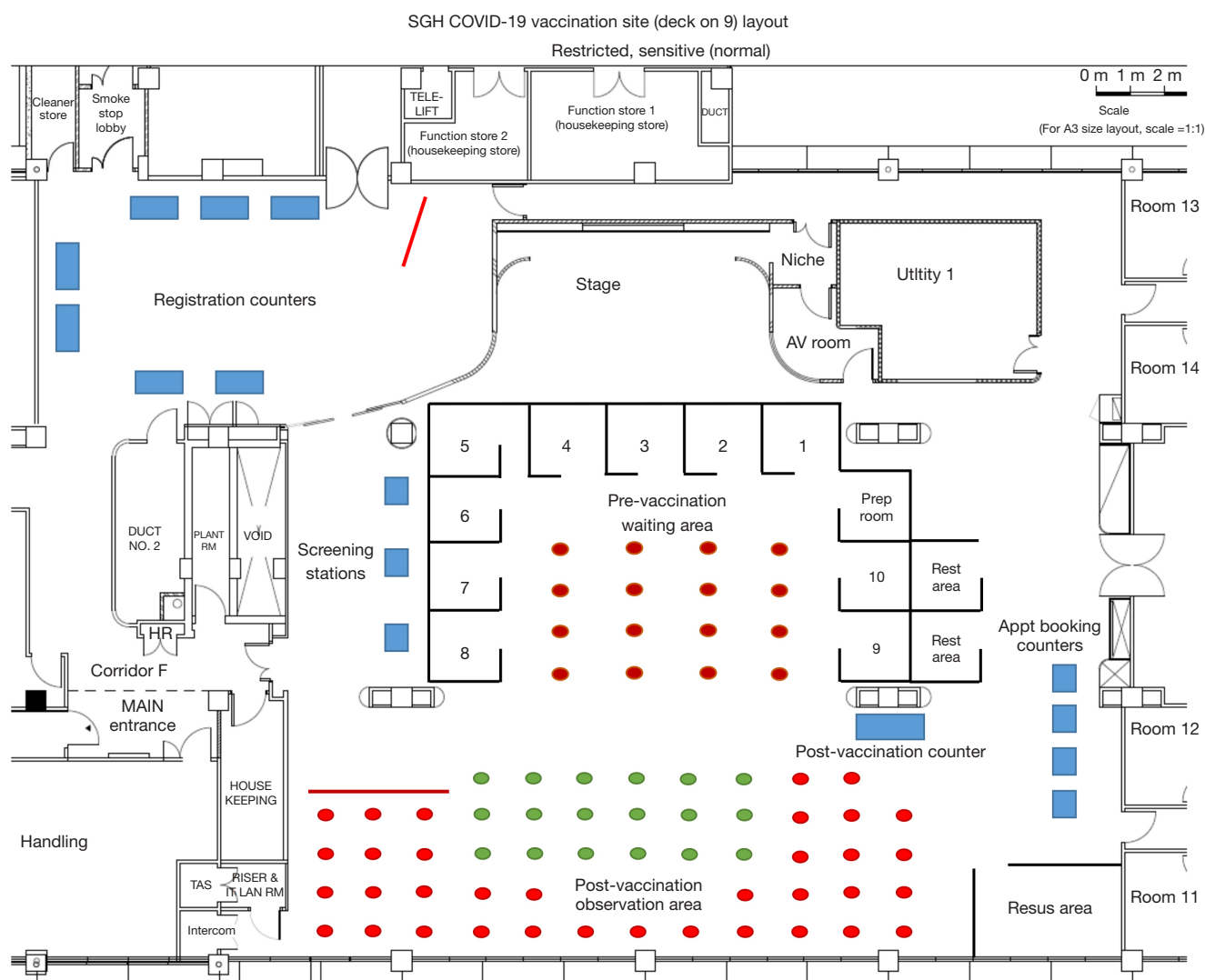


Figure 1 Floor layout in COVID-19 vaccination centre.

in the front rows of the post-vaccination observation area (green dots in *Figure 1*) during the 30-minute mandatory monitoring period. Such central location allowed full visibility of this group of vaccinees by the nurse stationed in front of the post-vaccination observation areas. This arrangement allowed our healthcare providers to monitor and attend to such vaccinees swiftly in the event they develop adverse or allergic reactions. Other low risk vaccinees were free to sit on any chair indicated by the red-dots.

Vaccination centre set-up and assembling the resuscitation capabilities

Our vaccination centre was equipped with two sick bays

(recliner rest area) and one resuscitation bay (trolley bed area) which was fully equipped to support cardiopulmonary resuscitation (CPR) by the on-site medical team. Vaccinees who complained of mild symptoms but were hemodynamically stable would be attended to by the on-site medical team and be observed in one of the two sick bays. Hemodynamically unstable vaccinees or those requiring closer monitoring would be treated at the resuscitation bay. The trolley bed and recliner rest areas were screened off and located away from the other waiting vaccinees, preventing the phenomenon of mass hysteria.

Multi-disciplinary team effort during any emergency response is pivotal in ensuring optimal patient care and safety. Various medical teams such as the airway team,

the Ear Nose and Throat (ENT) team, the code blue team, and the nursing teams involved in the immediate management provided their expertise in managing severe adverse reactions and anaphylaxis post-vaccination, augmenting the treatment capabilities during each emergency response. On-site medical team would hand over to the hospital code blue team upon their arrival, if activated, for continued resuscitation and stabilization. Stabilised vaccinees with residual symptoms would be transferred to Emergency Department (ED) for continuity of care. This was possible due to the prior arrangement with the ED and their close proximity to our centre, and the fact that most of the allergic reactions were expected to be mild which most did not require subsequent inpatient care after being attended to and further monitored at the ED. Coupled with a next day outpatient allergist review, this reduced the need for admission which would stress our institution's high bed occupancy rate. During transfer from the vaccination centre to the ED, auxiliary services such as the hospital security was alerted early so that the path would be cleared in advance for ensuring a smooth and swift transfer (see *Table 1*).

Competency assessments

A total of 3 simulation exercises involving scenarios of severe anaphylactic reactions were independently conducted by the medical team from the Department of Respiratory and Critical Care on separate days to ensure that the resuscitation procedures were performed competently. During each exercise, the reviewers used a checklist to detail steps of the resuscitation workflow which were expected to be carried out. A debrief was also held after each session to highlight the important learning points for improvement. Such exercises ensured that the on-site medical team and the various medical, nursing and auxiliary teams involved were familiar with the workflow and provided opportunities to identify potential challenges that could arise. The finalised and refined workflow based on these simulation exercises was displayed on the wall of the resuscitation area for easy reference.

Our results

As of 28 November 2021, 98.1% of our eligible staff have received at least 2 Pfizer-BioNTech vaccine doses and 30.3% have received a booster dose. All vaccinees with vaccine-related reactions were promptly attended to by our

on-site medical team within 5 minutes of the development of their symptoms. 26 cases that were sent to ED due to their severe reactions requiring closer monitoring and were discharged well. The overall rate of anaphylaxis was 0.02% with 4 anaphylaxis cases in the 23,006 vaccine doses administered. The 4 anaphylaxis cases were admitted for closer monitoring and discharge well after a period of observation. Those who were not eligible for Pfizer-BioNTech vaccine were eventually enrolled into another vaccination programme with the use of the Sinovac-Coronovac vaccine. As the number of this group is small, we have not included the rate of vaccination and vaccine-related reactions of this group.

Our staff have given us constant positive feedbacks through various hospital-wide channels on their confidence of being vaccinated at our centre and this was reflected in the high uptake rate of COVID-19 vaccination amongst our staff. Such high rates of staff vaccination allowed us to better equip our healthcare workers to continue to care for our patients during the COVID-19 pandemic. Due to the success of this operational framework for staff vaccination, the program transitioned to vaccinating our hospital's outpatients and medically stable inpatients since early April and July 2021 respectively using a similar model of care, where applicable. The current vaccination programme for our outpatients is well received as they generally prefer to be vaccinated in our centre given our experience. COVID-19 vaccination for our patients is crucial as they generally have multiple co-morbidities and hence are at risk of severe COVID-19 infection, which the vaccination may prevent.

The limitation and caveats to adopting our model of care

Though this programme was a success, it required multi-faceted and comprehensive team effort involving different medical specialties, nursing, administrative and auxiliary support and it was resource intensive. It also necessitated the need for a strategic location where such a layout could be implemented. Such requirements may pose as a barrier to the implementation of such a programme in a smaller hospital with relatively fewer resources.

The mass vaccination programme in our hospital allowed for healthcare workers, a high risk population for disease transmission, to be vaccinated in a safe environment. The confidence and trust amongst our staff in the vaccination programme is evident in the high rate of vaccination uptake. Moving towards endemicity, there is an ongoing

Table 1 Proposed protocol of an emergency medical response in a COVID-19 vaccination centre

Components of emergency medical response in COVID-19 Vaccination centre	Considerations
Planning principles	
Our experience—key processes, observations and lessons learnt	Risk stratification: identifying high risk vaccinees during screening to stratify them early prior to vaccination
	Strategic location: strategic location of the vaccination centre to be chosen with ease of access to definitive emergency care support (especially if it is in a non-hospital setting)
	Importance of multi-disciplinary team (MDT): MDT involvement and clear definition of the role of each member of the team
	Medications and equipment: availability of the medications and equipment needed for managing anaphylaxis.
	Code blue workflow: a code blue workflow was drawn up and agreed upon by the various medical, nursing, and auxiliary team members who will be involved in resuscitation efforts.
	Simulation training: simulation exercises to allow the multi-disciplinary team to familiarise with the medical response efforts for vaccinees with suspected anaphylaxis and severe allergic reactions
	On-site references: continual training and on-site reference material for the on-site medical providers on the management of anaphylaxis
Screening of vaccinees prior vaccination	
a) Training of vaccination providers	Educate providers on the indications and contraindications of vaccination to ascertain eligibility Educate providers to identify vaccinees at risk of allergic reactions post vaccination to ensure such vaccinees are closely monitored in the designated post-vaccination observation area
b) Material and Equipment	Pre-designed checklist to assist vaccination providers in the screening of prospective vaccinees for eligibility Computers to assess electronic medical records of vaccinees, if needed
c) Multidisciplinary team input	Phone consultations with allergist-on-duty to ascertain eligibility to vaccination for uncertain cases
Resuscitation capabilities at the vaccination centre	
a) Location and layout	Location of the vaccination centre to be close to a facility with definitive emergency care whenever possible Resuscitation areas facing away from the monitoring area equipped with screens for patient's privacy and to prevent mass hysteria of those under observation post-vaccination 2 sick bays and 1 fully equipped resuscitation bay with emergency drugs and equipment
b) Medications and equipment	Medications: Adrenaline vials and EpiPen, inhaled bronchodilators, intravenous fluid, oral and intravenous H1 and H2 antihistamines and intravenous corticosteroids Equipment and supplies: Intubation kit, oropharyngeal/nasopharyngeal airways, oxygen tank, emergency trolley, bag-valve mask, suctioning apparatus, consumables, and personal protective equipment etc. Posters of the treatment algorithms of allergic reactions and anaphylaxis and contact numbers of various emergency response teams erected on the walls of each bay Posters of the roles of each team doctor and nurses during the resuscitation

Table 1 (continued)

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Components of emergency medical response in COVID-19 Vaccination centre	Considerations
c) Manpower and Training of medical and nursing teams	<p>Segregation of duties: A nurse who is a floater with a “DO NOT DISTURB” vest monitors vaccinees post-vaccination for 30 minutes whilst vaccinee constituter focus on vaccine administration</p> <p>Selection of on-site doctor: All vaccination site doctors are Basic Cardiac Life Support (BCLS)/ Advanced Cardiac Life Support (ACLS) trained whilst all nurses are BCLS trained and are pre-selected based on their prior familiarity with vaccination processes and resuscitation</p> <p>Pre-assigned roles during resuscitation: each medical staff will be assigned a role in the event of resuscitation prior to starting their shift. The pre-assigned roles are:</p> <ul style="list-style-type: none"> • Doctor 1 (first responder and lead): Involved in history taking and clinical assessment for the need for additional medical support. Leads the resuscitation efforts • Doctor 2: Involved in alerting additional resuscitation teams and assist with vascular access • Nurse 1: Nurse Leader involved in assisting with cannulation, venepuncture, and administration of medications • Nurse 2: Involved in documentation and taking vitals • Nurse 3: Involved in performing cardiopulmonary resuscitation (CPR) <p>Simulation training: Medical and Nursing teams to undergo simulation training for various resuscitation scenarios prior to the start of vaccination programme</p> <p>Training: Training to recognize early signs and symptoms of anaphylaxis, on appropriate method of administering Epi-Pen and on managing anaphylaxis and other severe allergic reactions</p>
d) Multidisciplinary team input	Emergency workflow established together with the Airway team, ENT team, Code Blue team and Emergency Department (ED) team. These teams are also on standby to aid in the resuscitation efforts during medical emergency
Transporting to Emergency Department	
Transportation route	<p>Easy access route identified from vaccination centre to the emergency department</p> <p>Auxiliary services alerted prior transfer to clear the transfer route to allow for swift transport of patients to the Emergency Department</p>
Handing over care to Emergency Department	
Handing over patient care to Emergency Department team	<p>The ED team will be notified of the patient prior to transfer in preparation to receive the patient</p> <p>Patient will be handed over to the ED team by the vaccination centre medical team for continuation of care with a pre-designed checklist for this purpose</p>

ENT, Ear, Nose and Throat.

need for continued vaccination efforts to ensure that our staff and patient populations are adequately vaccinated. However, rare but severe adverse reactions that result in mortalities or morbidities have a negative rippling effect on vaccination uptake, thus hindering the progress of the vaccination exercise. Hence, it is advisable to ensure appropriate medical response measures to be in place at all vaccination centres to gain the vaccinees' confidence. Vaccination providers are responsible for ensuring that their

vaccination centres are equipped with the essential logistical and manpower support for prompt medical response in the event of vaccine-related severe allergic reactions. In doing so, severe allergic reactions such as anaphylaxis can be identified and treated appropriately for patients' safety.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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References

1. World Health Organization. WHO Coronavirus (COVID-19) Dashboard [Internet]. 2022 [updated 2022 Apr 19; cited 2022 Apr 19]. Available online: <https://covid19.who.int>
2. Earnest R, Uddin R, Matluk N, et al. Comparative transmissibility of SARS-CoV-2 variants Delta and Alpha in New England, USA. *Cell Rep Med*. 2022;3:100583.
3. Araf Y, Akter F, Tang YD, et al. Omicron variant of SARS-CoV-2: Genomics, transmissibility, and responses to current COVID-19 vaccines. *J Med Virol* 2022;94:1825-32.
4. National Institutes of Health. COVID-19 Treatment Guidelines Panel. Coronavirus Disease 2019 (COVID-19) Treatment Guidelines [Internet]. 2022 [updated 2022 08 Apr; cited 2022 Apr 20]. Available online: https://www.covid19treatmentguidelines.nih.gov/management/clinical-management/clinical-management-summary/?utm_source=site&utm_medium=home&utm_campaign=highlights
5. Dagan N, Barda N, Kepten E, et al. BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Mass Vaccination Setting. *N Engl J Med* 2021;384:1412-23.
6. National Centre for Infectious Diseases. Media Statement on the Effect of Age and Vaccination on COVID-19 Positive Patients [Internet]. 2021 [cited 2021 Dec 22]. Available online: <https://www.ncid.sg/News-Events/News/Pages/Media-Statement-on-the-Effect-of-Age-and-Vaccination-on-COVID-19-Positive-Patients.aspx>
7. Arbel R, Hammerman A, Sergienko R, et al. BNT162b2 Vaccine Booster and Mortality Due to Covid-19. *N Engl J Med* 2021;385:2413-20.
8. Shah ASV, Gribben C, Bishop J, et al. Effect of Vaccination on Transmission of SARS-CoV-2. *N Engl J Med* 2021;385:1718-20.
9. Beatty AL, Peyser ND, Butcher XE, et al. Analysis of COVID-19 Vaccine Type and Adverse Effects Following Vaccination. *JAMA Netw Open* 2021;4:e2140364.
10. Update on Local COVID-19 Situation [Internet]. Ministry of Health Singapore. 2022 [updated 2022 Apr 15; cited 2022 Apr 15]. Available online <https://www.moh.gov.sg/covid-19/vaccination/statistics>
11. Mascellino MT, Di Timoteo F, De Angelis M, et al. Overview of the Main Anti-SARS-CoV-2 Vaccines: Mechanism of Action, Efficacy and Safety. *Infect Drug Resist* 2021;14:3459-76.
12. Safety updates on COVID-19 vaccines [Internet]. HSA. 2022 [updated 2022 Mar 29; cited 2022 15 Apr]. Available online: <https://www.hsa.gov.sg/COVID19-vaccines-safety-updates>

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