International Journal of Infectious Diseases 113 (2021) 90–92

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Short Communication

COVID-19 vaccination: effective utilization of low dead space (LDS) syringes

Jun Shinozuka[1], Michiaki Hata[2], Hiromi Eguchi[1], Masahiro Mori[1,3], Mitsunori Eguchi[3], Mototaka Fukui[4], Natsuki Sai[4], Shinsaku Imashuku[3,*], Atsushi Sueyoshi[5]

[1] *Infection Control Committee*
[2] *Division of Emergency and Critical Care Medicine*
[3] *Department of Laboratory Medicine*
[4] *Division of Respiratory Medicine*
[5] *Director, Uji-Tokushukai Medical Center, Uji, Kyoto 611-0041, Japan*

ARTICLE INFO

Article history:
Received 17 June 2021
Revised 16 September 2021
Accepted 26 September 2021

Key words:
COVID-19
Pfizer vaccine
low dead space syringe
effective utilization

Introduction

In the spring 2021, the only available vaccine for COVID-19 was the Pfizer-BioNTech mRNA COVID-19 vaccine (Polack et al., 2020), which was in limited supply in Japan. Also, it was difficult to procure specialized low dead space (LDS) syringes that can extract the full six doses from each vial of the Pfizer vaccine. When the Government provided the Pfizer vaccine to health care workers in our hospital, 1,242 candidates applied for their first shot. However, the use of regular syringes with high dead space meant that only five of the six doses could be extracted from each vial. Thus, the number of doses was insufficient to vaccinate every applicant. Therefore, we looked for alternative ways of using available syringes to extract all of the vaccine doses from each vial.

Methods

Institutional review board approval

The following vaccination program was approved by the institutional review board of Uji-Tokushukai Medical Center. Also, written informed consent was obtained from every vaccine recipient.

Applicants for COVID-19 vaccine and the vials provided

The hospital received 195 vials of Pfizer vaccine to vaccinate 1,242 health care workers; however, using regular syringes meant that there was enough vaccine for only 975 applicants.

Syringes

Insulin syringes (BD; 29G), a type of LDS syringe used routinely for diabetic patients, have the lowest dead space (Figure 1); use of these syringes allowed extraction of seven doses per vial. However, the length of needle attached to the insulin syringe was only 12.7 mm. Since the Pfizer vaccine must be administered intramuscularly, there was some concern about whether this type of syringe can deliver vaccine into the shoulder muscle effectively.

* Correspondence: Shinsaku Imashuku, MD, Consultant, Departments of Pediatrics, Laboratory Medicine, Uji-Tokushukai Medical Center, Uji, Kyoto 611-0041, Japan. Tel: +81-774-20-1111; Fax: +81-774-20-2336.
E-mail address: shinim95@mbox.kyoto-inet.or.jp (S. Imashuku).

https://doi.org/10.1016/j.ijid.2021.09.068

Table 1
Summary of vaccination data

Total N (age; range)	1,242 (19–82 years of age)		
Group A/B	A	B	p
Syringe used	Insulin-type (seven doses/vial)	Regular-type (five doses/vial)	
Thickness of the subcutaneous fat (measured by US)	≦10 mm	>10 mm	
N (%) at 1st shot (N=1,242)	1003 (80.8%)	239 (19.2%)	
(male/female ratio)	399/588	38/217	0.000
Adverse reaction at the time of 1st shot			
Anaphylaxis/death	0/0	1*/0	
Non-anaphylactic reaction	8	4	0.077
N (%) at 2nd shot (N=1,205)	966 (80.2%)	239 (19.8%)	
Adverse reaction at the time of 2nd shot			
Anaphylaxis/death	0/0	0/0	
Non-anaphylactic reaction	44	7	0.199
Anti-spike-IgG antibodies measured 2 weeks after the 2nd shot (N=1,080)			
Seropositivity: Cut-off at 4000 AU/mL**	818/856(95.6%)	218/224(97.3%)	0.235
Symptomatic COVID-19 infection after 2nd shot	0	0	–

* Level 3 based on the Brighton criteria.
** Following the manufacturer's recommendation; Cut-off value of 4000 AU/mL nearly equals to 560 WHO (BAU/mL). Our negative control values were 0.2-10.1 AU/mL and positive controls were 6,122-12,496 AU/mL.

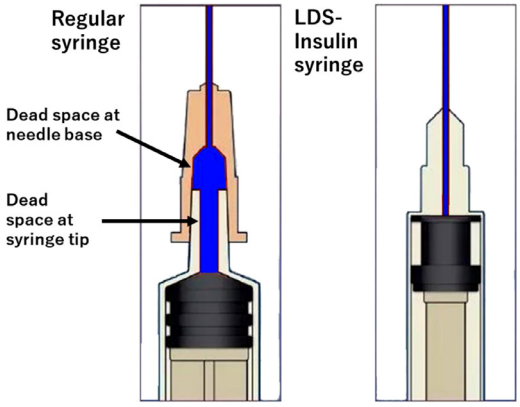

Figure 1. Schematic illustration showing a regular syringe with high dead space and a low dead space (LDS)-type insulin syringe.

Assessment of thickness of subcutaneous fat at the inoculation site

Each recipient underwent routine ultrasound (US) examination to assess the thickness of the subcutaneous fat (i.e., the distance from the skin surface to the muscle) at the injection site in the shoulder muscle.

Preparation for inoculation

Each vial of the Pfizer vaccine contained 0.45 mL, which was diluted with 1.8 mL of saline to yield a total volume of 2.25 mL. One shot contained 30 μg of vaccine product (0.3 mL/dose) per manufacturer's recommendation. From one vial, with a combination of insulin syringes and a regular syringe, 6 doses (each 0.3 mL) with insulin syringes and one dose (0.3 mL) with a regular syringe, a total of 7 doses could be extracted, of which insulin syringes were used for 1003 recipients (Group A, Table 1). On the other hand, with use of regular syringes only, 5 doses (each 0.3mL) could be extracted, all of regular syringes were applied for 239 recipients (Group B, Table 1).

Inoculation

Based on the above data, recipients with subcutaneous fat ≦10 mm thick were inoculated using insulin syringes, and those with subcutaneous fat >10 mm thick were inoculated with regular syringes (BD; 25G) with a long needle (25 mm). Two shots of vaccine (each at 0.3 ml) were given 3 weeks apart (1st and 2nd shots).

Evaluation of adverse reactions (ARs)

According to the manufacturer, possible ARs include anaphylaxis, fever >37.5°C, severe headache/fatigue, ulcer/necrosis at the injection site, seizure, and other complications. ARs were documented after the 1st and 2nd shots. The definition of anaphylaxis was based on the criteria of Brighton (Rüggeberg et al., 2007).

Effectiveness of vaccinations

Effectiveness was evaluated by measurement of anti-spike-IgG antibodies using SARS-CoV-2 IgG II Quant (a CLIA method; Abbott Japan LLC) at >2 weeks after the 2nd shot, as well as by monitoring occurrence of COVID-19 infection during the post-vaccination 2 month follow-up.

Statistical analysis

Data were assessed using the Chi-square test. Statistical significance was set at $P < 0.05$.

Results and Discussion

As summarized in Table 1, 1,242 applicants aged from 19 to 82 years received the vaccine, which was delivered using two types of syringes. Based on the thickness of the subcutaneous fat (determined by US), 1003 (80.8%) applicants were injected using the LDS-insulin syringe (group A; ≦10 mm) and 239 (19.2%) were injected with the regular syringe (group B; >10 mm). Thus, the 195 vials contained sufficient vaccine to provide all 1,242 applicants with a 1st dose. Three weeks later, 1,205 (97.0%) of the 1,242 recipients of a 1st shot received a 2nd shot. At 2 weeks after the 2nd vaccination, 1,080 (87.0%) were tested for anti-spike IgG antibodies. The majority of the 3 % recipients who received their 1st shot in our hospital got 2nd shots at other medical facilities (they were not included for antibody testing).

There was no significant difference in the incidence of ARs between groups A and B after the 1st and 2nd shots ($p>0.05$, Table 1). However, the incidence of ARs after the 2nd shot was significantly higher than that after the 1st shot ($p<0.05$). Only one case of anaphylaxis (Level 3 according to the Brighton criteria) was observed at the time of the 1st shot in group B. In terms of antibody induction, both groups elicited significantly high anti-spike-IgG antibody

titers (>95% seropositivity with the cut-off 4000 AU/mL) and there was no significant difference in antibody positivity rates between groups A and B ($p>0.05$, Table 1). Although anti-spike-IgG antibodies at baseline were not tested prior to vaccination, seropositivity in the vaccine recipients was considered due to vaccination effect, under the consideration of a low seropositive prevalence (5.3 %-5.8 % in general population, https://www.pref.kyoto.jp > kentai > corona > pcrkensa) in the spring of 2021 in Kyoto and in assessing from our anti-spike-IgG negative and positive control values (see footnotes of Table 1). No individuals in either group had a symptomatic infection with COVID-19 after the 2nd shot. Therefore, we concluded that COVID-19 vaccination using LDS-insulin syringes was as effective as that delivered using regular syringes. However, our ingenuity here may limit only for the occasions where sufficient doses of COVI-19 vaccine and suitable syringes were not procured. In cases in which insulin LDS syringes were applied for inoculation, US measurements of the recipients' subcutaneous fat, if possible, is ideal. In summary, because the COVID-19 vaccine is very precious, effective utilization of available vaccines is highly recommended.

Acknowledgments

The authors thank all medical staff involved in the COVID-19 vaccine program at Uji-Tokushukai Medical Center.

Ethical approval

The work was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

Funding source

None.

Conflict of interest

The authors declare no conflicts of interest.

References

Polack FP, Thomas SJ, Kitchin N, et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. N Engl J Med 2020;383:2603–15.

Rüggeberg JU, Gold MS, Bayas JMBrighton Collaboration Anaphylaxis Working Group. Anaphylaxis: case definition and guidelines for data collection, analysis, and presentation of immunization safety data. Vaccine 2007;25:5675–84.