HUMAN VACCINES & IMMUNOTHERAPEUTICS
2022, VOL. 18, NO. 1, e1989922 (4 pages)
https://doi.org/10.1080/21645515.2021.1989922

Taylor & Francis
Taylor & Francis Group

SHORT REPORT

OPEN ACCESS Check for updates

Evaluation of the seroprevalence of measles, rubella, mumps, and varicella and the requirement for additional vaccination based on the JSIPC guidelines among emergency medical technicians at eight fire stations in Narita, Japan: a project review

Ryota Hase[a,b], Yu Niiyama[a,b], and Haruki Mito[a]

[a]Department of Infectious Diseases, Japanese Red Cross Narita Hospital, Chiba, Japan; [b]Department of Infectious Diseases, Kameda Medical Center, Chiba, Japan

ABSTRACT

Limited data are available regarding the seroprevalence of measles, mumps, rubella, and varicella (MMRV) among emergency medical technicians (EMTs) in Japan. The present study aimed to review a project to evaluate adequate immunity against MMRV for the requirement of additional vaccination among EMTs in accordance with the Japanese Society for Infection Prevention and Control guidelines. A retrospective observational study was conducted as part of a vaccination program for EMTs. Each participant was evaluated for medical history, vaccination history, and serology using the criteria established by the Japanese Society of Infection Prevention and Control. In total, 85 EMTs (median age, 31 years; male, 92.9%) were included. Among the included EMTs, 32 (37.6%), 54 (63.5%), 46 (54.1%), and 84 (98.9%) were seropositive for measles, rubella, mumps, and varicella, respectively, whereas 1 (1.2%), 6 (7.1%), 5 (5.9%), and 0 (0%) were seronegative. Furthermore, 48 (56.5%), 27 (31.8%), 45 (52.9%), and 8 (9.4%) EMTs received an additional dose of vaccines for measles, rubella, mumps, and varicella, respectively. The present study suggests that EMTs are not fully immune to MMRV, which highlights the need for confirming the immune status and additional vaccination requirement to prevent occupational infections.

ARTICLE HISTORY
Received 20 July 2021
Revised 9 September 2021
Accepted 28 September 2021

KEYWORDS
Seroprevalence; vaccination; emergency medical technician; paramedic; Japan

Confirming adequate immunity against measles, mumps, rubella, and varicella (MMRV) is recommended for all healthcare workers (HCWs). The Japanese Society of Infection Prevention and Control (JSIPC) has established vaccine guidelines for HCWs in 2009, with subsequent updates published in 2014 and 2020.[1,2] Although several studies have evaluated the seroprevalence of MMRV among hospital-based HCWs in Japan,[3–5] few have focused on the seroepidemiology of MMRV among emergency medical technicians (EMTs).

The Fire and Disaster Management Agency (FDMA) in Japan had published their "infection prevention manual for emergency medical technicians" in 2019, which was updated in 2020.[6,7] This manual recommends vaccinations against MMRV, tetanus, and hepatitis B and serology check when needed according to the JSIPC guidelines. Because of a reported case of a paramedic getting infected with measles during the transport of an infected patient,[8] it is evident that EMTs working as front-line HCWs are at high risk of acquiring contagious diseases and should, therefore, be prioritized for adequate vaccination. In 2020, our hospital initiated a project to confirm adequate immunity against MMRV and the requirement of additional vaccination among EMTs at fire stations in Narita, Japan. The present study aimed to review this project and describe the seroepidemiology of MMRV among EMTs.

This retrospective observational study was performed as part of a vaccination program for EMTs that included paramedics at the Japanese Red Cross Narita Hospital. The hospital collaborated with all eight fire stations in Narita, a middle-sized city in Japan with an approximate population of 131,000, to confirm the immunity status of their EMTs against MMRV and arrange for vaccinations when needed. The project was conducted from August to November 2020. All participants completed a questionnaire distributed in advance that collected data on their medical history and past immunization against MMRV; they were then requested to submit a written vaccination history. Antibody titers against MMRV were measured using an enzyme immunoassay (EIA) kit (Denka Seiken, Tokyo, Japan), with positive and negative cutoff values of ≥4.0 and <2.0, respectively, as determined by the manufacturer. Determining the immune status and performing additional vaccinations were in accordance with the JSIPC guidelines. EMTs who submitted a documented history of two vaccinations were not required to receive any vaccine regardless of their antibody titer. Those who submitted a documented history of one vaccination required one additional vaccination regardless of their antibody titer. MMRV IgG EIA values of <2.0 indicated a negative antibody titer. In contrast, IgG EIA values of ≥16.0, ≥8.0, ≥4.0, and ≥4.0 indicated positive antibody titers for measles, rubella, mumps, and varicella, respectively. EMTs with antibody titers that did not fall into any of the categories were recommended to receive an additional dose of vaccine. This study was approved by the ethics committee of the Japanese Red Cross Narita Hospital under the condition that the confidentiality of all personal data be maintained

CONTACT Ryota Hase hase.ryota@kameda.jp Department of Infectious Diseases, Japanese Red Cross Narita Hospital, Iida-cho 90-1, Narita, Chiba 286-8523, Japan

(JRCNH-728-01). All participants of the vaccination program were included in the present study. Data on age, sex, medical history, and vaccination history with a written document were collected from the completed questionnaires. Vaccination histories were validated using the submitted copies of maternity health-record books or documented records issued by hospitals. In the statistical analysis, categorical variables were described as numbers and percentages, whereas continuous variables were described as medians and ranges.

In total, 85 EMTs, including 46 paramedics, were included. Table 1 details the demographic characteristics of the participants. Participants had a median age of 31 years, and 79 (92.9%) were male. The dominant age group was 21–30 years (44.7%). Table 2 summarizes the participants' medical history, documented vaccination history, seroprevalence, and additional vaccinations. Among the included participants, 16 (18.8%), 16 (18.8%), 41 (48.2%), and 54 (63.5%) reported that they have had measles, rubella, mumps, and varicella, respectively. Of the participants, >50% either had no history of vaccination or could not provide documents regarding the history of vaccination against MMRV. Moreover, 16 (18.8%), 17 (20.0%), 0 (0%), and 1 (1.2%) participant were vaccinated twice for measles, rubella, mumps, and varicella, respectively. Among the participants, 32 (37.6%), 54 (63.5%), 46 (54.1%), and 84 (98.9%) had positive antibodies for measles, rubella, mumps, and varicella, respectively. Furthermore, 1 (1.2%), 6 (7.1%), 5 (5.9%), and 0 (0%) participants were seronegative for measles, rubella, mumps, and varicella, respectively. Notably, five of six participants seronegative for rubella were males in their 40s. Additional measles, rubella, mumps, and varicella vaccinations were required for 48 (56.5%), 27 (31.8%), 45 (52.9%), and 8 (9.4%) participants.

The results from our present study indicated that approximately 50% EMTs required at least one additional dose of vaccine for measles, rubella, and mumps according to the JSIPC guidelines, with some being fully susceptible to measles, rubella, and mumps.

EMTs may have lower seropositivity for these contagious diseases than hospital-based HCWs. Seropositivity within a specific population can be affected by age and sex distribution; young and middle-aged men, the population that represents the majority of EMTs across Japan, tend to have lower seropositivity. According to statistical data from the FDMA, only 3.5% of all EMTs are females.[9] Using the same cutoff, a previous study showed that 62.2%, 80.3%, and 68.2% of hospital-based HCWs at a hospital in Japan exhibited seropositivity for measles, rubella, and mumps, respectively,[5] which were higher than the values (37.6%, 63.5%, and 54.1%, respectively) observed in the present cohort. This difference can be attributed primarily to the fact that majority of our participants were young and middle-aged men compared with the female-dominant population with a wide range of age distribution included in the aforementioned study. This is also supported by the lower seropositivity for measles and mumps among individuals in their 20s–30s included in the aforementioned study. Moreover, data from the Japanese National Institute of Infectious Diseases revealed that the seroprevalence for rubella among men in their 40s and 50s were lower than that in women of the same age owing to the precepts of the national vaccination program conducted during the time when they had received the rubella vaccine.[10]

Notably, vaccination history and seropositivity among individuals are affected by the changes of the national immunization program (NIP) in Japan. The measles and rubella vaccines were first introduced in 1966 and 1976, respectively, in Japan and became a part of routine vaccinations included in the NIP in 1978 and 1977, respectively. At this point in time, the rubella vaccine was administered only to female junior-high school students. The combined measles, mumps, and rubella vaccine, which was introduced to the NIP in 1989, was withdrawn in 1993 owing to aseptic meningitis as a side effect. In 2006, the two-dose schedule using the combined measles-rubella vaccine was implemented for universal immunization.[11–13] Since 2019, the Japanese government has started examining the levels of rubella antibody to determine the immunity status of adult males and provide the measles-rubella vaccine free of cost to susceptible males born between 1962 and 1979.[14] We found that some participants in the present study had received follow-up doses either independently or as part of the additional immunization campaign. The live attenuated varicella vaccine derived from the Oka strain, which was developed in 1974, was administered on a voluntary basis in Japan until 2014; at this point in time, it was introduced into the NIP for universal immunization by the government.[15] In contrast, the mumps vaccine has been offered on a voluntary basis till date.[16] The relatively higher rate of vaccination history against measles and rubella among younger individuals and the lower rate of vaccination history against mumps and varicella zoster virus among the individuals in all age groups in the present cohort also reflect this historical background. Moreover, the unique cohort of this study, which comprised primarily males and included a large number of middle-aged male EMTs, is more susceptible to measles and rubella because they had fewer opportunities to receive measles and rubella vaccine doses in the NIP.

The present study suggests that appropriate vaccination programs should be developed for healthcare students during or even before pre-occupational education. In the United States, the majority of healthcare professional schools require their students to receive these vaccines before admission.[17] However, such strict requirements are rare in Japan. In addition, the majority of the study participants could not provide a documented history of vaccination against MMRV and some were fully susceptible to MMRV, which suggests that no screening was performed at their occupational institute. In addition, each person should receive a vaccination record, which should then be preserved permanently. Ideally, systems for maintaining electronic records of vaccination should be implemented.[18] Guideline-compliant vaccination programs for EMTs are strongly encouraged for their as well as their patients' safety.

Table 1. Participant demographic characteristics (N = 85).

Characteristics	Overall (*n* = 85)
Median age in years (range)	31 (19–49)
Sex: male/female (%)	79/6 (92.9/7.1)
Age distribution (%)	
≤20	1 (1.2)
21–30	38 (44.7)
31–40	21 (24.7)
41–50	24 (28.2)

Table 2. Past history, documented vaccination history, seroprevalence, and additional vaccination (N = 85).

Past history (N = 85)	Yes	No	Unknown
Measles All (%)	16 (18.8)	46 (56.1)	23 (27.0)
Age 19–30, n (%), n = 39	9 (23.1)	25 (64.1)	5 (12.8)
Age 31–40, n (%), n = 22	3 (13.6)	13 (59.1)	6 (27.3)
Age 41–50, n (%), n = 24	4 (16.7)	8 (33.3)	12 (50.0)
Rubella All (%)	16 (18.8)	42 (49.4)	27 (31.8)
Age 19–30, n (%), n = 39	4 (10.3)	26 (66.7)	9 (23.1)
Age 31–40, n (%), n = 22	8 (36.4)	10 (45.5)	4 (18.2)
Age 41–50, n (%), n = 24	4 (16.7)	6 (25.0)	14 (58.3)
Mumps All (%)	41 (48.2)	26 (30.6)	18 (21.2)
Age 19–30, n (%) n = 39	20 (51.3)	12 (30.8)	7 (17.9)
Age 31–40, n (%) n = 22	9 (40.9)	8 (36.4)	5 (18.2)
Age 41–50, n (%) n = 24	12 (50.0)	6 (25.0)	6 (25.0)
Varicella All (%)	54 (63.5)	17 (20.0)	14 (16.5)
Age 19–30, n (%), n = 39	26 (66.7)	9 (23.1)	4 (10.3)
Age 31–40, n (%), n = 22	13 (59.1)	5 (22.7)	4 (18.2)
Age 41–50, n (%), n = 24	15 (62.5)	3 (12.5)	6 (25.0)
Vaccination history (N = 85)	**Once**	**≥ 2**	**No or Unknown**
Measles All (%)	21 (24.7)	16 (18.8)	48 (56.5)
Age 19–30, n (%), n = 39	9 (23.1)	14 (35.9)	16 (41.0)
Age 31–40, n (%), n = 22	9 (40.9)	2 (9.1)	11 (50.0)
Age 41–50, n (%), n = 24	3 (12.5)	0 (0)	21 (87.5)
Rubella All (%)	9 (10.6)	17 (20.0)	59 (69.4)
Age 19–30, n (%), n = 39	8 (20.5)	15 (38.5)	16 (41.0)
Age 31–40, n (%), n = 22	1 (4.5)	2 (9.1)	19 (86.4)
Age 41–50, n (%), n = 24	0 (0)	0 (0)	24 (100)
Mumps All (%)	11 (12.9)	0 (0)	74 (87.0)
Age 19–30, n (%), n = 39	5 (12.8)	0 (0)	34 (87.2)
Age 31–40, n (%), n = 22	4 (18.2)	0 (0)	18 (81.8)
Age 41–50, n (%), n = 24	2 (8.3)	0 (0)	22 (91.7)
Varicella All (%)	5 (5.9)	1 (1.2)	79 (92.9)
Age 19–30, n (%), n = 39	4 (10.3)	1 (2.6)	34 (87.2)
Age 31–40, n (%), n = 22	1 (4.5)	0 (0)	21 (95.5)
Age 41–50, n (%), n = 24	0 (0)	0 (0)	24 (100)
Serology (N = 85)	**Positive***	**Intermediate****	**Negative*****
Measles All (%)	32 (37.6)	52 (61.2)	1 (1.2)
Age 19–30 (%) n = 39	10 (25.6)	28 (71.7)	1 (2.6)
Age 31–40, n (%), n = 22	6 (27.3)	16 (72.7)	0 (0)
Age 41–50, n (%), n = 24	16 (66.7)	8 (33.3)	0 (0)
Rubella All (%)	54 (63.5)	25 (29.4)	6 (7.1)
Age 19–30, n (%), n = 39	24 (61.5)	14 (35.9)	1 (2.6)
Age 31–40, n (%), n = 22	16 (72.7)	6 (27.3)	0 (0)
Age 41–50, n (%), n = 24	14 (58.3)	5 (20.8)	5 (20.8)
Mumps All (%)	46 (54.1)	34 (40.0)	5 (5.9)
Age 19–30, n (%), n = 39	22 (56.4)	15 (38.5)	2 (5.1)
Age 31–40, n (%), n = 22	10 (45.5)	9 (40.9)	3 (13.6)
Age 41–50, n (%), n = 24	14 (58.3)	10 (41.7)	0 (0)
Varicella All (%)	84 (98.9)	1 (1.2)	0 (0)
Age 19–30, n (%), n = 39	39 (100)	0 (0)	0 (0)
Age 31–40, n (%), n = 22	21 (95.5)	1 (4.5)	0 (0)
Age 41–50, n (%), n = 24	24 (100)	0 (0)	0 (0)
Additional vaccinations (N = 85)	**Once**	**Twice**	**None**
Measles All (%)	48 (56.5)	0 (0)	37 (43.5)
Age 19–30, n (%), n = 39	21 (53.8)	0 (0)	18 (46.2)
Age 31–40, n (%), n = 22	17 (77.3)	0 (0)	5 (22.7)
Age 41–50, n (%), n = 24	10 (41.7)	0 (0)	14 (58.3)
Rubella All (%)	21 (24.7)	6 (7.1)	58 (68.2)
Age 19–30, n (%), n = 39	10 (25.6)	1 (2.6)	28 (71.8)
Age 31–40, n (%), n = 22	6 (27.3)	0 (0)	16 (72.7)
Age 41–50, n (%), n = 24	5 (20.8)	5 (20.8)	14 (58.3)
Mumps All (%)	41 (48.2)	4 (4.7)	40 (47.1)
Age 19–30, n (%), n = 39	18 (46.2)	2 (5.1)	19 (48.7)
Age 31–40, n (%), n = 22	11 (50.0)	2 (9.1)	9 (40.9)
Age 41–50, n (%), n = 24	12 (50.0)	0 (0)	12 (50.0)
Varicella All (%)	8 (9.4)	0 (0)	77 (90.6)
Age 19–30, n (%), n = 39	3 (7.7)	0 (0)	36 (92.3)
Age 31–40, n (%), n = 22	3 (13.6)	0 (0)	19 (86.4)
Age 41–50, n (%), n = 24	2 (8.3)	0 (0)	22 (91.7)

* IgG enzyme immunoassay values of ≥16.0, ≥8.0, ≥4.0, and ≥4.0 are defined as positive for measles, rubella, mumps, and varicella, respectively.
** IgG enzyme immunoassay values between positive and negative limits are defined as intermediate for measles, rubella, mumps, and varicella.
*** IgG enzyme immunoassay values of <2.0 are defined as negative for measles, rubella, mumps, and varicella.

The present study has some limitations. First, the sample size was small and may thus not reflect the general population of EMTs in Japan. However, considering that the female ratio in this cohort is higher than that in the general population, sex distribution may not cause bias for lower seropositivity in our cohort. Second, regionality could not be considered in this study because all EMTs were stationed at fire stations within one city. Third, no consensus has been established regarding the higher antibody titer used as the cutoff for seropositivity, with evidence showing that the effectiveness of higher titers in HCWs was inadequate.[4] However, these criteria were used based on the fact that both the JSIPC and FDMA recommend them. Moreover, we compared the data obtained from this cohort with those reported in a study that used the same criteria.[5]

In conclusion, this retrospective descriptive study suggests that EMTs in Japan are not fully immune to MMRV. Thus, promoting guideline-compliant vaccination programs for EMTs and the students of healthcare professional schools is strongly recommended to prevent occupational infections.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

ORCID

Ryota Hase http://orcid.org/0000-0002-3135-1757

References

1. Okabe N, Arakawa S, Iwata S, Ihara T, Shiraishi T, Taya K, Fujimoto T, Mikamo H, Yasuoka A. Vaccine guidelines for medical personnel. Jpn J Infect Prev Control. 2014;29:S1–S14.
2. Mikamo H, Taya K, Ishiguro N, Iwata S, Uchida M, Okada K, Kanai S, Toyokawa M, Nakano T, Fujimura S, et al. Vaccine guidelines for medical personnel. Jpn J Infect Prev Control. 2020;35:S1–S32.
3. Hatakeyama S, Moriya K, Itoyama S, Nukui Y, Uchida M, Shintani Y, Morisawa Y, Kimura S. Prevalence of measles, rubella, mumps, and varicella antibodies among healthcare workers in Japan. Infect Control Hosp Epidemiol. 2004;25:591–94. doi:10.1086/502444.
4. Yoshioka N, Deguchi M, Hagiya H, Kagita M, Tsukamoto H, Takao M, Tomono K. Vaccination strategy for epidemic viral diseases in healthcare workers: Cut-off for optimal immunization. J Infect Chemother. 2019;25:78–81.
5. Ogawa T, Inoue T, Kasahara K, Konishi M, Mikasa K. Impact of vaccination on measles, mumps, and rubella antibody titers in Japanese healthcare workers: an observational study. PLoS One. 2020;15:e0230329. doi:10.1371/journal.pone.0230329.
6. Fire and Disaster Management Agency, Japan. Infection prevention manual for emergency medical technicians Ver.1.0. (in Japanese). 2019 March 28. [accessed 2021, July 11]. https://www.fdma.go.jp/laws/tutatsu/items/2dc170661c3fee7f3f4c5dd337102e95efa0a853.pdf .
7. Fire and Disaster Management Agency, Japan. Infection prevention manual for emergency medical technicians Ver.2.0. (in Japanese). 2020 December 25. [accessed 2021, July 11]. https://www.fdma.go.jp/laws/tutatsu/items/201225_kyuuki_01.pdf .
8. Berry T, Palmer T, Wells F, Williams E, Sibal B, Timms J. Nosocomial outbreak of measles amongst a highly vaccinated population in an English hospital setting. Infect Prev Pract. 2019 Aug 17;1(2):100018. doi:10.1016/j.infpip.2019.100018.
9. Fire and Disaster Management Agency, Japan. Guidebook for women's empowerment. (in Japanese). 2021, March 31. [accessed 2021, July 11]. https://www.fdma.go.jp/relocation/josei_shokuin/r01_josei_shokuin_guidebook.pdf .
10. NIID. Rubella vaccination status and seroprevalence in Japan, FY2019—national epidemiological surveillance of vaccine-preventable diseases (provisional results). Infect Agents Surveill Rep. 2020;41:162–64.
11. Nakayama T. Vaccine chronicle in Japan. J Infect Chemother. 2013;19:787–98. doi:10.1007/s10156-013-0641-6.
12. Terada K. Rubella and congenital rubella syndrome in Japan: epidemiological problems. Jpn J Infect Dis. 2003;56:81–87.
13. Gomi H, Takahashi H. Why is measles still endemic in Japan? Lancet. 2004;364:328–29. doi:10.1016/S0140-6736(04)16715-9.
14. Ministry of Health. Labour and welfare of Japan. Tokyo: Press release; 2019 January 31. [accessed 31 August 2021]. https://www.mhlw.go.jp/content/10906000/000590968.pdf .
15. Yoshikawa T, Kawamura Y, Ohashi M. Universal varicella vaccine immunization in Japan. Vaccine. 2016;34:1965–70. doi:10.1016/j.vaccine.2016.02.058.
16. Ohfuji S, Takagi A, Nakano T, Kumihashi H, Kano M, Tanaka T. Mumps-related disease burden in Japan: analysis of JMDC Health Insurance reimbursement data for 2005–2017. J Epidemiol. 2021;31:464–70. doi:10.2188/jea.JE20200048.
17. Lindley MC, Lorick SA, Spinner JR, Krull AR, Mootrey GT, Ahmed F, Myers R, Bednash GP, Cymet TC, Maeshiro R, et al. Student vaccination requirements of U.S. health professional schools: a survey. Ann Intern Med. 2011;154:391–400. doi:10.7326/0003-4819-154-6-201103150-00004.
18. Atkinson KM, Mithani SS, Bell C, Rubens-Augustson T, Wilson K. The digital immunization system of the future: imagining a patient-centric, interoperable immunization information system. Ther Adv Vaccines Immunother. 2020;8:2515135520967203.