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# Vaccine usage and wastage in a designated Yellow Fever Vaccination Centre in North India

**Purpose:** Yellow fever is a viral hemorrhagic fever transmitted through the bite of mosquitoes. World Health Organization guidelines advocate a single dose of vaccine for life-long protective immunity against yellow fever. Yellow fever vaccine is included in routine childhood immunization schedules in countries at medium or high risk of yellow fever. For some travelers, visiting endemic countries, yellow fever vaccination is recommended to protect the travelers. We calculated the yellow fever vaccine wastage rate at a designated center in North India.

**Materials and Methods:** This is a record-based study. The data for the study was obtained from the immunization center of Government Medical College, Srinagar, Jammu and Kashmir. The particulars for every vaccine recipient were present in the register. The vaccine wastage rate was calculated. The analysis was done in IBM SPSS ver. 20.0 (IBM Corp., Armonk, NY, USA) and results were presented as numbers and frequencies.

**Results:** A total of 136 doses were issued out of which 111 doses were administered from November 2017 till October 2020. The maximum number of travelers was young adults (26.1%). In 83.7% of cases, the area of the visit was Africa. The vaccine wastage rate was 18.4%.

**Conclusion:** The vaccine wastage rate was not very high and was within that recommended for vaccines in routine immunization.

**Keywords:** Yellow fever, Vaccine, Immunization

## Introduction

Yellow fever is a viral hemorrhagic fever transmitted through the bite of mosquitoes [1]. The virus causing yellow fever is a flavivirus (family-Flaviviridae) that is transmitted to humans primarily through the bite of *Aedes* species and *Haemagogus* species of mosquitoes. Yellow fever virus infection can be asymptomatic or cause a spectrum of disease ranging from a mild non-specific febrile illness to hemorrhagic fever with multi-organ failure and death. "Yellow" refers to jaundice which is caused by the disease [2]. No specific treatment is available for yellow fever; only supportive treatment is given. Without treatment, mortality is up to 50% in severely affected persons [3].

Yellow fever is a disease endemic to the tropical areas of Africa and South America. Approximately 200,000 cases and 30,000 deaths from the disease occur each year [4]. Yellow fever is considered to be a re-emerging disease due to increasing reports of its occurrence in different parts of the world in recent years [3].

Yellow fever virus can cause devastating epidemics with high case fatality rates es-

pecially in populations where vaccine-derived or naturally acquired immunity is low [3,5-7]. Elimination of yellow fever is not feasible, but control is achievable due to the availability of a safe, low cost, and highly effective vaccine [6]. A live attenuated vaccine, developed by Max Theiler and colleagues in the 1930s has helped to control yellow fever [8]. All currently available vaccines derive from the sub-strains 17D-204 (China, France, Senegal, and the United States), 17D-213 (Russia), and 17DD (Brazil). The vaccines available for yellow fever prevention are safe and efficacious and are usually administered by subcutaneous injection. World Health Organization guidelines advocate a single dose of vaccine for life-long protective immunity against yellow fever [5]. A single dose of yellow fever vaccine is included in routine childhood immunization schedules in countries at medium or high risk of yellow fever. Some countries are at risk of yellow fever only in circumscribed areas and only infants in those areas are vaccinated; these decisions follow risk analyses but can also be influenced by the availability of the yellow fever vaccine [9]. Proof of yellow fever vaccination is required for entry into some countries according to the International Health Regulations. For some travelers, visiting endemic countries, yellow fever vaccination is recommended to protect the travelers [10]. Unvaccinated travelers may import the infection to other countries. Vaccination of travelers against yellow fever is important for two reasons: (1) travelers into endemic areas require yellow fever vaccination to protect their health and to prevent them from bringing yellow fever back to their home country and (2) travelers from endemic areas need to receive yellow fever vaccine to prevent them from introducing yellow fever into areas with susceptible mosquito vectors and a susceptible population [9].

The yellow fever vaccine available in India is produced and supplied by Central Research Institute, Kasauli. Yellow fever vaccines are available in multi-dose (10, 5, and 2 doses) or single-dose vials. The vaccine is freeze-dried and has to be reconstituted before administration [7]. The reconstituted vaccine cannot be used beyond 4 hours after reconstitution and hence has to be discarded irrespective of the doses remaining in the vial, leading to wastage. Thus, vaccine wastage is expected to be high in a yellow fever vaccination center with a limited number of daily vaccinations. The type of vaccine vial used, single-dose or multi-dose, also affects the wastage rates. We designed the present study to calculate yellow fever vaccine usage rate and wastage factor at a designated Yellow Fever Vaccination Centre in a tertiary care hospital setting.

## Materials and Methods

This study involves an analysis of secondary data. The data for the study was obtained from the immunization center of a tertiary care hospital in Srinagar, Jammu and Kashmir. The immunization center vaccinates around 250–300 children and 15–20 ante-natal females per month for the vaccines enlisted in National Immunization Schedule. The immunization center is a designated Yellow Fever Vaccination Centre since 2017. The center uses a 2-dose yellow fever vaccine vial. Records of people vaccinated at the center are maintained in a register. Information recorded includes socio-demographic particulars, the area of visit, and the date of vaccination. The same register was used as a source of information and data was recorded in a Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). The particulars for every vaccinee were present in the register and there was no missing data.

Vaccine usage and wastage rates were calculated using the formula [11].

$$\text{Vaccine usage rate} = (\text{doses administered} \div \text{doses issued}) \times 100$$

$$\text{Vaccine wastage rate} = 100 - \text{vaccine usage rate}$$

The analysis was done in IBM SPSS Statistics for Windows ver. 20.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages. Ethical clearance for the study was obtained from the Institutional Ethical Committee of Government Medical College Srinagar before undertaking the study (152/ETH/GMC).

## Results

Between November 2017 and October 2020, a total of 136 doses were issued out of which 111 doses were administered. Table 1 presents the year-wise number of vaccinations since 2017. Socio-demographic characteristics of the vaccinees are presented in Table 2. Most of the vaccine recipients were young males planning to visit Africa more than 10 days after vacci-

**Table 1.** Year-wise distribution of vaccination doses given

Year	No. of vaccinations done (%)
2017	1 (0.9)
2018	56 (50.4)
2019	40 (36.1)
2020	14 (12.6)
Total	111 (100.0)

**Table 2.** Socio-demographic characteristics of the vaccinees (n=111)

Characteristic	No. (%)
Age group (yr)	
1–10	4 (3.6)
11–20	2 (1.8)
21–30	29 (26.1)
31–40	26 (23.5)
41–50	29 (26.1)
51–60	10 (9.0)
61–70	11 (9.9)
Gender	
Male	91 (81.9)
Female	20 (18.1)
Place of residence	
Jammu and Kashmir	88 (79.3)
Others	23 (20.7)
Place of visit	
Africa	93 (83.7)
Asia	6 (5.5)
North America	1 (0.9)
South America	11 (9.9)
Time before travel (day)	
<10	1 (0.9)
≥10	110 (99.1)
Religion	
Muslim	80 (72.1)
Hindu	24 (21.6)
Sikh	7 (6.3)

nation. The overall vaccine wastage rate since the inception of the Yellow Fever Vaccination Centre was 18.4% (Table 3).

## Discussion

This was a record-based study conducted at a designated Yellow Fever Vaccination Centre in Government Medical College, Srinagar. The yellow fever vaccine wastage rate at the center was 18.4%.

The center was designated as Yellow Fever Vaccination Centre in November 2017 and only one person received the vaccine during that time. The number of vaccinees again dropped in 2020 because of travel restrictions during the coronavirus disease 2019 pandemic.

Most of the vaccine recipients were young males between 21–50 years. This reflects the cultural practices in Jammu & Kashmir wherein males who go out of the country for jobs and other income prospects leaving their families behind. In 83.7% of cases, the area of the visit was Africa. The catchment

**Table 3.** Vaccine usage and wastage

Variable	Value
Doses issued	136
Doses administered	111
Vaccine vials used	68
Vaccine usage rate (%): [(doses administered÷doses issued)× 100]	81.6
Vaccine wastage rate (%): (100-vaccine usage rate)	18.4

Values are presented as number or %.

area of the vaccination center is a Muslim majority area; hence, most (72.1%) of the vaccine recipients were Muslims.

A total of 136 doses were issued during the study period, out of which only 111 doses were administered. A total of 68 vials were used. The vaccine usage rate as calculated by the formula was 81.6%; thus, vaccine wastage rate was 18.4%. Vaccine wastage can be anticipated in all immunization programs [12]. Vaccine wastage can be classified into two types. Firstly, vaccine wastage in opened vials (wastage of the remaining doses in opened vials at the end of an immunization session and poor reconstitution practices). These causes can be partly prevented by the introduction of multi-dose vial policy (open vial policy), use of vaccine vial monitors, and enhanced immunization plans and practices [9,13]. Secondly, vaccine wastage in unopened vials (wastage from unopened vials due to faulty cold chain management, breakage, expiry, and stock management problems). These causes can be minimized or reduced. In all these factors the relationship between vaccine wastage rate and immunization coverage is the crucial factor to determine whether wastage is high and plan remedial measures. However, immunization coverage can only be determined for a vaccine that is a part of the routine immunization program [12,13].

A single cut-off for the optimal vaccine wastage cannot be determined or recommended since it depends on many factors including local situations and coverage of the vaccine. Both coverage and wastage rates should be analyzed over some time rather than at a point in time to reveal trends [12]. In endemic countries where yellow fever vaccine is given as routine immunization, the wastage rate is variable and has been reported to range from 0%–55% [13]. Endemic countries, where the vaccine usage rate is high, cannot afford high vaccine wastage rates. In India, the yellow fever vaccine is not a part of routine immunization and is only given to travelers visiting the endemic countries; hence, its coverage cannot be determined.

We found a vaccine wastage rate of 18.4% in our study, main-

ly through unused doses at the end of an immunization session. At our center, we use a two-dose, freeze-dried yellow fever vaccine. Any unused dose needs to be discarded. The wastage rate at our center is less than what is reported from an endemic country [13]. To the best of our knowledge, yellow fever vaccine wastage rates haven't been reported from non-endemic countries or regions before our study. World Health Organization has set no maximum limit of vaccine wastage rate for yellow fever vaccine in multi-dose vials [12]. The Ministry of Health and Family Welfare, Government of India, has recommended that the wastage rate of all vaccines should not be higher than 25% [7].

Rustagi et al. [14] have reported a wastage of 23.5% for fractional inactivated polio vaccine (IPV) and 18%–31% for rotavirus vaccine before introduction of a tool for wastage reduction. The wastage rates dropped to 8.6% and 11.4% for fractional IPV and rotavirus vaccine respectively following use of the tool. In Cambodia, the average facility-level wastage rate has been reported to range from 4% for single-dose pentavalent vaccine to 60% for 10-dose measles containing vaccine [15].

## Recommendations

### *Changing the vial size*

As vaccine wastage in our center was mostly through unused doses at the end of an immunization session, using a single-dose vial instead of a two-dose vial can minimize vaccine wastage.

### *Reconstitution practices*

If the whole content of diluent is not used to reconstitute powder vaccine, fewer doses are generated in the vaccine vial for vaccination. Thus, training and re-training of vaccinators are needed for better reconstitution practices. Vaccines reconstituted with the wrong volume of diluent may also cause adverse events following immunization. A liquid form of the vaccine can thus reduce wastage and adverse events.

### *Earliest-expiry-first-out principle*

Always applying this principle helps in overcoming the problem with expiry and is safer than first-in-first-out handling.

### *Improved vaccine management practices*

Training and disseminating proper manuals and materials to build the capacity of the vaccinators will work towards avoiding and minimizing wastage.

### *Improved procurement practices*

Better vaccine forecasting with more realistic vaccine wastage rates will prevent the arrival of excess amounts of vaccine.

### *Monitoring vaccine wastage regularly*

It is observed and documented that monitoring vaccine wastage regularly will help improve vaccine estimation and minimize wastage.

## Conclusion

The yellow fever vaccine wastage rate was not high in our study. Unused doses at the end of an immunization session were the main reason for vaccine wastage.

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