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Cold chain evaluation of the immunization program in Primary Health Centers in 2022

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Abstract

Purpose: The major challenges of vaccination programs are associated with the vaccine cold chain management in primary health centers that must be evaluated. This paper discusses how vaccine cold chain management can address the challenges of vaccination programs in primary health centers. Specifically, it examines how the vaccine chain is managed. **Methods:** The design of this observational study was cross-sectional. Evaluations assessed in this study include input aspects, output aspects, process aspects, and outcome aspects of vaccine chain management. Observation methods and direct interviews with the evaluated vaccine chain staff collected primary data. **Results:** Management of the vaccine chain has been carried out properly with the support of human resources or immunization personnel who are in accordance with their competence, based on research results, the management staff are diploma graduates in nursing and midwifery. The defrosting process is carried out for a certain period, as well as using vaccine carriers and ice flasks, which are still good for vaccine distribution. It is very important to pay attention to the supply of the number and type of vaccines for the next month's needs at the public health center. **Conclusion:** The three key factors that guide the vaccine cold chain are educated vaccine control staff, vaccine storage, and delivery equipment, and efficient vaccine control procedures

Keywords: immunization personnel; primary health center; vaccine chain

INTRODUCTION

Immunization in Indonesia began in 1956 with smallpox immunization in Central Java. This activity succeeded in eradicating smallpox in Indonesia, in 1974, Indonesia was declared smallpox-free by the World Health Organization (WHO). Subsequent developments in immunization began in 1973 with BCG immunization, in 1974 with tetanus toxoid (TT) immunization in pregnant women, in 1976 with Diphtheria Pertussis Tetanus (DPT) immunization, in 1980 with polio immunization, in 1982 with measles immunization, and in In 1993 Hepatitis B immunization began.

The Ministry of Health has determined that the ultimate goal of immunization is polio eradication, elimination of neonatal tetanus, and reduction of measles. Various efforts have been made to achieve this goal, in addition to routine immunization carried out at *POSYANDU* (integrated service post) and puskesmas (community health center) mass immunization is also carried out, including polio immunization for toddlers through the national immunization week (PIN/ *Pekan Imunisasi Nasional*) in 1995, 1996, and 1997, measles immunization for toddlers aged 9-59 months in high-risk villages for measles through the national immunization week in 1999, TT immunization for women of childbearing

age in high-risk villages for TT through the 1996 and 1997 national immunization weeks and polio eradication at immunization weeks 2016 national level, the World Immunization Week in 2019 to maintain Polio-Free Indonesia towards achieving global polio eradication, maintaining Tetanus Neonatorum Elimination and Measles Elimination and realizing Rubella disease control in 2020. as well as elementary school children grades II to grade VI through the School Children's Immunization Month (BIAS), and now in 2022 the Ministry of Health launched the National Childhood Immunization Month (BIAN) with a target of eliminating measles-rubella/Congenital Rubella Syndrome (CRS) in 2023, maintaining Polio-free Indonesia and realizing a Polio-free world in 2026 and preventing its occurrence. Other Extraordinary Events of Diseases Preventable by Immunization.

In the 2018-2023 Strategic Plan, the Central Java Provincial Health Office found that not all villages had reached UCI (Universal Child Immunization), in 2017 there were still extraordinary cases of diseases that could be prevented by immunization because there were still rejections in some districts in Central Java. The increasing number of cases of pulmonary tuberculosis is because not all components implementing case finding in healthcare facilities have received training and the availability of infrastructure and facilities in health centers and hospitals is not yet optimal. The percentage of toddlers who have received immunization by type of immunization in Magelang Regency from 2016-2019 tends to experience an increasing trend.

Based on the research background, it is necessary to evaluate the management of the vaccine chain from the Regency Health Office to the integrated health service post (*POSYANDU*) level which is carried out by the Primary Health Center (*puskesmas*) immunization officers which include three aspect: input, process, and output [1].

METHODS

The research targets were vaccine chain officers at the District Health Office and Community Health Centers in Magelang District. This observation research design is a cross-sectional design. Evaluation carried out: a) Input aspects include vaccine chain implementing staff, operational funds, and facilities for vaccine chain equipment [2]; b) Output aspects include fulfillment of the quantity and quality of vaccines [3]; c) Process aspects include equipment maintenance, equipment placement, taking and receiving vaccines, storing vaccines, and using vaccines [4]; d) Outcome aspects include cases of diseases that can be prevented by immunization in toddlers who have been immunized [5].

The location for evaluation of this research program was carried out at the Health Office and Community Health Centers throughout Magelang Regency. Primary data collection is carried out by observation and direct interviews with the evaluated vaccine chain staff. Secondary data collection was carried out by collecting report data and records of immunization program facilities from the District Health Office and Community Health Centers.

Measuring tools in questionnaire research and checklists at each stage or level of evaluation: a) Input is measured using a structured questionnaire by conducting interviews with subjects [6]; b) Process is measured by using a questionnaire and observation format in the form of a checklist by conducting direct observations and interviews with research subjects [7]; c) Output is measured using a structured questionnaire by conducting interviews with subjects [8]; d) Outcome is measured using a structured questionnaire [9].

RESULTS

Magelang Regency is one of 35 regencies in the Province of Central Java with the capital city of Mungkid with an area of 1,086 km^2. Based on data from Magelang Regency Statistics Center, based on the 2020 population census, the population is 1,305,512 people. Health service facilities in Magelang Regency include Muntilan Hospital and Merah Putih Hospital, as well as several private hospitals, and 29 Community Health Centers.

Routine immunization services have been carried out in every health service facility in Magelang Regency such as hospitals, health centers, auxiliary health centers, *POSYANDU* and *POLINDES*. The success of the immunization program is determined by looking at the quality of the vaccine chain management implemented at the Magelang District Health Office.

Inputs: **Vaccine chain manager**

The immunization section under the disease control department oversees the management of the vaccine chain at the Magelang District Health Office. A section head is in charge of the immunization section. In addition to managing the vaccine chain, he also performs technical development and supervision duties at the *puskesmas* (primary health center).

Table. 1. Characteristics distribution of vaccine chain officers in Magelang Regency in 2022 (n=26)

	Public Health Center		Regency Health Office	
	Freq	%	Freq	%
Age group (years)				
21-30	2	7.7	0	0
31-40	5	19.2	0	0
41-50	9	34.6	0	0
51-60	10	38.5	1	100.0
Education				
High school	0	0	1	100.0
Diploma of Health	23	88.5	0	0
Bachelor of Health	3	11.5	0	0
Main position				
Midwife	13	50		
Immunization coordinator	8	30.8		
Nurse	5	19.2		

There are 26 vaccine chain managers at the health center consisting of 1 male (3.84%) and 25 female (96.16%), while at the Magelang District Health Office, there are 1 provincial, one. The age group managing the vaccine chain at the health center was the most in the age group of 51 - 60 years: 10 people (37.0%) and one from the health office had the age group of 51 - 60 years.

Vaccine chain managers have different educational backgrounds. The most recent educational background at the puskesmas was D3 Health with as many as 23 people (88.5%) and in the health office all were general high schools.

The vaccine chain manager at the health office is a surveillance and immunization staff member in the disease control sector. The management of the vaccine chain at the puskesmas is carried out by immunization coordinators (*KORIM*), midwives and nurses. Most of these activities were carried out by 13 midwives or (50.0%) (**Table 1**).

Vaccine chain managers at the health office and *puskesmas* who stated that they had attended upgrading or training on vaccine management either held at the national, provincial or district level were 22 people (81.5%) while 5 people (18.5%) had not attended upgrading or training on vaccine management. 22 people (100%) stated that operational funds were available and sufficient for one year, but when asked about the source of funds, their answers varied at the puskesmas, 21 people (76.2%) stated that operational funds were sourced from the district budget. Magelang and 4 people (19.0%) from the Provincial Budget.

Facilities (equipment)

Most of the vaccine chain equipment is procured from APBN (State budget) funds, only a small portion is procured from APBD (Regional budget) funds, since the enactment of regional autonomy for recording and maintaining vaccine chains is procured by the regions. The equipment provided by the center includes refrigerators, freezers, vaccine carriers, cold boxes, and cold packs. While the local government holds the vaccine stock book and temperature cards through the regional budget.

Table 2 found that 1 *Puskesmas* or Primary Health Center (3.70%) did not have a technical guidebook for vaccine management. 100% had refrigerators that could still be used properly for vaccine storage. As many as 74.1% use refrigerators with refrigerants (Freon). All refrigerators used are top opening. Refrigerators using compression cooling systems were 74.1% and refrigerators using absorption cooling systems were 40.7%. The number of work units that have a thermostat in the refrigerator is 92.6%. The percentage of work units that have refrigerator spare parts is only 22.2% and only 14.8% have sufficient types of refrigerator spare parts.

Data related to refrigerators as a means of storing vaccines. A work unit that has a vaccine box of 81.5% is equivalent to 22 work units. The condition of vaccine box facilities in each work unit is made of plastic as much as 81.5% of all work units involved in this study.

Several facilities must be fulfilled in the management of vaccines including the availability of thermos (vaccine carrier) and cold liquid boxes (cool packs) which reach 100% [10]. Only 74.1% of work units have cold packs. Dial thermometers (muller) are owned by 21 work units or 77.8% of all respondents and only 44.4% of respondents have thermographs. All of the respondents' work units own the time temperature monitor (TTM) tool, but only 66.7% of the respondents have a freezer watch (freezer tag).

All facilities in the vaccine supply chain need to be documented in the media so that they can be accounted for more openly [11]. Documentation media can be in the form of chart books or blanks for recording and reporting. All respondents' work units had a chart book for recording temperature and only one work unit did not always fill out a chart book for recording temperature [12]. There are at least 88.9% of respondents' work units whose number of recording and reporting blanks is sufficient in a year.

Table 2. Vaccine chain facilities or equipment at the Magelang Primary Health Center

Criteria	n	%
Has a fridge	27	100.0
Refrigerators can still be used to store vaccines	27	100.0
Refrigerators use refrigerant (Freon)	7	25.9
Fridge open from the front (front opening)	2	7.4
Fridge open from the top (top opening)	27	100.0
The refrigerator uses a compression cooling system	20	74.1
The refrigerator uses an absorption cooling system	11	40.7
There is a thermostat in the refrigerator	25	92.6
Has refrigerator parts	6	22.2
There are sufficient types of refrigerator spare parts	4	14.8
Have a vaccine box	22	81.5
The vaccine box is made of plastic	22	81.5
Have a thermos (vaccine carrier)	27	100.0
Has a cool liquid box (cool pack)	27	100.0
Have a frozen ice box (cold pack	20	74.1
Has a thermometer dial (muller)	21	77.8
Has a thermograph	12	44.4
Has a time temperature monitor (TTM)	27	100.0
Have a freezer watch (freezer tag)	18	66.7
Operational vehicles available	22	81.5
Have a temperature chart book	27	100.0
The temperature recording chart book is always filled	26	96.3
Recording and reporting blanks are available	26	96.3
The number of recording and reporting blanks is sufficient in a year	24	88.9
Refrigerator or freezer temperatures are checked daily	27	100.0
The average refrigerator is not opened < 2 times per day	17	63.0
The outside of the fridge is cleaned	27	100.0
Refrigerator plugs checked daily	26	96.3
Rubber door seal cleaned and checked for density	26	96.3
Refrigerator door hinges are always inspected & lubricated	11	40.7
Routine defrosting	18	66.7
Do you need to pay attention to the placement of the refrigerator?	27	100.0
Can the refrigerator not be exposed to direct sunlight?	27	100.0
Is the refrigerator placed in a room with sufficient air circulation?	26	96.3

The availability of transportation facilities during the immunization service process is an important factor determining the success of immunized area coverage [13]. As many as 81.5% of respondents' work units have operational vehicles rationale for immunization activities.

Process

a) Equipment maintenance

Refrigerator maintenance is an important thing to note because vaccine stock is stored in the refrigerator. As many as 100% of the work units of respondents always check the temperature of the fridge or freezer. On average, 63.0% of respondents' work units have refrigerators that are not opened <2 times per day. As many as 100% of the respondent's work unit always cleans the outside of the refrigerator and only one respondent's work unit does not check the refrigerator socket every day. As many as 66.7% of the work units of respondents routinely defrost.

In addition to several technical matters in refrigerator maintenance, as shown in **Table 4**, defrosting activities need to be carried out regularly. The defrosting process is carried out at a certain level of defrosting thickness. The data in Table 4 is the thickness of the ice flower when defrosting is carried out in the work unit of each respondent. In addition to several technical matters in refrigerator maintenance, defrosting activities need to be carried out regularly. The defrosting process is carried out at a certain time. The following in Table 4 is the time required to clear

the ice when defrosting is carried out in each respondent's work unit.

b) Equipment placement

Based on the results of data collection using a questionnaire, it is necessary to pay attention to the placement of the refrigerator and the placement of the refrigerator in a room that has air circulation and should not be exposed to direct sunlight, all respondents agreed on this matter, but the distance between the refrigerator and the back wall was different, 5 people (18.5%) said it was less than 10 cm, 22 people (81.5%) said it was more than 10 cm. A total of 3.7% of respondents put the minimum distance between refrigerators and other refrigerators <10 cm.

Refrigerators as an important means of storing vaccines need to pay attention to the location of their placement [14]. The best area for the refrigerator to be the effort to keep the refrigerator functioning properly. There are 3.7% of respondents who do not put the refrigerator in a room that has sufficient air circulation.

c) Collection and reception of vaccines

Vaccine collection by *puskesmas* officers in districts is usually not based on a pre-planned schedule but rather depends on the vaccine stock available at the *puskesmas*. Vaccines taken by health center staff from the district are brought using a vaccine carrier or thermos. However, 18.5% of respondents said that the vaccine carrier and the thermos used to lift the vaccine were not equipped with a thermometer and 14 people 3.7% said that when they took the vaccine they did not see and did not record their temperature. Besides that, there were only 74.1% of officers who stated that when a cold box was received it was counted and separated according to the administrative letter.

Health center staff always (100%) prepare a vaccine carrier/thermos as a vaccine transport medium, but only 70.4% make efforts to check the vaccine in each vaccine box randomly. Several 81.5% of respondents after the vaccine examination documented it in the inspection report (BAP).

d) Vaccine Storage

Vaccine management by vaccine chain officers is crucial to maintaining vaccine quality [15]. Vaccine storage by officers was carried out by 59.3% of respondents using the Ice Line Refrigerator (ILR), a total of 51.9% of respondents stored each type of vaccine at different temperatures in the refrigerator. Placement of vaccine boxes in the refrigerator by paying attention to the distance was carried out by 85.2% of respondents. There are 88.9% of respondents who have refrigerators with dial thermometers.

e) Vaccine use

During the process of using the vaccine, 100% of respondents paid attention to removing the vaccine from storage before carrying out the service. As many as 81.5% of respondents use special tools to carry vaccines while providing immunization services. According to 92.6% of respondents, 92.6% of respondents felt that the use of vaccine carriers and ice flasks was good for vaccine distribution.

Output

Vaccine quantity

The supply of vaccines for one month's needs at the *puskesmas* is very important to note for the availability of this type of vaccine, respondents stated that 100% was available for one month, such as the Measles vaccine, DT Vaccine, DPT-HB but for the Hepatitis A vaccine the respondents' answers were different, 21 people (77.8%) said available one month ahead. The availability of BCG and DPT vaccines for the next month is only guaranteed in 96.3% of the work units of respondents (**Table 3**).

Vaccine quality

Based on the data obtained from the questionnaire, 100% of the respondents stated that the quality of the BCG, DT, DPT/HB, and measles vaccines met the vaccine quality standard requirements. DPT vaccine with standard quality was found in 96.3 work units of respondents, while only 77.8% of Hepatitis A vaccine met the vaccine quality requirements.

Table 3. The availability and quality of vaccine at Community Health Centers in Magelang District

Type of vaccine	Availability of one-month	Quality of vaccine
	%	%
BCG	96.3	100.0
DPT	96.3	96.3
DT	100.0	100.0
Measles	100.0	100.0
Hepatitis A	77.8	77.8
DPT HB	100.0	100.0

Table 4. Conditions during the process of taking and receiving vaccine (n=27)

Criteria	n	%
Conditions during the process of taking and receiving vaccine		
In taking the vaccine at the Magelang District Health Office using a vaccine carrier	27	100.0
When taking the vaccine, you see and record the temperature	26	96.3
When taking the vaccine, always insert a thermometer into the vaccine carrier	22	81.5
At the time of receiving the cold box, vaccine must be protected from direct sunlight	27	100.0
Cold boxes received are counted and separated by administrative letters	20	74.1
Always do a shake test for DPT, TT and DT vaccines received from the district	18	66.7
Re-store vaccines that have been opened, leftovers from field activities	1	3.7
Note the batch number and expiration date of the vaccine when entering and dispensing it	26	96.3
Vaccine stocks are always recorded every month and reported to the Magelang District Health Office	27	100.0
Vaccine inspection in each vaccine box is carried out randomly	19	70.4
The position and condition of the VVM are always checked	27	100.0
Conditions on VVM A & B are separated for storage	20	74.1
Freeze watch and freeze tag are always checked	26	96.3
Have received vaccine exposure below temperature >0ºC	4	14.8
After the vaccine examination, an inspection report (BAP) is made	22	81.5
Conditions during the vaccine storage process by vaccine chain officials		
Storing vaccines in the ILR refrigerator (Ice Lining Refrigerator)	16	59.3
Vaccine types are stored at different temperatures in the refrigerator	14	51.9
Polio vaccine is stored at 0 ºC to + 8 ºC	20	74.1
Storing the polio vaccine in the freezer	1	3.7
Store the DPT, B hepatitis, TT, DPT-HB, DT vaccines in the refrigerator	24	88.9
The bottom of the refrigerator is used to store vaccines	10	37.0
Place the vaccine box in the fridge paying attention to the distance	23	85.2
Heat sensitive (HS) vaccine is placed against the refrigerator wall	13	48.1
Freeze sensitive (FS) vaccine is placed against the refrigerator wall	10	37.0
The refrigerator has a dial thermometer	24	88.9
Conditions during the vaccine use process by vaccine chain officials: Yes		
Pay attention to removing vaccines from storage prior to service	27	100.0
Pay attention to the packaging/packaging of vaccines before distribution	27	100.0
The vaccine packing process follows the technical manual	27	100.0
There are differences in the packing of each vaccine in the cold box (Cool Box)	24	88.9
Use special tools to carry vaccines while providing immunization services	22	81.5
The use of vaccine carriers and ice flasks is still good for vaccine distribution	25	92.6

DISCUSSION

The problems identified in the immunization program in Magelang Regency, especially in cold chain management, including the training for vaccine chain managers is too long; that is, almost half of all respondents attended training more than five years ago, and only two people attended training in 2022. Every vaccine chain officer needs to be allowed to get a refresher on vaccine chain material, especially about new things given in previous training [16].

One of the main problems in vaccine transportation at Puskesmas is temperature fluctuation which can damage the vaccines. If vaccines are not stored or transported at the appropriate temperature, their effectiveness can be compromised. Malfunctioning temperature monitoring devices or human errors in temperature monitoring can be an issue. The storage conditions during the transportation and distribution process are crucial, considering that temperature is a factor that affects vaccine quality.

Training for cold chain officers is essential in managing the Immunization vaccine storage and transportation at the Padang City Health Center Level [17]. The study concluded that there was a significant relationship between the knowledge of staff and the practice of vaccine storage and transportation at the Health Center so vaccine cold chain management officers in primary care must have good knowledge and understanding of vaccine transportation and storage [18]. A similar study was also conducted to explain the correlation between the knowledge and attitudes of vaccine managers and vaccine management scores in diphtheria case areas [19].

Through research related to this cold chain, the urgency of providing adequate facilities for the

operation of the vaccine chain can be identified to maintain the quantity of quality vaccines [20]. The identified problem was that most of the respondents' work units did not have refrigerator spare parts. This is certainly very risky if there is damage to the refrigerator. It will take a long time to meet the need for spare parts because they are not yet available. The storage distance between vaccine boxes in the chiller and freezer recommended in the Vaccine Storage and Handling Toolkit (CDC 2019) guidelines is around 1-2 cm. The distance between the boxes makes the storage less dense so that air circulation can be maintained. The provision of distance aims to increase the circulation of cold air around the vaccine. Adequate air circulation helps each vaccine maintain a consistent temperature [21]. This study also managed to confirm that fact: there were still a small number of work units of respondents who did not have vaccine boxes, and a quarter of all work units of respondents did not have cold packs, with more than half of all work units of respondents not having a thermograph.

Based on various studies that have previously been conducted, it was found that the management of the vaccine cold chain is still not optimal due to the lack of knowledge of the vaccine chain staff, which affects the quality of the vaccine. This certainly has an impact on the quality of immunization services. A case study study in the city of Semarang in private service units showed the results of the conclusion that there were risk factors that affected the quality of vaccine management, which included lack of knowledge of staff, unavailability of guidelines, refrigerator function not specifically for storing vaccines, unavailability of thermometers, how to carry vaccines wrong, and the lack of commitment of officers as well as owners of health service units [22].

The results of this study indicate that in the process of taking the vaccine at the Magelang District Health Office, all work units of the respondents used a vaccine carrier. Almost all respondents in this study believed that the use of vaccine carriers and ice flasks was still good for vaccine distribution. Previous research stated that the practice of implementing immunization is not by the cold chain management guidelines in terms of storage and distribution of vaccines, which can be seen from the absence of temperature gauges, freeze tags, not having a generator, not having a freezing indicator, and limited liquid cold boxes in cold boxes during distribution [23].

There are still respondents' work units that do not have special equipment to carry vaccines while providing immunization services. It is necessary to have tools for vaccine transportation that are lightweight, easy to carry anywhere, with quality standards that can maintain vaccine quality [24]. Vaccines stored in vaccine carriers experience VVM changes longer than those stored in cooler bags, and there is no difference in protein levels in vaccines when stored in vaccine carriers or cooler bags [23]. According to previous research from 2022, the three key elements that support the vaccine cold chain are trained vaccine management staff, vaccine storage and transport equipment, and efficient vaccine management procedures [26, 27]. Innovations related to tools that can facilitate transporting vaccines so that quality is maintained are concrete outcomes of this research.

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