Universitas Ahmad Dahlan Public Health Conference (UPHEC)
https://seminar.uad.ac.id/index.php/uphec/index
Volume December 2024

Type Cold Chain Management of DPT Vaccine in Healthcare Facilities in Indonesia: A Systematic Review

Sulistyawati[a,1*], Fatia Rizka Adela[a,2], Dessy Apriyani[a,3], Adriano Ximenes[b,1]

a Faculty of Public Health, Universitas Ahmad Dahlan, Indonesia

b The Economist Intelligence Unit at The Economist, Timor-Leste

*corresponding author: sulistyawati.suyanto@ikm.uad.ac.id

ARTICLE INFO

Article history:
Received Oct 05, 2024
Revised Oct 20, 2024
Accepted Oct 21, 2024

Keywords
Cold chain;
DPT Vaccine;
Evaluation;
Healthcare

ABSTRACT

Background: The immunization program is a vital societal intervention in preventing infectious diseases, including through the DPT vaccine (Diphtheria, Pertussis, Tetanus). Although coverage of the DPT vaccine in Indonesia reached around 80% in 2020, significant variation in various areas and incidents of plague diphtheria in 2017 showed the need for more attention on vaccine management. The effectiveness of vaccines depends highly on the management of the cold chain, including storage and transportation at safe temperatures. However, challenges like lack of training of health workers and inadequate infrastructure often result in damaged vaccines. Therefore, the evaluation management cold chain of the DPT vaccine at the health facility is significant for increasing coverage and maintaining the effectiveness of the vaccine.
Method: Systematic Review, which follows guidelines Preferred Reporting Items for Systematic and Meta-Analysis (PRISMA), was conducted, including 8 of 132 relevant articles obtained using the Publish or Perish tool.
Results: Evaluation shows that management and storage of vaccines still face challenges, including empty stock, temperature storage that is not stable, and lack of training for health workers. Second, the transportation procedure and vaccine distribution are often inadequate, and many health centres do not correctly apply FIFO and FEFO principles.
Conclusion: It is crucial to strengthen the management chain through more training for health workers and implementing standard strict operations to increase the effectiveness and coverage of vaccines in the community.

1. Introduction

Immunization is an effective intervention for overcoming infectious diseases. In Indonesia, immunization programs under the Ministry of Health are being developed to reduce disease incidents that immunization can prevent (1). This program is essential to increase immunization coverage and protect the public from disease-serious infection. One of the types of vaccine given in this program is the DPT vaccine (Diphtheria, Pertussis, and Tetanus) (2). DPT immunization is vaccination mandatory for children with the objective immunity active to diphtheria, pertussis, and tetanus simultaneously (3). The coverage of the DPT vaccine in Indonesia is experiencing variations, with several areas achieving the desired target while others are still under the standard. According to the Ministry of Health, the coverage immunization base 2020 only reached around 80% (4).

Indonesia includes countries with the highest ranking for case diphtheria. In 2017, Indonesia experienced plague diphtheria, which caused more than 1,000 cases and 50 deaths (5). Furthermore, recent statistics indicate that the number of cases has fluctuated, underscoring the need for improved vaccination efforts. The effectiveness of the DPT vaccine highly depends on proper storage and

management before administration to patients. Vaccines exposed to unsuitable temperatures can become damaged, reducing their efficacy and leading to immunization (6).

Ensuring vaccination programs walk fluently can be seen from the management chain of managed vaccines; this involves the management, storage, transportation and distribution of vaccines and determining the right temperature for the vaccine to be effective and safe use (7). Management cold chain is a crucial system in the distribution of vaccines, which guarantees that the vaccine will still be at a safe temperature from the manufacturer to the health facility (8). Indonesia is facing significant challenges in managing the cold chain, considering diverse geographical and climatic conditions that can influence the stability of temperature vaccines (9). These challenges are exacerbated by the country's vast archipelago, which complicates logistics. Service providers in primary health care are essential to in-depth knowledge and understanding of the management of vaccines. Health workers in primary facilities must truly understand vaccines' transportation and storage process until vaccines are given (10). Research has previously shown that knowledge officers are one of the risk factors affecting vaccine quality management.

One of the crucial elements in cold chain vaccines is procedures that ensure the vaccines are stored and transported at appropriate temperatures (9). Management that is not in accordance can cause damage to vaccines and reduce or even remove their effectiveness. Monitoring accurate temperature is critical in managing a chain of good colds (10). Infrastructure health that is not evenly distributed across various areas also becomes an obstacle in managing effective vaccines (11). Research shows that errors in the management chain cold can lower the effectiveness of vaccines, impacting society. In line with Kimura M. et al. (2022) (12) findings, a lack of training for healthcare personnel and inadequate storage equipment are leading causes of vaccine damage. In addition, investing in better infrastructure and training programs can significantly improve vaccine management. Evaluating the cold chain management of DPT vaccines at health facilities is essential, given its impact on immunization coverage and public health. This study aims to evaluate the effectiveness of DPT vaccine cold chain management and its impact on immunization coverage in Indonesia. Thus, this study seeks to identify weaknesses in the management, storage, transportation, and distribution of vaccines and enhance healthcare workers' understanding of cold chain management.

2. Method

This is a Systematic Review following Preferred Reporting Items of Systematic and Meta-Analysis (PRISMA). Publish, or Perish tool was used to collect the articles with the keywords "cold chain", "evaluation", "DPT vaccine", and "health facilities" in articles published from 1998 to 2024. We yielded 132 articles; 124 of them are free to access. Screening was done according to inclusion criteria: the article should discuss the DPT vaccine cold chain in health facilities. Eight articles were obtained and included in the final analysis.

3. Result

Researchers obtained as many as 132 articles from the Google Scholar database. In the screening process, based on title, abstract and article, free access or not. We found eight relevant articles with a topic study that evaluates cold chain management of the DPT vaccine in facilities in Indonesian health facilities.

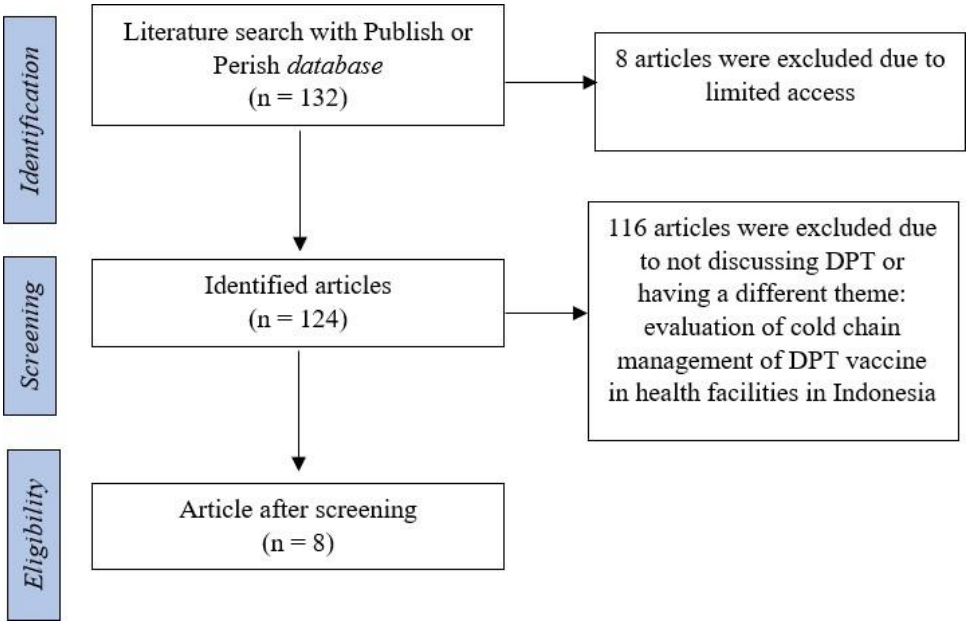

Figure 1. PRISMA Flow Chart

A summary descriptive of cold chain management of the DPT vaccine is prepared based on the management and storage of vaccines, temperature standards and monitoring, transportation and distribution of vaccines, training power health, documentation and reporting, and preparedness for emergencies. Based on the results, we present the summary in Figure 1 and Table 1.

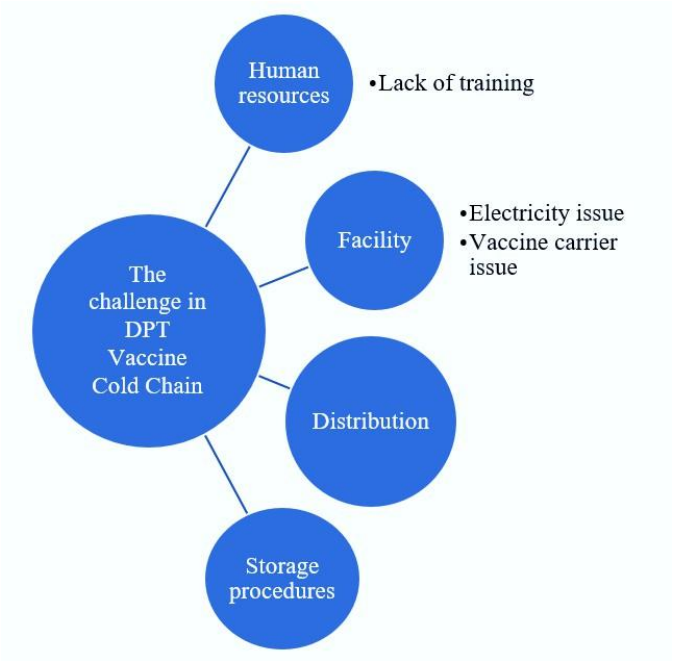

Figure 2. Summary challenge of DPT vaccine cold chain management

Table 1. Article Review Result

Title	Research Place	Key point on Challenges to Vaccine Cold Chain Management
Management Overview Cold Chain Vaccine at Tasikmalaya City Health Center Year 2024 (Aisya Rahmawati et al., 2024)	Health Center Mangkubumi, Health Center Tamansari, Health Center Cibeureum and Health Center Cigeureung	1 officer manager of vaccines has not been trained. 3 health centres provide several types of vaccines not in place/containers in the appropriate box with the vaccine type. Fourth health centre: No apply plan emergency saved/pasted near the refrigerator.
System Management and Inventory Vaccines in Two Indonesian Provinces (Susyanty et al., 2014)	Based on immunization data, measles RISKESDAS 2007 consists of, Provincial Health Offices, 6 District /City Health Offices, 6 District /City Pharmaceutical Warehouses/ Immunization program managers, and 18 Community Health Centers.	One province has officer health office districts/cities and health centres that still need training. Service Health does not own an adequate vaccine carrier in one province, so use thermos vaccine. No document was found on the vaccine cold chain monitor (VCCM) Several service health districts/cities have no freeze tag for controlling quality Vaccines, so they only depend on the thermometer and VVM attached to the vaccine. Most health centres complain about the number of vaccines received due to requests or needs.
Closeness Storage and Recording with Quality Chain Cold DPT Vaccine at the Health Center (Hikamarida, 2014)	Over health centres in the Regency area Sidoarjo, as many as 26 Health Centers.	There is 1 health centre with arrangement vaccines that are not following provision, namely, the DPT vaccine, which is placed near the evaporator by 4%. Health centres use refrigerators to keep objects besides Vaccines by 8%. There is 1 health centre that does not put a thermometer in the refrigerator. Health centres in the district Sidoarjo have refrigerators with a thickness of more ice flowers from 0.5 cm by 35%. 6 health centres have refrigerators with outside temperatures of 2℃ to 8 ℃. 3 health centres do not own freeze indicators. There is 1 health centre that has a freeze tag.
Evaluation System Cold Chain Vaccine at the Health Office of Sleman Regency, Special Region of Yogyakarta (Shafa, 2017)	UPT POAK Sleman Health Service.	Delays in vaccine distribution cause an empty stock of vaccines or no fulfilment of the need for vaccines. Cold box and setup location Vaccines and cool packs are interrelated touch. The capacity chiller and freezer have no appropriate distance rules. Namely, they range from 1 to 2 cm.
Literature Review: Implementation System Cold Chain in Maintenance	Through the Google Scholar, PubMed, Sciencedirect.com sites	There are 12 health centres in Regency Sarolangun, and the

Title	Research Place	Key point on Challenges to Vaccine Cold Chain Management
Efforts Quality Vaccine (Setyo, 2021)		refrigerator must still be completed with a thermometer.
Evaluation Compliance Storage DPT-Hb-Hib Vaccine at the District Health Office Blitar (Ilmanafi'a, 2019)	District Health Office Blitar	The person responsible for warehouse storage of the DPT-Hb-Hib vaccine is not yet by the rules because there is no pharmacist. Public Health Office Regency Blitar does not yet have a generator for warehouse storage for the DPT-Hb-Hib vaccine.
Related Factors with Midwife Practices in Distribution and Storage DPT Vaccine (Rahayu, 2014)	East Surabaya Regional Health Center	Training cold chains are not given to all midwives. Socialization from service health needs to be developed comprehensively, especially in the storage and distribution of vaccines.
Evaluation Storage and Distribution of Vaccines from the Manado City Health Service to Health Center Tuminting, Health Center Paniki Bawah and Health Center Wenang (Gabbie Priziliya Lumentut, Nancy C. Pelealu, 2015)	Manado City Health Service, Community Health Center Tuminting, Health Center Paniki Bawah and Health Center Wenang	Distribution vaccine: No use of the Goods Proof Letter, but only based on the sheet request vaccines administered by the officer's health centre. It does not fit the distance storage vaccine. Placement is an excellent pack that does not follow the rules; there is no storage in the lower place. The placement of heat- and freeze-sensitive vaccines was not followed by the guidelines.

4. Discussion

Management-effective vaccines have shown no empty stock, stable temperature, or occurrence damage, and vaccines that have not been past date expired. Empty vaccines can be due to delays in supply (10). In contrast, damaged vaccines often result from planning that is not right, the system under distribution, or a lack of monitoring quality in storage. Expired vaccines signify the existence of a mismatch in request or weakness in system distribution as well as supervision quality storage (13). Management not following these standards can damage vaccines and reduce or even remove their effectiveness. The damaged vaccine cannot give immunity If given to the recipient (14). Therefore, keeping the chain cold vaccine is very important because after the potential vaccine is lost, there is another way to restore it. The damaged vaccine cannot be fixed, and this can cause the occurrence of diseases that should be prevented through immunization (15).

The research conducted by Aisya Rahmawaty et al. (2024) (16) found that facility Health No keeps vaccines in appropriate containers with the type of vaccine. In line with the study by Hikamarida (2014) (15), one health centre reported using refrigerators to keep goods besides vaccines by 8%. According to Guidelines for Vaccine Management in Health Care Facilities, the distance storage box vaccine should be between 1-2 cm for guard circulation temperature in cupboard storage. Storage vaccines that are not as seen in the study Hikamarida (2014) (15), where the DPT vaccine is placed too near with an evaporator of 4%. DPT vaccine is inactive, very sensitive to cold temperatures and should be saved near the evaporator. Storage vaccine must follow the FEFO (First Expire First Out) principle in the freezer and chiller. The use of vaccines must based on the FIFO (First In, First Out) principle and paying attention to VVM (Vaccine Vial Monitor) (13).

Based on Regulation of the Minister of Health of the Republic of Indonesia Number 12 of 2017, Concerning the Implementation of Immunization, the vaccines must be stored in a suitable place with

a strict temperature and tools cooler that meets the standard. Management chain cold vaccine covers all steps from storage until distribution, focusing on maintaining the vaccine's temperature and quality (17). Storage process vaccine must notice several things, including not quite enough answer officer, training routine, facilities adequate storage, how to proper storage, as well as maintenance tool support like cupboard coolers and thermometers, including calibration and validation tools (18).

Research by Susyanti et al. (2014) (19) shows that at the level of health centres, there are problems such as cold chain status of loans, deficiencies in vaccine carriers, no existence of freeze tags and VCCM (Vaccine Cold Chain Monitor), all health centre own supply 24-hour electricity and generator. Note that stock vaccine is done manually. Conditions increase the risk of damage to the vaccine during storage. Standard storage required for guard quality vaccine is still tall from the moment it is accepted until it is distributed to the next level to ensure the vaccine is stored at a predetermined temperature set (13).

Following instructions, Cold Chain Management Guidelines for Immunization Officers that room col, refrigerator, cool box, and vaccine carrier must be equipped with a thermometer for control temperature when bringing the vaccine from centre to province, from province to district and from regency to health centre. Setyo's (2021) (20) research was conducted on 12 health centre's parents in Regency Sarolangun. Still, there is an 8.3% temperature sheet > 8℃. Based on research by (21), temperature storage vaccine must be stored at the appropriate temperature, namely 2℃ to 8℃, to guard its stability and effectiveness. Based on the article review by Shafa (2017) (13), vaccines in a chiller or freezer are not arranged at a distance when saved. A large number of vaccines will fill the storage space more densely, whereas if the number of vaccines is few, the vaccine storage space will be larger or more proper (22). The recommended storage distance between the vaccine box in the chiller and freezer is around 1-2 cm (23). Administration distance on storage vaccine aims to increase circulation of air cold all around the vaccine; adequate air circulation helps each vaccine maintain temperature consistent (24). Research by Setyo (2021) (20) shows that vaccine storage at health centers does not fulfil standard storage. Namely, 19% of vaccine refrigerators in health centres have temperatures between 20-80℃. Use a cooler that stores vaccines rather than a fridge and freezer (10). The temperature of the vaccine must also be monitored with notes in a way many times temperature vaccine, at least twice a day.

Activity distribution of vaccines carried out by officers' vaccine from every health centre use system picks up the ball, meaning officer health centres come to service health in Tasikmalaya City. Findings in the study by Aisya Rahmawaty et al. (2024) (16) show the procedure distribution of the vaccine with take-to-service health use of a cool box so that the vaccine is still in cold temperature. Research results in Shafa (2017) (13), which was carried out at the UPT POAK, Sleman Health Service, shows that the Health Service has a cold box used for the storage of vaccines short-term or nature temporary and the distribution of vaccines with reasonable and possible conditions For guard temperature vaccine. In line with the results of the study, Gebbie P.L., Nancy C., and Pelealu (2015) (25) state that the distribution of vaccines in object health centres studied used cold boxes containing excellent packs for vaccine freeze sensitivity as well as cold packs for vaccine heat sensitivity no done by the three health centre due to Because limited excellent pack and distribution vaccine in an amount small. Based on the results, the study said that following standard en, vaccines can saved in a range of temperatures that can accepted in accordance, namely 2℃ to 8℃ (17).

Procedure operation Indonesian standard for distribution of vaccines in institutions' health polymer, namely FEFO (First Expire First Out), meaning emit or use vaccine expired first, and FIFO (First in First Out) implies that what comes in must be released or used first. Activities distribution of each vaccine start from place shipping, type vaccine, amount, number batch, and date expired must noted. A carrier vaccine or cooler must emit the vaccine (20). Conditions that need to be met and noticed in moment distribution are VVM, FEFO, and FIFO conditions. Distribution constraints happened when the Provincial Health Service Officer delivered the vaccine, but no officers were in the office health district/city (10). The condition is that the need is allocated for return with budget delivery from province to district/city. In addition, it is necessary to coordinate with the warehouse pharmacy to include vaccines in the post-drug to the district. We must coordinate the return in matter planning,

shipping, and storage vaccine for conditions like no-repeat returns (10). In the research, Setyo (2021) (20) states that vaccines at the health center will distributed to the service unit immunization. The study found that Health Centre No is implementing FIFO or taking notes on issued vaccines. However, the study states that all health centres have applied the FEFO system and issued vaccines with C and VVM. If the vaccine has the same VVM condition, the first one used is one with a more extended expiration date. UNICEF Supply Division 2020 evaluation shows that management and storage of vaccines still face challenges, including empty stock, unstable temperature storage, and lack of training for health workers. Additionally, the label on a DPT vaccine that has been scratched may raise some concerns regarding its usability, depending on the extent of the damage.

In the research, Susyanty et al. (2014) (19) state that facilities and infrastructure distribution are not yet sufficient, there are not enough vaccine carriers and many cool packs are missing or have no apparent existence, so system distribution is not effective enough remember facilities and infrastructure still not adequate so that need done addition to improving quality vaccine can be maintained during distribution. The officers who bring vaccines must also get training in handling good vaccines. Transportation and distribution of vaccines, including stage critical in the management cold chain, ensure that the vaccine is still effective and safe until it is delivered to the recipient. This process involves several steps and principles that must be followed to guard the temperature and quality of the vaccine (20).

Training power health in cold chain management vaccines has become vital in ensuring success in guarding quality vaccines and can increase the public's trust in vaccination (26). Based on the study's results, Aisya Rahmawaty et al. (2024) (16) state that officer management vaccines Still do not yet get training related to the management cold chain; it is known that only One of the four health centres that have followed and gotten training. In line with the study by Susyanty et al. (2014) (19), some officers have yet to be trained in cold chain management. Following the standard that power health officer immunization must own qualifications and follow training (27). Based on the study by Rahmah et al. (2015) (26), there is still power in health that does not realize the importance of the theory management of vaccine immunization. The training provided for health workers aims to increase their knowledge and skills in health to understand more about proper procedure storage and identify proper temperature storage as a guard temperature to prevent vaccine damage (28).

5. Conclusion

The importance of managing the cold chain in the transportation and distribution of vaccines cannot be underestimated, as maintaining the integrity of vaccines is crucial for the effectiveness of immunization programs. Careful execution of transportation and distribution processes ensures that vaccines remain optimal for healthcare facilities (World Health Organization 2021). Additionally, training health workers plays a critical role in enhancing their knowledge and skills, which impacts error reduction and improves immunization rates. Regular monitoring and evaluation of vaccine storage conditions are also necessary to maintain the quality and efficacy of vaccines. By prioritizing these practices, we can foster greater public trust in vaccination programs, which, in turn, will contribute to improved community health outcomes. Therefore, a coordinated approach involving all stakeholders in the healthcare system is essential to ensure that immunization efforts achieve their full potential in preventing diseases.

Acknowledgment

State the research funding (if any) or state, “This research has not received external funding” for research without a donor. (1–11)

REFERENCES

1. T. A. Dillyana and I. Nurmala, “Hubungan Pengetahuan, Sikap Dan Persepsi Ibu Dengan Status Imunisasi Dasar Di Wonokusumo,” Jurnal PROMKES: The Indonesian Journal of Health Promotion and Health Education, vol. 7, no. 1, p. 67, 2019, doi: 10.20473/jpk.v7.i1.2019.67-77.

2. P. Plans-Rubió, "Strategies to Increase the Percentages of Vaccination Coverage," Vaccines (Basel), vol. 10, no. 12, Dec. 2022, doi: 10.3390/vaccines10122103.
3. L. Lestari, H. Heryani, F. Nopianti, F. Nuraeni, Istikharoh, and I. Lestari, "Upaya Peningkatan Pemahaman Pentingnya Imunisasi DPT pada Kader," Kolaborasi Jurnal Pengabdian Masyarakat, vol. 2, no. 6, pp. 454–458, 2022, doi: 10.56359/kolaborasi.v2i6.172.
4. Kemenkes RI, Pedoman Pengelolaan Vaksin di Fasilitas Pelayanan Kesehatan. Jakarta: Kementerian Kesehatan Republik Indonesia, 2021.
5. R. Tosepu, J. Gunawan, D. S. Effendy, L. O. A. I. Ahmad, and A. Farzan, "The Outbreak of Diphtheria in Indonesia," Pan African Medical Journal, vol. 31, 2018, doi: 10.11604/pamj.2018.31.249.16629.
6. A. Thielmann, M. T. Puth, and B. Weltermann, "Improving knowledge on vaccine storage management in General Practices: Learning Effectiveness of an Online-Based Program," Vaccine, vol. 38, no. 47, pp. 7551–7557, Nov. 2020, doi: 10.1016/j.vaccine.2020.09.049.
7. D. Arkan Admoko Putra, A. Reza Ar-Rafi, A. Muslim, and B. Darmawan, "Proposed Solutions to Vaccine Storing and Distribution at PT. POS Logistik Indonesia, Bandung," Journal of Logistics and Supply Chain, vol. 03, no. 02, pp. 77–82, 2023, doi: https://doi.org/10.17509/jlsc.v3i2.62080.
8. WHO, Unit 4: Cold chain and logistics management- Immunization Handbook for Medical Officers. World Health Organization, 2021.
9. UNICEF, Handbook for Vaccine & Cold Chain Handlers. UNICEF, 2010. Accessed: Oct. 11, 2024. [Online]. Available: https://pdf.usaid.gov/pdf_docs/PA00JVPG.pdf
10. CDC, Centers for Diesease Control and Prevention: Vaccine Storage and Handling Toolkit. U.S. Centers For Disease Control and Prevention, 2024. Accessed: Oct. 11, 2024. [Online]. Available: https://www.cdc.gov/vaccines/hcp/admin/storage/toolkit/storage-handling-toolkit.pdf
11. S. Hu, R. Zhao, Y. Cui, D. Zhang, and Y. Ge, "Identifying The Uneven Distribution of Health and Education Services in China Using Open Geospatial Data," Geography and Sustainability, vol. 4, no. 2, pp. 91–99, Jun. 2023, doi: 10.1016/j.geosus.2023.01.002.
12. M. Kimura, J. I. Niwa, and M. Doyu, "Recurring Weakness in Rhabdomyolysis Following Pfizer–BioNTech Coronavirus Disease 2019 mRNA Vaccination," Vaccines (Basel), vol. 10, no. 6, Jun. 2022, doi: 10.3390/vaccines10060935.
13. Y. N. Shafa, "Evaluasi Sistem Cold Chain Vaksin Di Dinas Kesehatan Kabupaten Sleman Daerah Istimewa Yogyakarta," Universitas Islam Indonesia, 2017.
14. K. Yamamoto, "Adverse Effects of COVID-19 Vaccines and Measures to Prevent Them," Virol J, vol. 19, no. 1, Dec. 2022, doi: 10.1186/s12985-022-01831-0.
15. F. Hikamarida, "Keeratan Penyimpanan dan Pencatatan dengan Kualitas Rantai Dingin Vaksin DPT di Puskesmas," Jurnal berkala Epidemiologi, vol. 2, no. 22, p. 283, 2014.
16. Aisya Rahmawaty, Dita Destiati, Defira Salwaa Putri Insani, and Anida Rahma Junita, "Gambaran Manajemen Cold Chain Vaksin di Puskesmas Kota Tasikmalaya Tahun 2024," Jurnal Kesehatan Masyarakat Indonesia (JKMI), vol. 1, no. 3, pp. 68–78, 2024, doi: 10.62017/jkmi.v1i3.1224.
17. Permenkes RI, "Peraturan Menteri Kesehatan Republik Indonesia Nomor 12 Tahun 2017 Tentang Penyelenggaraan Imunisasi," 2017.
18. L. Ilmanafi'a, "Evaluasi Kesesuaian Penyimpanan Vaksin DPT-Hb-Hib Di Dinas Kesehatan Kabupaten Blitar," Universitas Islam Negeri Maulana Malik Ibrahim, 2019. Accessed: Oct. 12, 2024. [Online]. Available: http://etheses.uin-malang.ac.id/id/eprint/14350
19. A. L. Susyanty, R. Sasanti, M. Syaripuddin, and Y. Yuniar, "Sistem Manajemen Dan Persediaan Vaksin Di Dua Provinsi Indonesia," Buletin Penelitian Kesehatan, vol. 42, no. 2, pp. 108–121, 2014.
20. B. Setyo, "Kajian Literatur: Penerapan Sistem Cold Chain Dalam Upaya Pemeliharaan Kualitas Vaksin," Universitas Islam Indonesia, 2021. Accessed: Oct. 12, 2024. [Online]. Available: https://dspace.uii.ac.id/handle/123456789/29972
21. A. J. Leidner, H. Fisun, S. Trimble, P. Lucas, C. Noblit, and J. M. Stevenson, "Evaluation of temperature stability among different types and grades of vaccine storage units: Data from

continuous temperature monitoring devices," Vaccine, vol. 38, no. 14, pp. 3008–3014, Mar. 2020, doi: 10.1016/j.vaccine.2020.02.043.
22. M. Cattin, S. Jonnalagedda, S. Makohliso, and K. Schönenberger, "The Status of refrigeration Solutions for Last Mile Vaccine Delivery in Low-Income Settings," Vaccine X, vol. 11, Aug. 2022, doi: 10.1016/j.jvacx.2022.100184.
23. A. Kurniawan, Jason Merari Peranginangin, and Samuel Budi Harsono, "Evaluation of Vaccine Stock Management at the Karanganyar Regency Health Service Indonesia," Open Access Indonesian Journal of Medical Reviews, vol. 4, no. 1, pp. 569–582, Feb. 2024, doi: 10.37275/oaijmr.v4i1.506.
24. CDC, "Storage Best Practices for Refrigerated Vaccines–Fahrenheit (F)," 2018. [Online]. Available: www.cdc.gov/vaccines/SandH
25. A. C. W. Gebbie Prisiliya Lumentut , Nancy C. Pelealu, "Evaluasi Penyimpanan dan Pendistribusian Vaksin dari Dinas Kesehatan Kota Manado Ke Puskesmas Tuminting, Puskemas Paniki Bawah dan Puskesmas Wenang," PHARMACON: Jurnal Ilmiah Farmasi, vol. 4, no. 3, pp. 9–15, 2015.
26. N. Rahmah, P. S. Lasmini, and R. Rahmatini, "Hubungan Karakteristik dan Tingkat Pengetahuan Petugas Imunisasi terhadap Praktik Penyimpanan dan Transportasi Vaksin Imunisasi di Tingkat Puskesmas Kota Padang Tahun 2014," Jurnal Kesehatan Andalas, vol. 4, no. 3, pp. 917–924, 2015, doi: 10.25077/jka.v4i3.386.
27. F. Rahayu, "Faktor Yang Berhubungan Dengan Praktik Bidan Dalam Distribusi Dan Penyimpanan Vaksin DPT," Jurnal Berkala Epidemiologi, vol. 2, no. 2, pp. 240–250, 2014.
28. A. Joubert and M. Reid, "Knowledge, skills, and Training Community Health Workers Require to Contribute to an Interprofessional Learning Initiative," Int J Afr Nurs Sci, vol. 18, Jan. 2023, doi: 10.1016/j.ijans.2023.100531.
29. World Health Organization (WHO) 2021, Guidance for Establishing and Operating Immunization Supply Chains, WHO Press, Geneva. Available at: https://www.who.int (Accessed: 27 October 2024).
30. UNICEF Supply Division 2020, Vaccine Supply Chain Challenges: Global and National Perspectives, UNICEF, New York. Available at: https://www.unicef.org/supply (Accessed: 27 October 2024).