

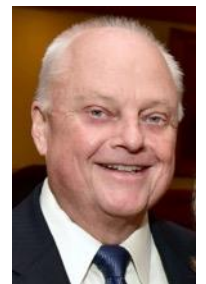
VVM BASED VACCINE MANAGEMENT



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THE BOOK OF VVM

Yesterday-today-and-tomorrow

When you look at a vaccine vial monitor, you have no idea of the complex chemistry used as it integrates time and temperature in a way that mimics how heat affects the vaccine in its container. And until you read Dr. Ümit Kartoglu's *The Book of VVM*, you probably have no knowledge of the scientists, physicians, manufacturers, and public health professionals who used their knowledge, skills, creativity, passion, and perseverance in bringing this amazing little invention to market. It is not an overstatement to say that the VVM – the small square in a circle – revolutionized vaccination programs around the world, preventing countless cases of disease and death.

With this book, Dr. Kartoglu adds historian to his list of credentials as a physician, scientist, author, illustrator, and educator.

Beyond the detailed history of VVM that Dr. Kartoglu tells is an example of what can happen when people with a shared dream come together and make that dream happen for the common good. That is a lesson that should inspire us all.

Dr. James Vesper, MPH, PhD
Director of Learning Solutions
Valsource



Extensio et Progressio

ISBN 978-2-9701347-0-1



NOT FOR SALE

THE BOOK OF VVM

ÜMIT H. KARTOĞLU



Ümit H. Kartoglu

THE BOOK OF VVM

Yesterday-today-and-tomorrow

Moreover, VVM renders immunization operations much more effective. It allows programmes to exploit the stability of each vaccine to the greatest possible extent, it minimizes distribution costs, and it increases flexibility in the handling of vaccines in the field. Immunization outreach increased, VVM helps to pinpoint cold chain problems and facilitates the efficient management of vaccine stocks. Countries adopting VVM-based vaccine management can now make informed decisions with the help of VVM readings. Although VVM was developed as a time and temperature integrator, it also made a significant contribution to the reduction of inadvertent vaccine freezing. VVM facilitated the extension of the vaccine freezing concept by removing the ice that is a common source of freeze damage. This helped health workers to better understand the heat stability of vaccines and accept the fact that freezing is a greater danger than mild heat exposure. Today, VVM continues to evolve to address emerging needs in immunization programmes. Incorporating a threshold indicator into VVMs (VVM+ or VVM-T) and integrating VVM into 2D barcodes are the most recent examples of this evolution. This simple, yet elegant tool, which has sold over eight billion units by 2018, has played a decisive role in saving millions of children's lives across the planet.

It is not an overstatement to say that VVM is one of the most important recent innovations in the area of public health, providing health workers with affordable and sustainable means of ensuring that the administered vaccine has not been rendered by heat. Without a VVM, the only reference available as point-of-use is the expiration date. But, if a vaccine has no expiry date, does this mean it is never safe to use? Vaccine expiry is a complex matter with exposure to heat. Before the development of the VVM, health workers had no means of identifying whether vaccines had suffered damage from heat exposure at any point during transportation and/or storage. Nowadays, the administration of safe life-saving vaccines is much less a matter of chance. With VVM health practitioners in the field can focus on providing an efficient care and treatment service without needing to be concerned about medicine validity.

<http://kartoglu.ch/vvm>

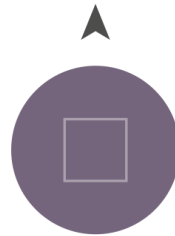
Vaccine Vial Monitors

USE

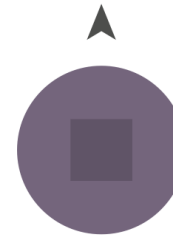
DO NOT USE



Square is lighter than outer circle



Square matches circle



Square is darker than circle

The color of the inner square of the VVMs begins with a shade that is lighter than the outer circle and continues to darken with time and/or exposure to heat.

DISCARD POINT

Once a vaccine has reached or exceeded the discard point, the colour of the inner square will be the same colour or darker than the outer circle.

Inform your supervisor

Cumulative heat exposure over time

There is no temperature monitoring device that has changed vaccine management practices as profoundly as VVM.

TËRHEQJA E VAKSINAVE DHE MATERIJAVE TË TËRABËNËSHME TË TËRABËNËSHME
RRETHIT PËR QENDREN SHËNDETËSORE: *NE-11*

VAKSINA/ MATERIALE	doza	SASIA flakon	copë	NR. LOTI	SHËNDESA	NUM
DTP-HepB-Hib	<i>120</i>	<i>120</i>	<i>✓</i>	285Y7022A	12.2019	1
PCV-10	<i>60</i>	<i>30</i>	<i>✓</i>	ASPNB089AA	04.2020	1
PCV-13	<i>80</i>	<i>80</i>	<i>✓</i>	X35433	12.2020	1
DTP	<i>20</i>	<i>2</i>	<i>✓</i>	0001717	10.2019	1
DTP (pentavalente)	<i>20</i>	<i>2</i>	<i>✓</i>	C2128	10.2020	1
DTP (trivalent)	<i>40</i>	<i>4</i>	<i>✓</i>	D2405	05.2020	1
MM	<i>120</i>	<i>120</i>	<i>✓</i>	365-1	10.2020	1
MM	<i>80</i>	<i>80</i>	<i>✓</i>	430-2-1	09.2022	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	ADPAA617AA	10.2019	2
MM	<i>15</i>	<i>15</i>	<i>✓</i>	1811300A	12.03.2021	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	AMUCR33AA	01.2020	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	1811300A	08.2021	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	AMUCR33AA	04.2020	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	1811300A	07.2020	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	AMUCR33AA	07.2020	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	1811300A	07.2020	1
MM	<i>15</i>	<i>15</i>	<i>✓</i>	AMUCR33AA	07.2020	1



Some critical approaches we have today in vaccine management have only been made possible with the help of VVM, and others have been made more effective.



PERTUSSIS VACCINE ADSORBED
DO NOT FREEZE
VVM14
B.NO.: 2828X006B
EXP.: JUN, 2020
LTD. 20012712/1
(01108901213051174)

WHO Policy Statement: Multi-dose Vial Policy (MDVP)

Revision 2014

HANDLING OF MULTI-DOSE VACCINE VIALS AFTER OPENING



- The vaccine is currently prequalified by WHO.
- The vaccine is approved for use for up to 28 days after opening the vial, as determined by WHO.
- The expiry date of the vaccine has not passed.
- The vaccine vial has been, and will continue to be, stored at WHO- or manufacturer recommended temperatures; furthermore, the vaccine vial monitor, if one is attached, is visible on the vaccine label and is not past its discard-point, and the vaccine has not been damaged by freezing.

THE VISUAL CUE



Proper handling of 2-dose vial Cervarix HPV Vaccine



Vaccine Vial Monitor (VVM) placed on cap

Proper handling of 2-dose vial Cervarix HPV Vaccine

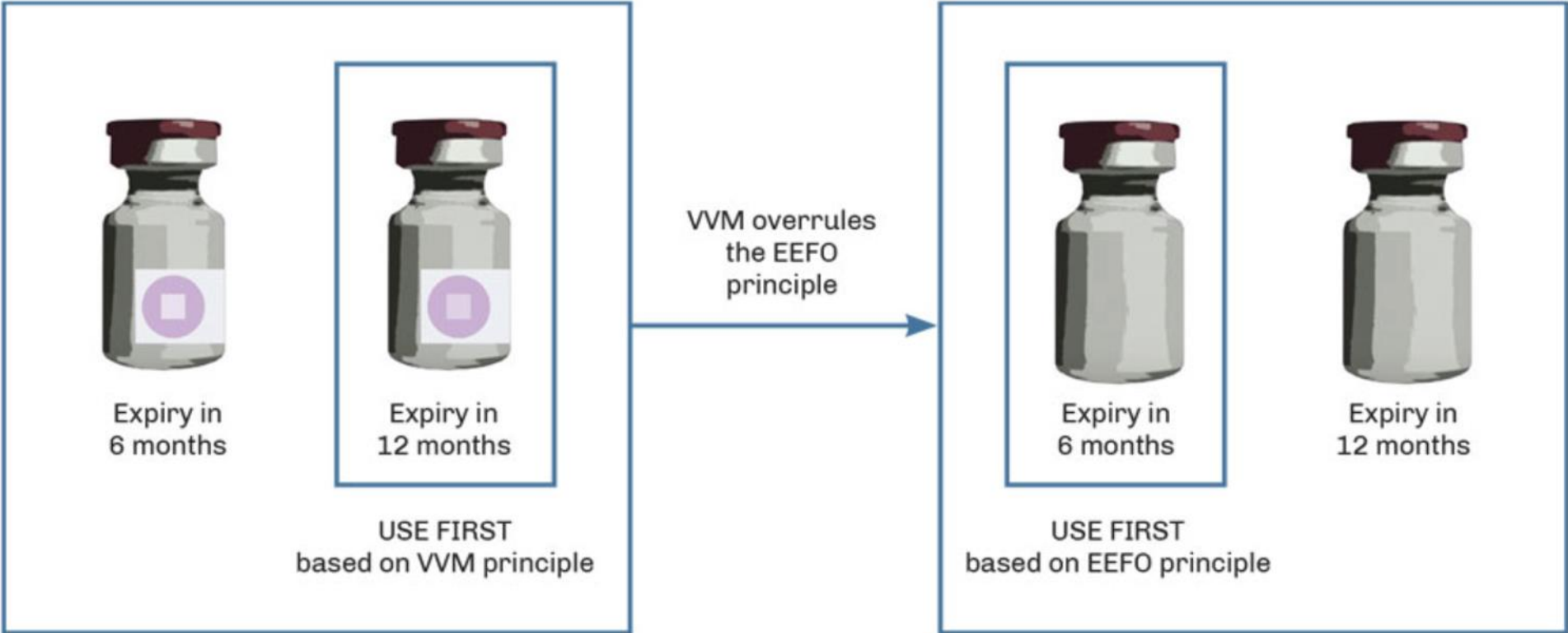
1. After opening, this vaccine vial should be handled in the same manner as a reconstituted BCG or measles vaccine vial.
2. Discard any unused dose at the end of the immunization session or six hours, whichever comes first.
3. During the session, put the open vials in the vaccine carrier, do not return them in the refrigerator.

- Shake before use
- Check the expiry date and the VVM before opening the vial
 - Store in the cold chain at +2°C to +8°C
 - Do not freeze, protect from light

SMART EXPIRY DATE



SMART EXPIRY DATE



ROTATING STOCKS WITH THE HELP OF VVM

Pershkrimi fl 1doze
 (Nr. i dozave per flakon apo lloji i shiringes)
 Data e skadences 11/2017
 Cmimi 343.28

Nr Lotit IPV851 B
 (Vaksine, hollues, shiringe, kuti sigurie)
 Prodhuesi Biological Holland
 Data e hyrjes ne ISHP/DSHP 01/09/2016

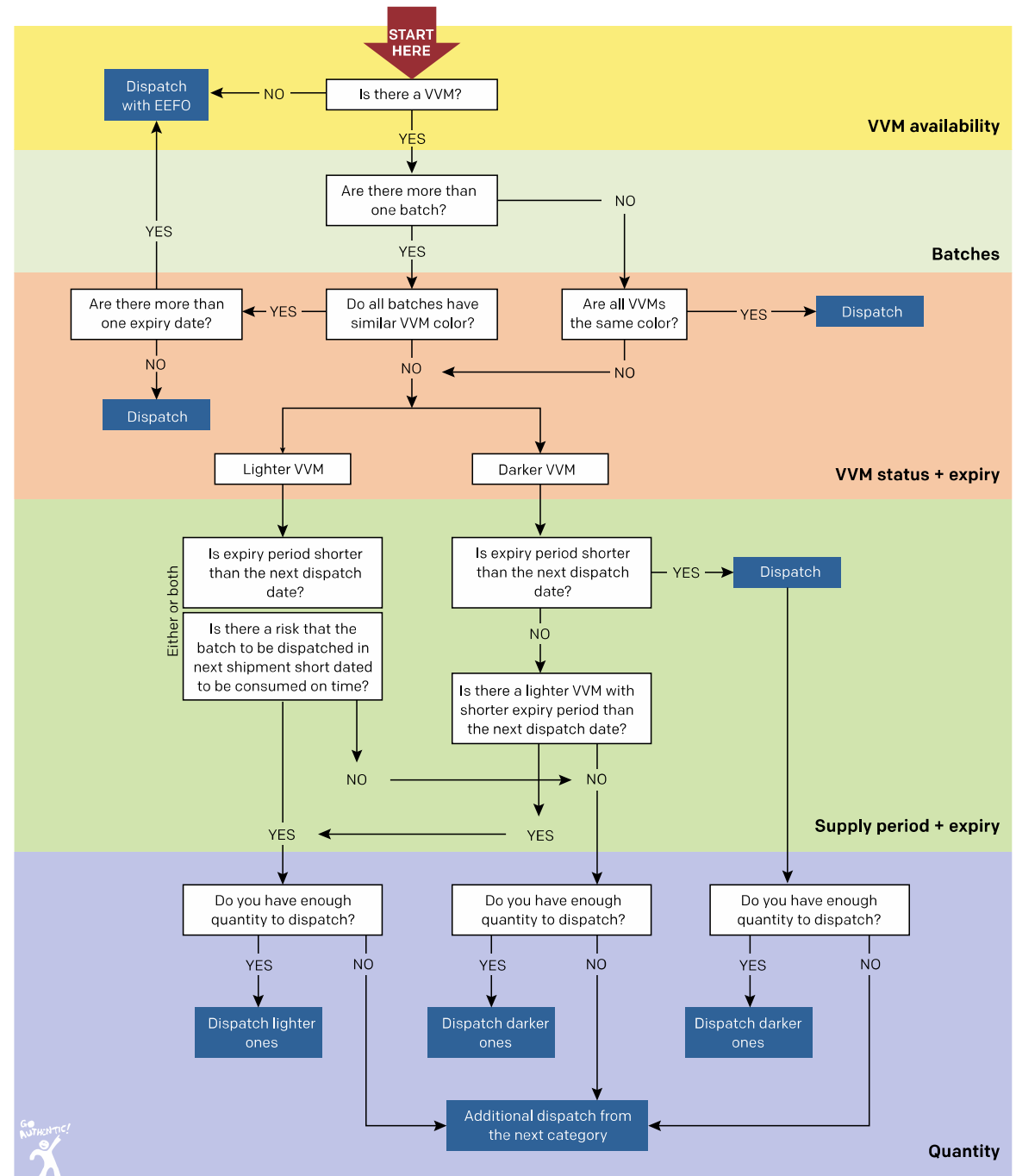
Emertimi Vaccin 1PV-1
 (Vaksine, hollues, shiringe, kuti sigurie)
 Pershkrimi fl 1doze
 (Nr. i dozave per flakon apo lloji i shiringes)
 Data e skadences 11/2017
 Cmimi 343.28

Data	Kujt i dergohet malli	Hyrje	Dalje	Mungesa/ Teprica	Gjendje	Indikatoret			Shenime
						FW	VVM	CCM	
10/3/017	DSHP Gjirokaste		125		18714		1		
03/017	-4- Delvise		40		18674		1		
03/017	-4- Sarande		200		18474		1		
03/017	-4- Lezhe		200		18274		1		
03/017	-4- SHKoder		300		17474		1		
03/017	-4- M. Maalke		50		17424		1		
03/017	-4- Lushje		550		16874		1		
03/017	-4- Fier		700		16174		1		
03/017	-4- Vlore		360		15814		1		
03/017	-4- Skrapes		60		15754		1		
03/017	-4- Berat		500		15254		1		
03/017	-4- Kucove		50		15204		1		
05/017	-4- Korce		360		14844		2		
05/017	-4- Dorell		24		14820		2		
05/017	-4- Kolonje		50		14770		2		
05/017	-4- Mat		280		14490		2		
05/017	-4- Bulqize		250		14240		2		
05/017	-4- Diber		400		13840		2		
06/017	-4- Kruje		200		13640		2		
06/017	-4- Ruzhica		260		13380		2		
06/017	-4- Durres		750		12630		2		
06/017	-4- Lushje		600		12030		2		
06/017	-4- Tjer		800		11230		2		
06/017	-4- Vlore		600		10630		2		
06/017	-4- Kavaje		300		10330		2		

[Handwritten signature]

Nr	Nr i fatures	Data	Kujt i dergohet malli	Hyrje	Dalje	Mungesa/ Teprica	Gjendje	Data
1	226	07/06/017	DSHP Has					
2	227	07/06/017	-4- Tropis		200		10130	
3	230	09/06/017	-4- Kavaje		50		10080	
4	231	09/06/017	-4- Pepin		300		9780	
5	232	09/06/017	-4- Gramez		160		9620	
6	236	12/06/017	-4- Gjirokaste		160		9460	
7	233		-4- Sarande		0		9460	
8	243		-4- M. Maalke		150		9310	
							9210	
20	259							
21	260	27/06/						
22	261	27/06/						
23	338							
24								

DISPATCHING VACCINES



KEEPING VACCINES IN ORDER

Arranging vaccines in front opening refrigerators

All vaccines must be segregated by type and each type must be kept in a tray to prevent vials from getting mixed up.

Vaccines that are already expired and with VVMs at or beyond the discard-point must not be kept in the refrigerator. They must be kept outside the cold chain with a clear marking "not for use" to obtain authorization to discard them.

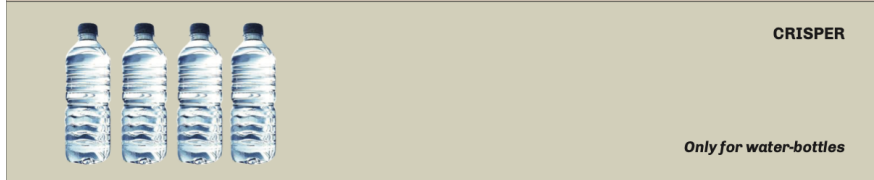
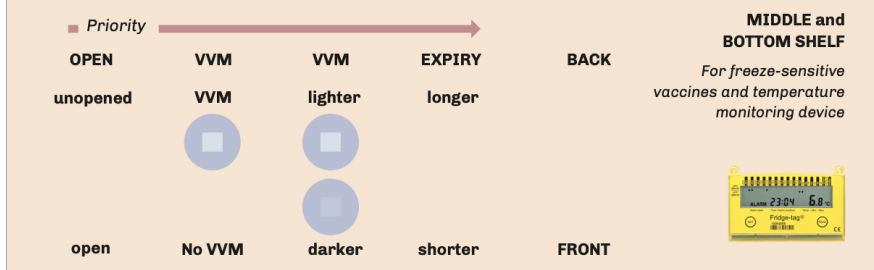
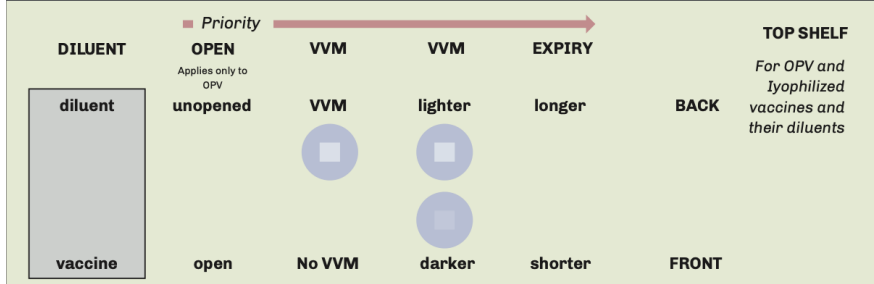
Only matching quantities of Iyophilized vaccines and diluents must be kept in the refrigerator.

Diluents are not interchangeable.



FREEZER

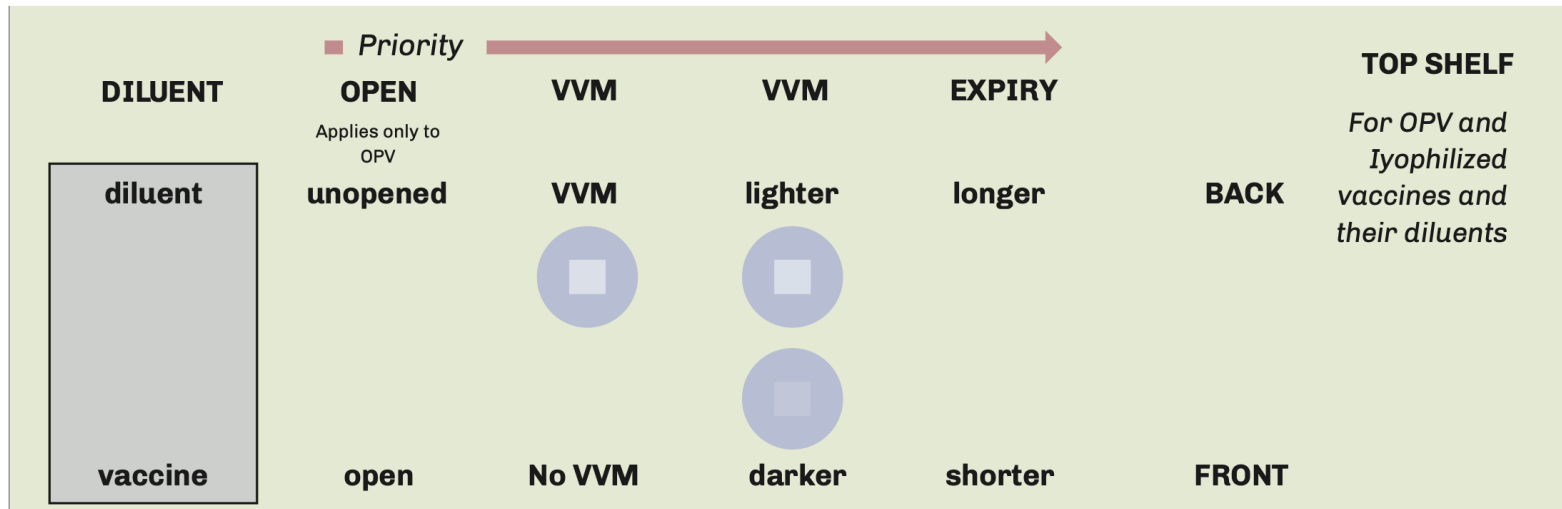
Only for water packs to produce ice



If you have any shelves in the door REMOVE them.

DOOR

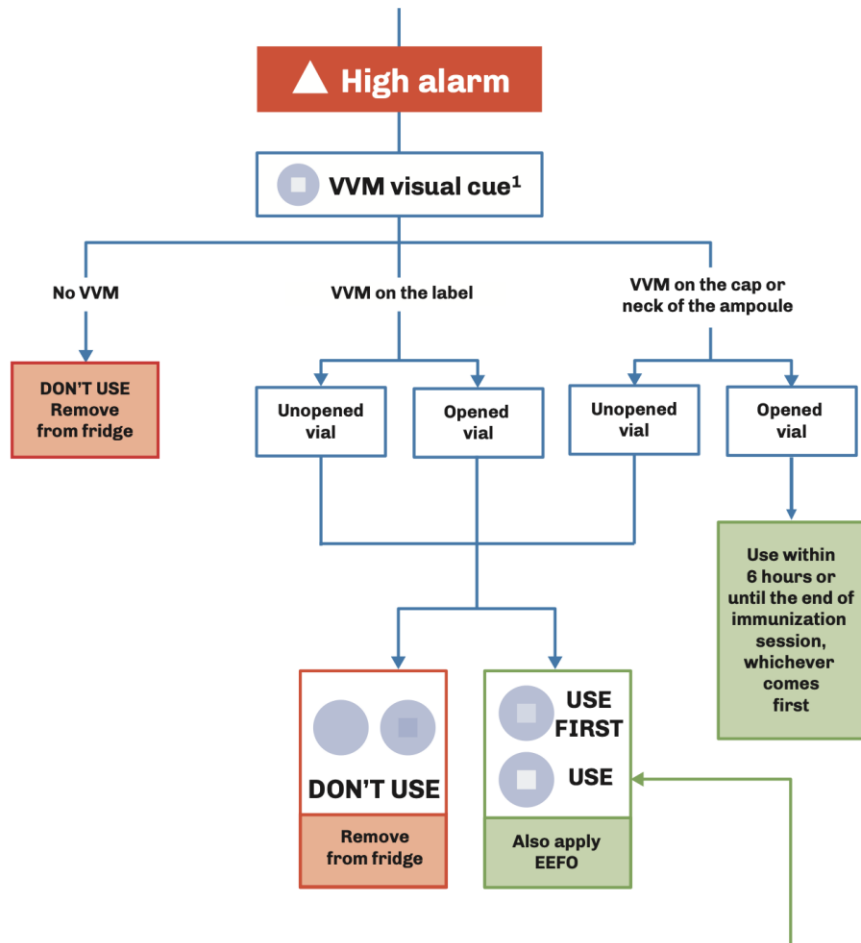
NOTHING



WHICH VIAL TO USE FIRST?

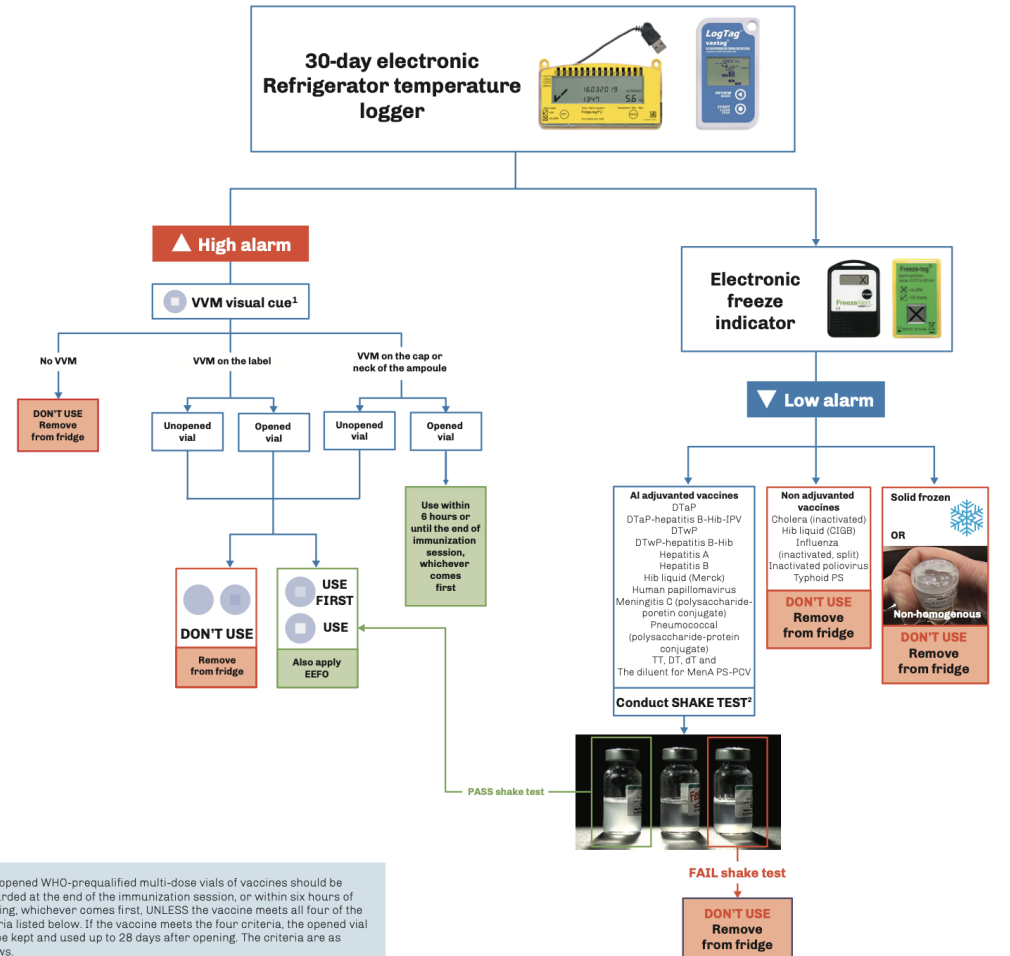


WHEN THERE IS AN ALARM



WHEN THERE IS AN ALARM

Interpretation of temperature monitoring devices



¹ All opened WHO-prequalified multi-dose vials of vaccines should be discarded at the end of the immunization session, or within six hours of opening, whichever comes first, UNLESS the vaccine meets all four of the criteria listed below. If the vaccine meets the four criteria, the opened vial can be kept and used up to 28 days after opening. The criteria are as follows:

- The vaccine is currently prequalified by WHO.
- The vaccine is approved for use for up to 28 days after opening the vial, as determined by WHO.
- The expiry date of the vaccine has not passed.
- The vaccine vial has been, and will continue to be, stored at WHO- or manufacturer recommended temperatures; furthermore, the vaccine vial monitor, if one is attached, is visible on the vaccine label and is not past its discard point, and the vaccine has not been damaged by freezing.

For multi-dose vial policy application and visual cue, refer to WHO Policy Statement: Multi-dose vial policy (MDVP). Handling of multi-dose vials after opening. Revision 2014. WHO/IVB/14.07

Also consult each individual vaccine product sheet at the WHO prequalification website, referencing the description "Handling of opened multi-dose vials"

<http://bit.ly/2zJEKwq>

² WHO SHAKE TEST PROTOCOL must be followed. For shake test protocol, refer to [When and how to conduct shake test](http://bit.ly/32C3Cx4), EVM-SOP-EB-01, effective 07 OCT 2011 at <http://bit.ly/32C3Cx4> and video [Step-by-step how to conduct shake test](http://bit.ly/2JPAVVC) at <http://bit.ly/2JPAVVC>

If only a few vials are available in the refrigerator, shake test may not be conducted, but all freeze suspected vials must then be taken out of the refrigerator for discard.

Do not conduct shake test for opened multi-dose vials, they must be discarded. However, if "same type of unopened vaccine vials" pass the shake test, you may keep the opened one to be used first.

For freeze-sensitive vaccines, check package insert whether it is aluminum adjuvanted.

DO NOT USE IF THERE IS NO LABEL.

REMOVING ICE FROM IN-COUNTRY TRANSPORT

RESEARCH

Use of Cool Water Packs To Prevent Freezing During Vaccine Transportation at the Country Level

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ABSTRACT: Objectives: To study the impact of the use of cool water packs (water packs refrigerated at 2 to 8 °C) on the cold life of vaccine transport boxes and the shelf life of the vaccines. **Methods:** Data loggers were used to measure the temperatures of vaccine shipments with cool water packs in laboratory studies and country evaluations. The temperature recordings were mathematically translated into reduction of vaccines shelf life, which are illustrated through degrees of color changes of Vaccine Vial Monitors. **Findings:** Laboratory studies at extreme ambient temperatures (43 °C) showed that, with the use of cool water packs, temperatures inside the cold box rise to around 20 °C within 48 h. When this exposure scenario was repeated four times, the impact of the temperature history on the different heat stability categories of vaccines varied between 2.4 and 36.0% shelf life loss. Oral polio vaccine was found to be the most affected vaccine. All other vaccines were affected with 2.4 to 10.4% life loss. Country assessments (real life situation with temperature variations between day and night) showed between 0.4% to 4.6% life loss when the boxes were exposed to ambient temperatures ranging from 11.7 to 39.8 °C over the 98 h 15 min test period. **Conclusions:** The use of cool water packs is found to be a legitimate and safe practice for vaccines other than oral polio vaccine, so that cool water packs can safely replace frozen icepacks without any serious consequences on the ability of vaccines to confer protection against disease.

KEYWORDS: Cool water packs, Freezing, Transportation, Vaccines, VVM, Nepal, Myanmar, Turkey, Zimbabwe.

Introduction

World Health Organization (WHO) guidelines recommend that liquid formulations of vaccines containing diphtheria, pertussis, tetanus, hepatitis B, *Haemophilus influenzae* type b and their combinations should not be frozen (1). Freezing of these vaccines provokes a loss of potency and, as a consequence, can result in compromised protective immunogenicity in recipients (2–5).

Freezing of vaccines occurs when vials are exposed to temperatures below 0 °C either during storage or transport depending upon a host of factors, including

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the duration that vaccine is exposed and whether the vaccine is agitated during that time period. Studies have shown exposure of vaccines to both subzero and freezing temperatures at all levels of the cold chain. Practices that put freeze-sensitive vaccines at risk are common not only in the developing world, but also in industrialized countries. Studies have shown freeze damage to vaccines in Australia (6, 7), Bolivia (8), Canada (9), Hungary (10), Indonesia (11), Malaysia (12), Papua New Guinea (13), the United Kingdom (14–17), and the United States (18).

The severity of the problem has been highlighted in a recent publication in which, of 14 shipments that were monitored, 12 experienced temperatures below 0 °C at one or more points in the cold chain in Indonesia (11). Ten of those were exposed to temperatures below 0 °C during district or sub-district transport in cold boxes.

TABLE II
Temperature Recordings of RCW25/CF and RCW2/CF During 48 Hours Exposure to 43°C and 32°C Ambient Temperatures at CSIR (in °C)

Box type	Ambient temperature	Initial water packs temperature	Temperature of the cold box/vaccine carrier ^a			VVM readings at the end of the test ^b			
			Average	Min	Max	VVM2	VVM7	VVM14	VVM30
Large RCW25/CF	43.0 ± 0.5	2 ± 0.5	11.5	2.5	20.0	☐	☐	☐	☐
	43.0 ± 0.5	8 ± 0.5	16.3	8.2	23.6	☐	☐	☐	☐
	43.0 ± 0.5	No packs	33.5	11.6	41.5	☐	☐	☐	☐
	32.0 ± 0.5	2 ± 0.5	10.5	5.0	16.1	☐	☐	☐	☐
	32.0 ± 0.5	8 ± 0.5	14.5	8.2	19.2	☐	☐	☐	☐
Small RCW2/CF	43.0 ± 0.5	2 ± 0.5	34.1	3.1	42.7	☐	☐	☐	☐
	43.0 ± 0.5	8 ± 0.5	35.1	9.1	42.2	☐	☐	☐	☐
	43.0 ± 0.5	No packs	40.9	14.1	43.2	☐	☐	☐	☐
	32.0 ± 0.5	2 ± 0.5	25.8	4.2	31.3	☐	☐	☐	☐
	32.0±0.5	8 ± 0.5	27.4	10.8	31.7	☐	☐	☐	☐

TABLE III
Remaining VVM Life After Storage in Large Cold Box and Small Vaccine Carrier Loaded with 8°C Water Packs, at an Ambient Temperature of 43°C for 48 Hours, CSIR Laboratory

VVM Type	VVM End-Point (Days)	Percentage of VVM Life Used	Remaining VVM Life in Days if Kept at 37°C
RCW25/CF large cold box			
VVM2	1.75	6.3	1.64
VVM7	6.125	1.8	6.02
VVM14	12.25	0.9	12.14
VVM30	26.25	0.4	26.14
RCW2/CF small vaccine carrier			
VVM2	1.75	138.4	Beyond the end-point
VVM7	6.125	39.6	3.70
VVM14	12.25	19.8	9.83
VVM30	26.25	9.2	23.83

TABLE IX
Repeated Temperature Exposure Impact on the VVM Life Simulation (Four Times of Transport at Ambient Temperature of 43°C for 48 Hours)

VVM Type (and End-Point Days)	VVM Life Used (%)	Remaining VVM Life if Kept at 37°C (Days)
1. RCW25/CF (Domestic)		
VVM2 (1.75)	25.2	1.3
VVM7 (6.125)	7.2	5.7
VVM14 (12.25)	3.6	11.8
VVM30 (26.25)	1.6	25.8
2. CB20-50-CF (Blow Kings)		
VVM2 (1.75)	2.8	1.7
VVM7 (6.125)	0.8	6.1
VVM14 (12.25)	0.4	12.2
VVM30 (26.25)	0.4	26.1
3. Insulated Box (PT BioFarma)		
VVM2 (1.75)	36.0	1.1
VVM7 (6.125)	10.4	5.5
VVM14 (12.25)	5.2	11.6
VVM30 (26.25)	2.4	25.6

- Vaccines are transported four times (primary to intermediate 1, intermediate 1 to intermediate 2, intermediate 2 to intermediate 3, and intermediate 3 to health centre)
- Only cold water packs are used
- Ambient temperature is constant 43 °C day and night
- Each and every transport takes 48 h

a different type of VVM. However, in most cases, freeze sensitive vaccines such as DTP are assigned VVM14 and TT and HepB are assigned a VVM30.

Figure 5 shows the calculated highest impact on VVM readings in a scenario (number 3 in Table IX) in which the transport is repeated four times for 48 h at 43 °C

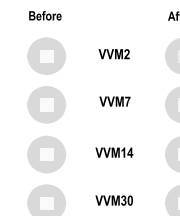


Figure 5

Temperature impact on VVM readings, insulated box.

Repeated temperature exposure is applied to used and remaining VVM life calculation through the Arrhenius equation. Results are shown in Table IX.

In spite of the low impact calculated when the Blow-Kings cold box is used, the VVM2 (OPV) loses 25% of its life with RCW25/CF and 36% of its life with the insulated box. It is therefore obvious that OPV should not be transported with cool water packs. VVMs are classified according to vaccine stability (see Box 1). VVM category to vaccines is assigned by WHO experts based on the stability data of the vaccine examined. It is possible that the same type of vaccines produced by different manufacturers will be assigned



CONTROLLED TEMPERATURE CHAIN: Strategic Roadmap for Priority Vaccines 2017-2020



CONTROLLED TEMPERATURE CHAIN USE OF VACCINES



- CTC use of vaccines allows for a single excursion of a vaccine into ambient temperatures not exceeding $+40^{\circ}\text{C}$ for a minimum of 3 days, just prior to administration.
- Heat-stable vaccines differ in the length of time they can be stored in a CTC and the maximum temperature they can endure while remaining stable and potent.
- CTC qualification involves regulatory approval and prequalification by WHO.
- CTC is a priority for vaccines used in campaigns and special strategies.

Status of CTC vaccines

- There are currently three vaccines that are thermostable and qualified for CTC use.
 - Serum Institute of India's MenAfriVac® (conjugate meningitis A vaccine) that can be used for up to **4 days** at temperatures not exceeding **40°C**.
 - Merck's Gardasil® 4 (quadrivalent human papillomavirus vaccine) that can be used for **3 days** at temperatures not exceeding **42°C**.
 - Shantha Biotechnics Shanchol™ (oral cholera vaccine) that can be used for **14 days** at temperatures not exceeding **40°C**.
- A number of vaccine manufacturers are in the process of qualifying their existing and pipeline liquid vaccines for CTC use.
- Some vaccines are inherently heat stable, others may require additional formulation efforts to improve their stability, and some vaccines may never qualify for CTC use.



TEMPERATURE MONITORING OF VACCINES IN A CTC

- Although a VVM changes color in response to cumulative heat exposure, its response is not rapid enough at higher temperatures (e.g., above 37°C).
- A threshold indicator (TI) is therefore also needed when vaccines are kept in a CTC. TIs react rapidly if exposed at or above a defined threshold temperature.

TEMPERATURE MONITORING OF VACCINES IN A CTC

- At present, a standalone TI is used in vaccine carriers and cold boxes.
- The TI is on a card and the indicator changes color from light grey to black as soon as the temperature has exceeded +40°C.
- The need to supply, distribute, and provide training on TI cards is a barrier to CTC vaccine introduction.



PEAK TEMPERATURE THRESHOLD INDICATOR



INSTRUCTIONS

Check the indicator as follows:

- When you load the vaccines into the cold box
- As you remove each vial from the cold box
- When the last dose of vaccine for the day is administered



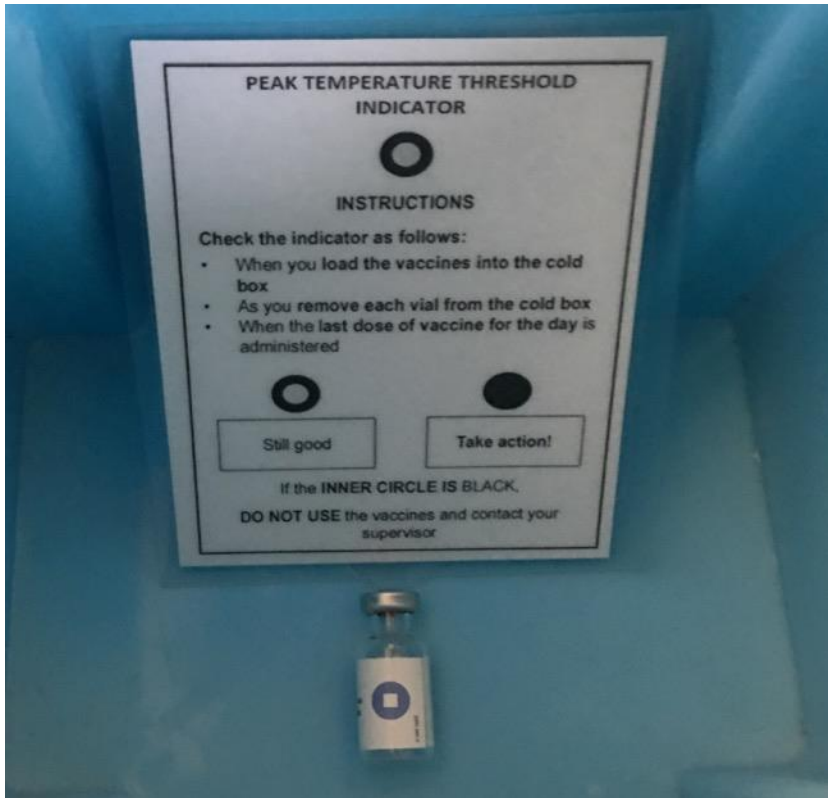
Still good



Take action!

If the **INNER CIRCLE IS BLACK**,
DO NOT USE the vaccines and contact your supervisor

VVM with THRESHOLD INDICATOR



A combined VVM-TI on primary containers undergoes gradual color change up to the specified threshold temperature and rapidly reacts if exposed at or above the threshold temperature.

Integrates the VVM and TI

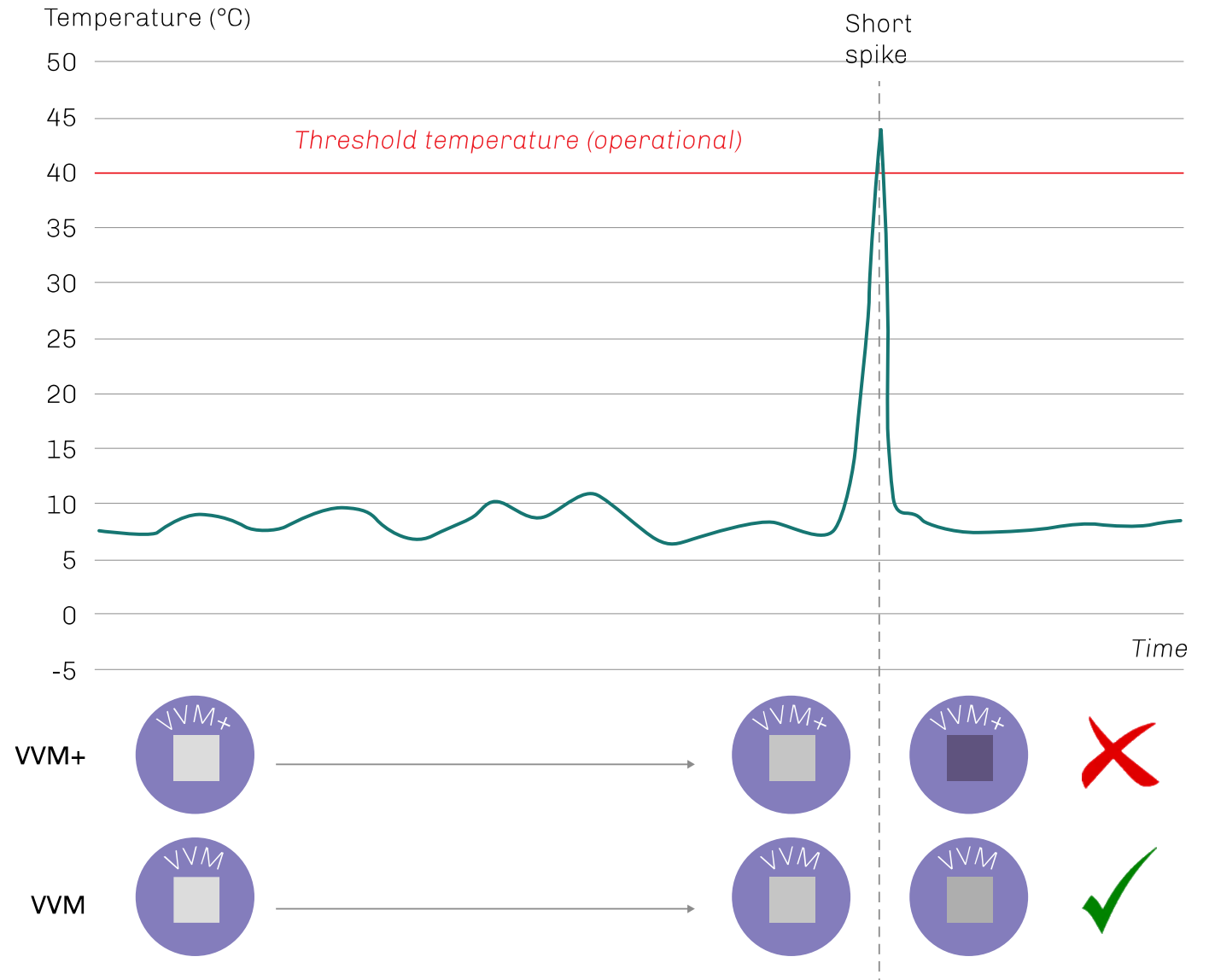


VVM Plus Threshold Indicator - VVM+[®]



VVM+ developed for Controlled Temperature Chain(CTC)

- VVM+ reacts like VVM up to 37°C
- At 40°C VVM+ reaches end point rapidly to show exposure to critical peak temperature
- VVM+ supports CTC initiatives



WHO PQS specification for COMBINED VVM and TI

VVM+250, VVM250 and TI Prequalified



PQS performance specification

WHO/PQS/E006/IN06.1
Original: English
Distribution: General

TITLE: Combined Vaccine Vial Monitor and Threshold Indicator

Specification reference: E006/IN06.1
Product verification: E006/IN06-VP.01
Issue date: January 2019
Date of last revision: New specification

The screenshot shows the WHO website interface. At the top, there is a navigation bar with the WHO logo and the text "World Health Organization". To the right of the logo, there are language options: عربي, 中文, English, Français, Русский, and Español. Below the navigation bar is a search box with a "Search" button. The main content area is divided into a left sidebar with navigation links: Home, About WHO, Countries, Health topics, and Publications. The "Product List" link is highlighted in orange. The main content area displays the breadcrumb path: "PQS Catalogue > Prequalified Devices and Equipment > Product List". Below this, the title "E006: Temperature monitoring devices" is shown. A table with the following columns is displayed: Product, Description, Company, and Mfr reference. Each row in the table includes a "Download PDF" button and a "Copy link" button.

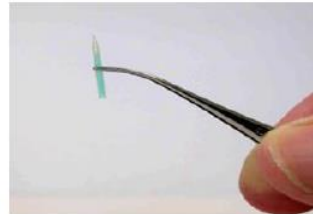
Product	Description	Company	Mfr reference		
E006/058	Vaccine Vial Monitor Type 250	Temptime Corporation	HEATmarker® VVM 250	Download PDF	Copy link
E006/057	Threshold Indicator40	Temptime Corporation	LIMITmarker I-K	Download PDF	Copy link
E006/059	Combined VVM250 and Threshold Indicator40	Temptime Corporation	HEATmarker® VVM+250	Download PDF	Copy link

VVM+ shortlisted on VACCINE INNOVATION PRIORITIZATION STRATEGY (VIPS)

Under Phase I, 9 innovations have been short-listed



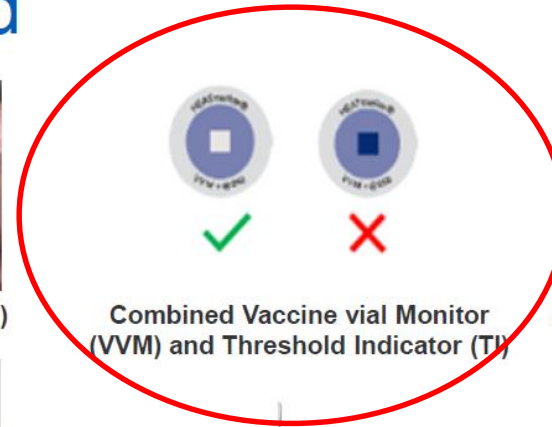
Microarray patches (MAPs)



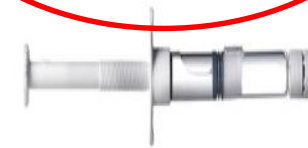
Solid-dose implants



Heat stable/controlled temperature chain (CTC) qualified liquid formulations



Combined Vaccine vial Monitor (VVM) and Threshold Indicator (TI)



Dual-chamber delivery devices



Compact prefilled auto-disable devices (CPADs)



AD sharps-injury protection (SIP) syringes



Freeze damage resistant liquid formulations



Barcodes / Radio Frequency Identification (RFID)

BARCODES



Gavi announced GS1 barcodes required on secondary packaging

**Tenders
after**



https://www.unicef.org/supply/index_103734.html

- **First step to transition track and trace system technology on vaccines to a labelling requirement**

GAVI announcement: vaccine manufacturer GS1 compliance

Starting 1st October 2019, for vaccine tenders backed by Gavi financing and issued by UNICEF, GS1 barcoding on the secondary packaging will be a requirement by latest 31st December 2021.

- **WHO is developing a Track and Trace Policy Brief**



US CDC 2D barcode update

>80% compliance of 2D barcodes on vials and prefilled syringes

“These Bad Boys are a Game-Changer” Scaling 2D Vaccine Barcode Scanning

AIRA 2018 National Meeting
August 16, 2018

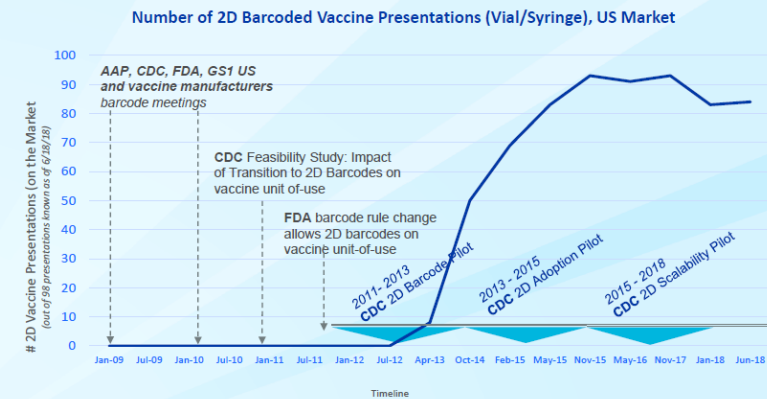
Ken Gerlach, MPH
Immunization Services Division, CDC

Immunization Services Division
National Center for Immunization & Respiratory Diseases



1

2D Barcoded Vaccines Timeline

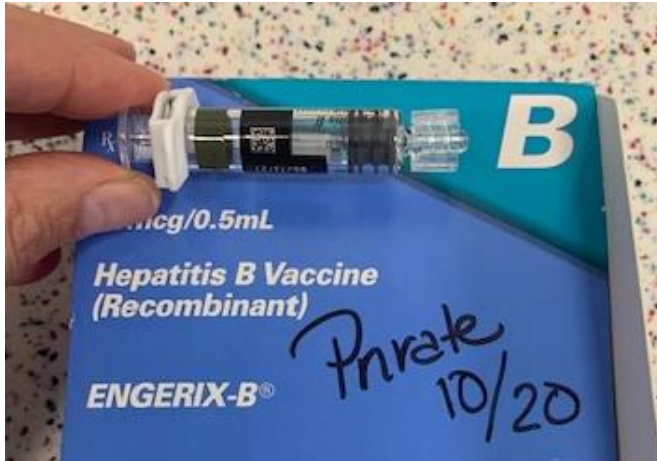


5

US CDC 2D barcode update

Essentially all US vaccine vials and syringes have 2D barcodes

GSK Hep B



Pfizer – Pneumo



Merck – Gardasil



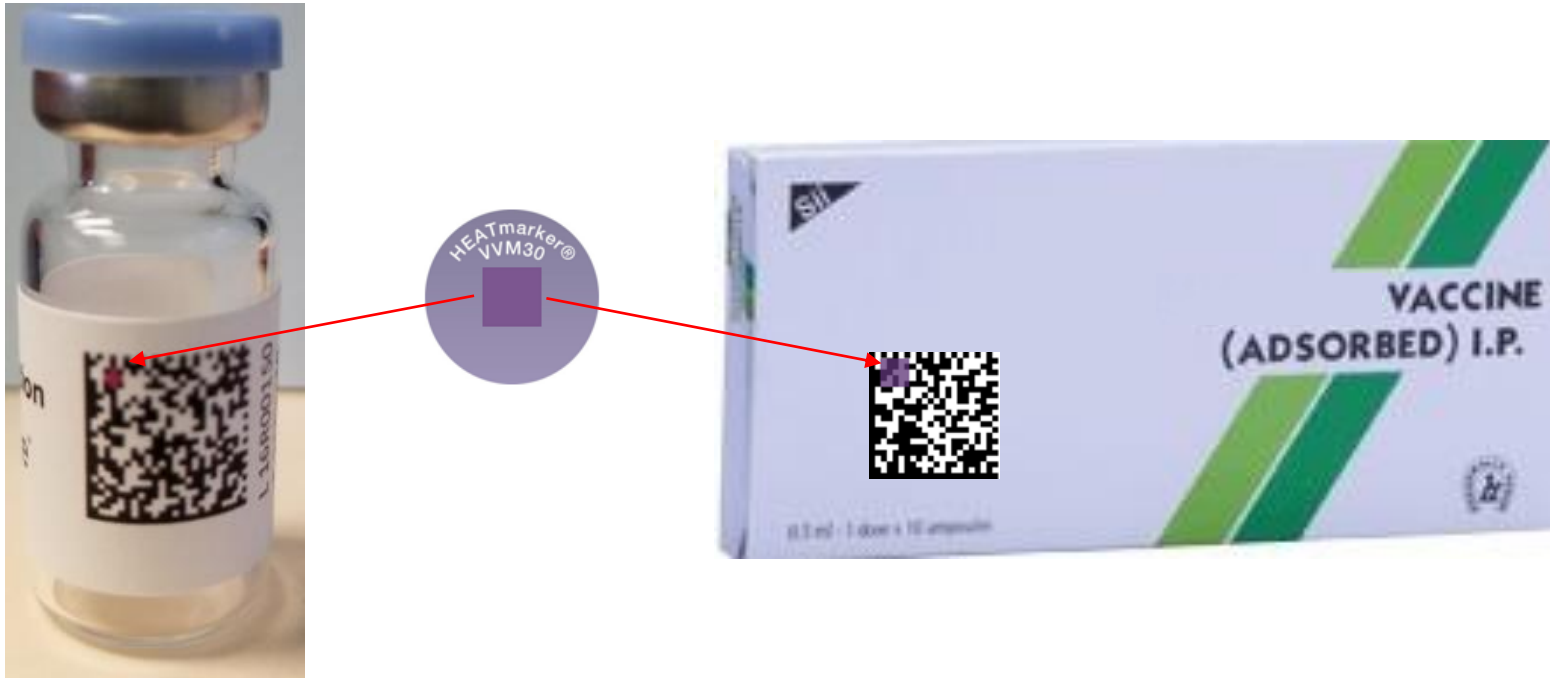
Sanofi - Tdap



GTIN, lot number, expiry date

Transformational innovation

2D barcode and digitized VVM (eVVM)

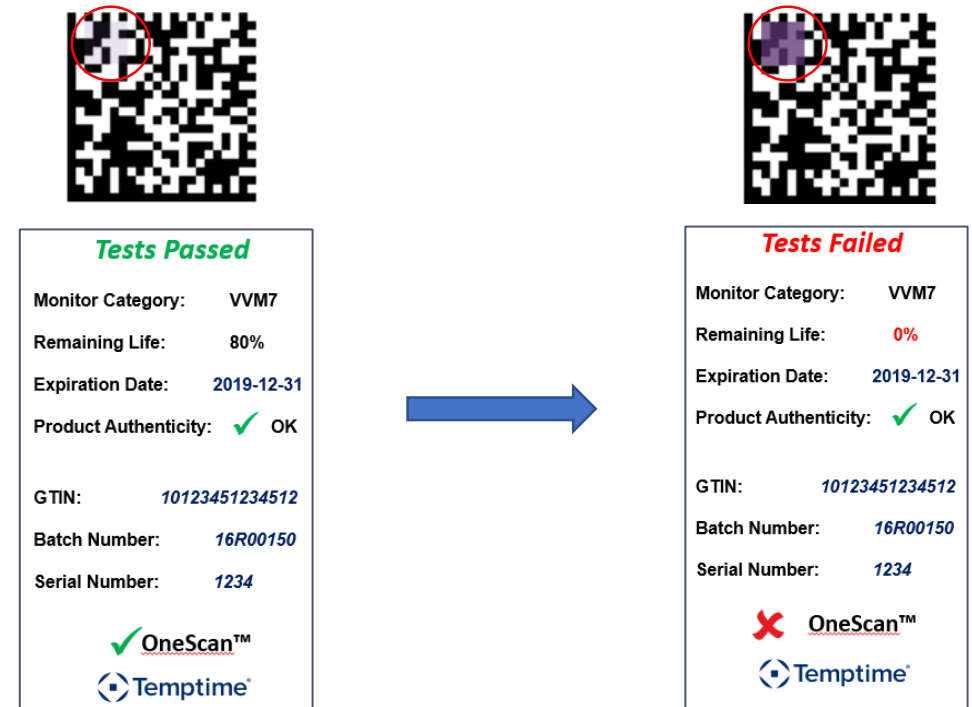


2D barcode with embedded temperature sensor

Digitize chemical indicators with unit of sale level data connection

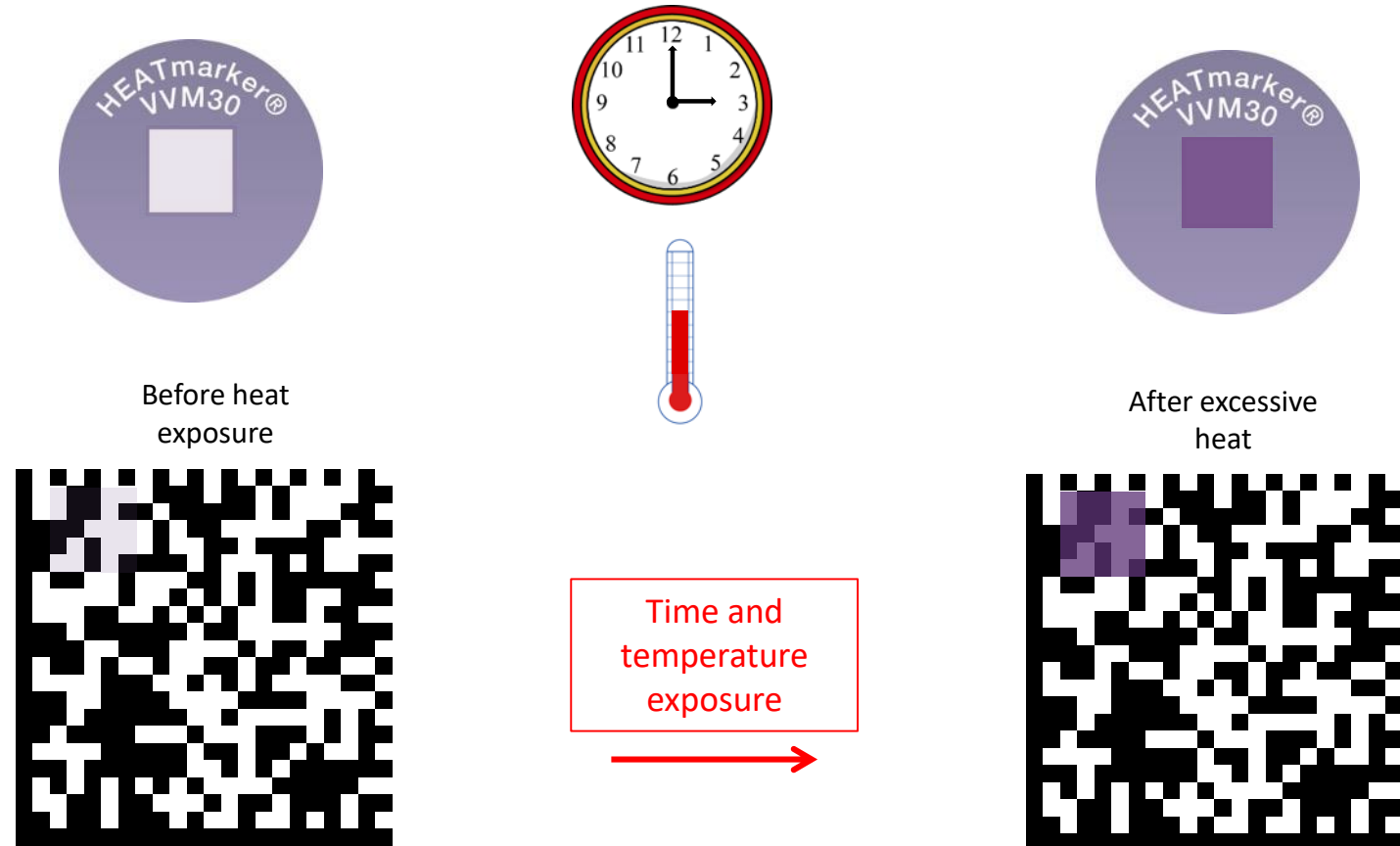
Enhance the value of 2D barcodes for stock management, patient safety and anti-counterfeiting by incorporating temperature integrity

- Specific area has cumulative (VVM) and/or threshold ink printed as part of barcode
- Rapid reading with phone or scanner
- Connect with cloud-based data set of other sensors

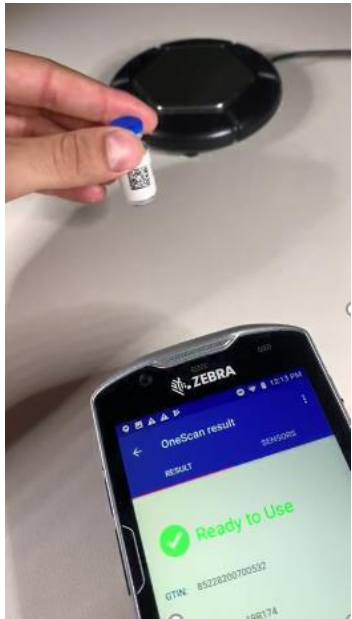


GS1 2D datamatrix with VVM

VVM – gradual, irreversible color change from light to dark develops with cumulative temperature exposure over time



Demo of OneScan™ indicator



Before Heat

Hot Plate



After Heat

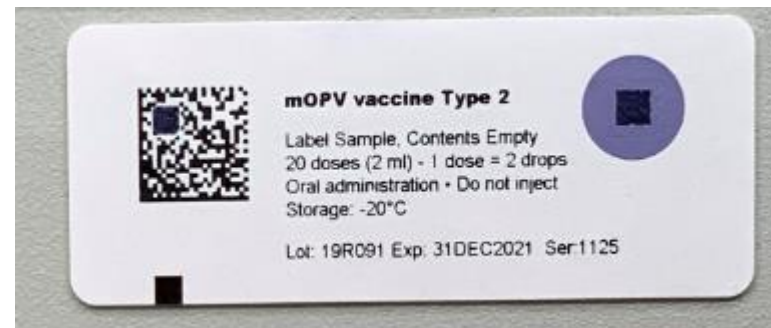


2D barcode with embedded VVM active

Color evolution over time

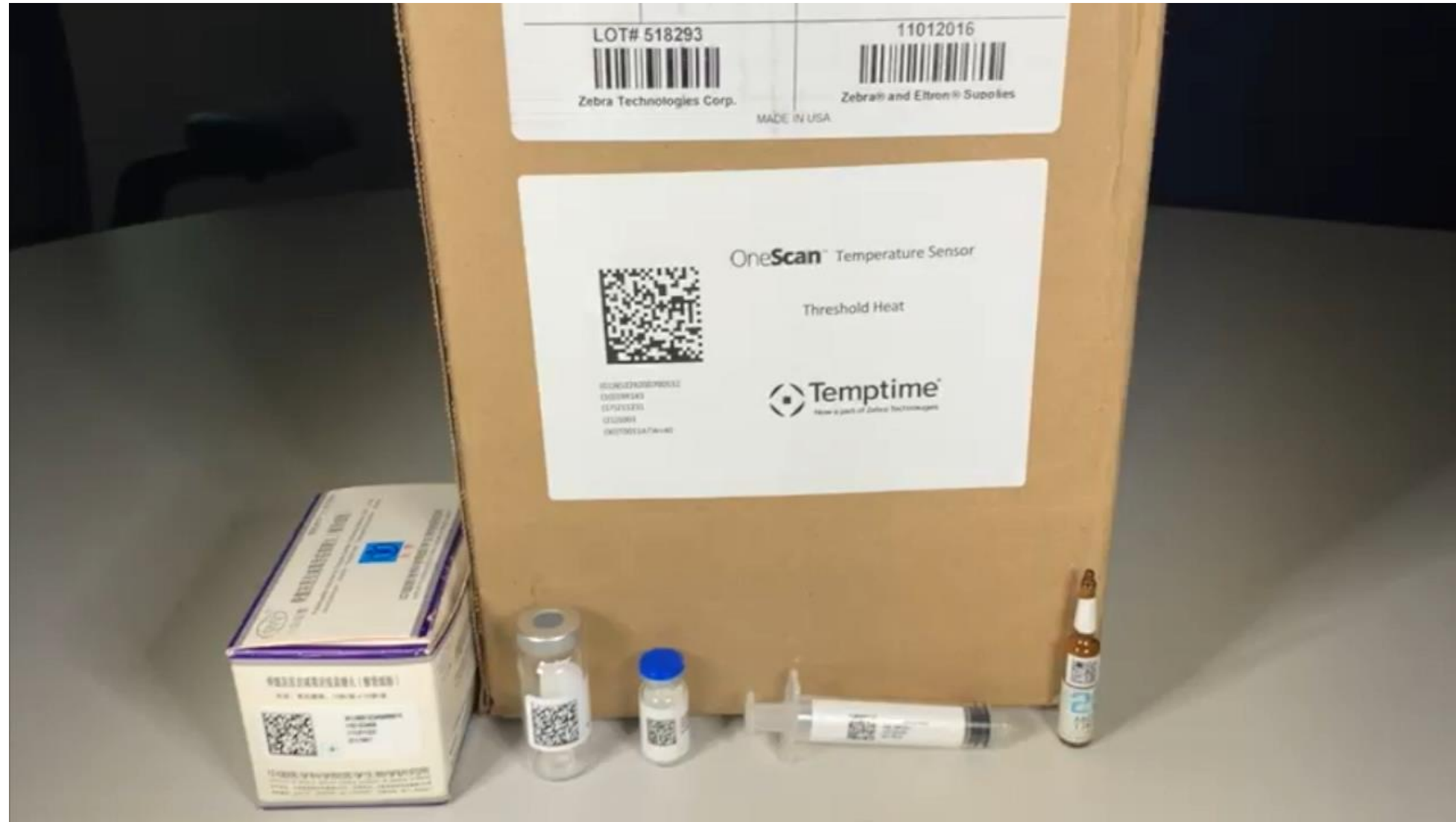


Early adoption would likely maintain classic VVM



Size doesn't matter for product integrity

Temperature monitoring and traceability for shipping box, carton box, vial, syringe, ampoule



Leverage value of VVM with linkage to HMIS





Thank you...